ESIA

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

of the Proposed

SPECIAL AGRO-PROCESSING ZONE (SAPZ II) – AGRICULTURAL INDUSTRIAL HUB PROJECT

at

(HAIPANG COMMUNITY) BARKIN-LADI LGA, PLATEAU STATE

By

PLATEAU STATE GOVERNMENT

DRAFT REPORT **MAY 2024**

Bolben Energy and Environmental Services Limited
B214, Zitel Plaza, Jabi Abuja
ceo@bolben.org
Draft Report, May 2024

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

OF THE PROPOSED

AGRICULTUTAL INDUSTRIAL HUB (AIH)
BARKIN LADI LGA / SAPZ II

Report No.: PSG/SAPZ II-AIH/30052024/002

Client: **PLATEAU STATE GOVERNMENT**

Date of Report: **MAY 2024**

Project Consultant: **BOLBEN ENERGY AND ENVIRONMENTAL SERVICES LIMITED**

Bolben Quality Assurance:

	Name	Function	Signature	Date
Reviewed & approved by	Mariam Mopelola .M	QA/QC Expert		30/05/2024
Compiled by	Divine Okafor	Chief Operating Officer		30/05/2024
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Bolben Energy and Environmental Services Limited
B214, Zitel Plaza, Jabi Abuja
ceo@bolben.org

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LIST OF ACRONYMS AND ABBREVIATIONS

AC - Aggregation Centre

ACMV - Air Conditioning and Mechanical Ventilation

AfDB - African Development Bank

AIH - Agricultural Industrial Hub

ASTM - American Society for Testing and Materials

ATC - Agricultural Transformation Centre

BAT - Best Available Techniques

CAFÉ - Corporate Average Fuel Economy

CBOs - Community Based Organizations

CDC - Community Development Committee

CFU - Colony Forming Unit

CLO - Community Liaison Officer

CO - Carbon Monoxide

CO_2 - Carbo dioxide

CR - Community Relations

CSR - Corporate Social Responsibility

dBA - Decibel

DDT - Dichloro-Diphenyl-Trichloroethane

E&S - Environmental and Social Standards

EA - Environmental Assessment

EC - European Community

EHS - Environmental, Health, and Safety

EIA - Environmental Impact Assessment

EMP - Environmental Management Plan

EMS - Environmental Management System

EPA - Environmental Protection Agency

EPR - Extended Producer Responsibility

ESAP - Environmental and Social Assessment Procedures

ESMP - Environmental & Social Management Plan

ESMS - Environmental and Social Management System

ESSP - Earth System Science Partnership

ETP - Effluent Treatment Plant

F&G - Fire and Gas

FAOSTAT - Food and Agriculture Organization Corporate Statistical Database

FBOs - Faith Based Organizations

FEPA - Federal Environmental Protection Agency

FGD - Focus Group discussion

FGN - Federal Government of Nigeria

FMAFS - Federal Ministry of Agriculture and Food Security

FMARD - Federal Ministry of Agriculture and Rural Development

FMEnv - Federal Ministry of Environment

FRSC - Federal Road safety Corps

GBV - Gender Based Violence

GHGs - Green House Gases

GIS - Geographic Information System

GRC - Grievance Redress Committee

GRM - Grievance Resolution Mechanism

H_2S - Hydrogen Sulfide

HA - Hectare

HAZMAT - Hazardous Materials

HBC - Heterotopic Bacteria Count

HBP - High Blood Pressure

HFC - Heterotopic Fungi Count

HIV/AIDS - Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
HSE - Health, Safety and Environment
HSEQ - Health, Safety, Environment and Quality
HSSE - Health, Safety, Security, and Environment
HUBC - Hydrocarbon Utilizing Bacteria Count
HUFC - Hydrocarbon Utilizing Fungi Count
HVAC - Heating, ventilation, and Air Conditioning
IEC - International Electric Codes
IESIA - Integrated Environmental and Social Impact Assessment
IFAD - International Funds for Agricultural Development
IFC - International Finance Corporation
IFCS - Intergovernmental Forum on Chemical Safety
ILO - International Labour Organisation
ILO - International Labour Organization
IMM - Impact Mitigation and Compliance Monitoring
IoT - Internet of Things
IPCS - International Programme on Chemical Safety
IR - Infrared
IRM - Independent Review Mechanism
IsDB - Islamic Development Bank
ISS - Integrated Safeguards System
KIIs - Key Informant Interviews
Km - Kilometer
L&FS - Life and Fire Safety
LCA - Life Cycle Analysis
LEMP - Local and Employment Management Plan
Leq - Equivalent Continuous Sound Level

LEV - Local Exhaust Ventilation

LEV - Local Exhaust Ventilation

LFN - Laws of the Federation of Nigeria

LGA - Local Government Area

LGs - Local Governments

LTI - Lost Time Injuries

M - Meter

MDAs - Federal Ministries, Departments and Agencies

MSDS - Material Safety Data Sheet

MSMEs - Micro, Small and Medium-Sized Enterprises

MT - Metric Ton

MT/ha - Metric Ton/Hectare

MW - Mega Watt

NAERLS - National Agriculture Extension and Research Liaison Services

NAFDAC - National Agency for Food and Drug Administration and Control

NDCs - Nationally Determined Contributions

NEC - National Electric Codes

NEDEP - National Enterprise Development Programme

NEMA - National Emergency Management Agency

NESREA - National Environmental Standards and Regulatory Enforcement Agency

NGOs - Non-Governmental Organizations

NIRP - Nigerian Industrial Revolution Plan

NIRSAL - Nigerian Incentive-based Risk Sharing for Agricultural Lending

NMA - Nigerian Maritime Administration

NOX - Nitrogen oxides

NPSWM - National Pricing strategy for Waste Management

NPSWM - National Pricing strategy for Waste Management

NSDWQ - Nigeria Standard for Drinking Water Quality

NURTW - National Union of Road Transport Workers

OECD - Organization for Economic Co-operation and Development

OHS - Occupational Health and Safety

OHSP - Occupational Health and Safety Plan

OSs - Operational Safeguards

PDO - Project Development Objective

PDR - Post Decommissioning Report

PEBEC - Presidential Enabling Business Environment Council

PEPSA - Plateau Environmental Protection and sanitation Agency

PLCS - Programmable logic controllers

PLSG - Plateau State Government

PM - Particulate Matter

POPs - Persistent Organic Pollutants

PPE - Personal Protective Equipment

PtW - Permit to Work

PWD - People with physical Disabilities

QA/QC - Quality Assurance / Quality Control

SAPZ - Special Agro-industrial Processing Zone

SCPZ - Staple Crop Processing Zone

SDGs - Sustainable Development Goals

SEA - Sexual Exploitation and Abuse

SECAP - Social, Environmental and Climate Assessment Procedures

SEIA - Socio-economic Impact Assessment

SMEs - Small and Medium Enterprises

SON - Standard Organization of Nigeria

SoW - Scope of Work

SOX - Sulfur oxides

SSO - Social Safeguard Officer

STDs/STIs - Sexual Transmitted Diseases / Sexual Transmitted Infections

STP - Sewage Treatment Plant

SWM - Solid Waste Management

TA - Technical Assistance

TDS - Total Dissolved Solids

THC - Total Hydrocarbon Content

ToR - Terms of Reference

UNCED - United Nations Conference on the Environment and Development

UNEP - United Nations Environment Programme

UNFCCC - United Nations Framework Convention on Climate Change

USD - United State Dollars

UV - Ultraviolet

WCN - Waste Consignment Note

WEEE - Waste for Electrical and Electronic Equipment's

WHO - World Health Organization

WMP - Waste Management Plan

WMS - Waste Management System

WTO - World Trade Organization

LIST OF ESIA PREPARERS

S/n	Resource Person	Qualifications	Position Assigned	Years of Experience
1	Mariam Mopelola M.	MSc.	Environmental Management Specialist/Project Manager	10 Years
2	Prof. Ezwkiel Yonnana	Ph.D.	Geomorphology and Hydrologist	20 Years
3	Clement kelvin D.	Ph.D.	Communication and Stakeholders Engagement Expert	25 Years
4	Suleiman Abdulkadir	MSc.	GIS Expert	18 Years
5	Sadia Edna Okoh	Ph.D.	Ecological Expert	10 Years
6	Nurudeen Onomhoale A.	Ph.D.	Environmental Biochemist/Climatologist	10 Years
7	Kpalo Okoh	Ph.D.	Waste Management Expert	8 Years
8	Moyosore Abdulmujeeb	BSc.	Field Assistant I	3 Years
9	Taiwo Mariam	BSc.	Field Assistant II	4 Years

EXECUTIVE SUMMARY

ES 1.1 Introduction

The Government of the Federal Republic of Nigeria through the Federal Ministry of Agriculture and Food Security with assistance from the African Development Bank (AfDB), Islamic Development Bank (IsDB) as well as International Funds for Agricultural Development (IFAD) seeks to increase value addition to some staple agricultural products in Nigeria through the introduction of Special Agro-Industrial Processing Zones (SAPZ) Programme.

The Special Agro-industrial Processing Zones (SAPZ) is a major investment program of the Federal Government of Nigeria (FGN), driven by the Federal Ministry of Agriculture and Food Security (FMAFS) in collaboration with the State Governments, Development partners, relevant Federal Ministries, Departments and Agencies (MDAs) and private investors to develop agro-processing clusters in areas of high agricultural production across the country. It is a strategic move to rapidly develop modern agro-processing capacity to serve the vast and growing local market, create sustainable market for farmers and reduce postharvest losses of local agricultural produce and thereby create wealth for farmers, promote import substitution and create sustainable agriculture related jobs for women and youth.

This approach is to help address investment challenges in the development of agro-processing enclaves across Nigeria, including poor access to quality infrastructure, inadequate feedstock supplies and other challenges confronting agro-processing environment. SAPZs, therefore, will be developed with requisite infrastructure like road, power, water for agro-processing environment which will help reduce cost absorptions and engender competitiveness in agro-industrial production that is critical to further unlocking the potentials of Nigeria's Agriculture to create ready markets and wealth for farming communities and reduce rural poverty.

The first Phase of Special Agro-Industrial Processing Zone (SAPZ) Program was implemented in seven (7) states, namely: Cross River, Imo, Kaduna, Kano, Kwara, Ogun, and Oyo, and the Federal Capital Territory (FCT).

The second phase of the SAPZ program (SAPZ II) has been receiving relevant attention at appropriate quarters. Expression of interests (EOIs) from about twenty-seven (27) states to participate in the second phase have been submitted to Federal Ministry of Agriculture and Food Security. Plateau State has shown interest and commitment to participate in this phase of the programme.

The SAPZ II will be made up of two major components which are the Agricultural Transformation Centers (ATCs) and the Agro-Industrial Hubs (AIHs) across all the participating states.

ES 1.3 The Proponent

Plateau State Government through the State Ministry of Agriculture and Rural Development is the proponent of the proposed project. However, as a result of the potential environmental and scio-economic effects that could result from the proposed project activities and in line with emerging global trends on the benefit of an environmentally sustainability as well as compliance with all relevant regulatory requirements, Plateau State Government has Commissioned **Messr Bolben Energy and Environmental Services Limited** to conduct the Environmental and Social Impact Assessment (ESIA) Studies for the Proposed Agro-Industrial Hub at Heipang, Plateau State.

ES 1.4 Project Location

The proposed site for the Agro-Industrial Hub (AIH) at Heipang is located between Latitudes 09°38′30″N and 09°40′00″N of the Equator, and longitudes 8°51′00″E and 8°53′30″E of the Prime Meridian. The site is located close to the airport and is adjacent to the Jos dry port and is well connected by road network. The land is generally flat and devoid of any perineal vegetation and has been used for agriculture. A land area of around 543.9 hectares has been identified at Heipang community, Barkin Ladi LGA for the development of an AIH. Out of the 543.9 hectares, an area of 100 hectares is being developed as an industrial zone and the remaining 443.9 hectares is being allocated for commercial cultivation of focus crops and seed multiplication.

ES 1.5 Project Objectives

The SAPZ II Program goal is to increase household income, foster job creation in rural agricultural communities and enhance food and nutritional security in Nigeria. The development objective is to support inclusive and sustainable agro-industrial development. The SAPZ Program interventions will seek to enhance the competitiveness of selected value chains which include Yam and Cassava. This will be achieved through increased productivity, aggregation and reliable supply of quality raw materials, value addition, market access and private sector investment.

ES 1.6 Objective of the EIA

The ESIA is aimed at assessing the potential impacts of proposed project activities on the physical, chemical, biological, health and social components of the project environment with the aim of proffering appropriate mitigation measures to reduce the potential project's adverse impacts and enhance the beneficial ones.

The specific objectives of this ESIA for the proposed Agricultural Transformation Center are to:

- provide specific details of the baseline characteristic of the environment of the proposed project;
- provide details of the proposed projects detailed operations and activities, their wastes streams, their planned disposal methods, and the built-in control measures;
- assess the impacts of the proposed project activities at the different phases (design, construction, operation and decommissioning stages) on the environment including its area of influence;
- evaluate in quantitative terms, the adverse impacts in (magnitude, prevalence, duration, frequency of occurrence, risk and importance) and recommend reasonable and cost-effective measures, procedures and practices to be followed during the design, construction, operation and decommissioning of the proposed project to ensure that the environmental adverse effects are mitigated, minimized or ameliorated;
- recommend an Environmental and Social Management Plan for the factory's lifetime, including compliance monitoring, auditing and contingency planning;
- provide the foundation for regular and sustained consultation with the relevant regulatory authorities, the public and other stakeholders;
- ensure the Client's strict compliance with the regulatory requirements and company policy on health, safety, and environment (HSE) issues.

ES 1.7 Legal and Administrative Framework

The EIA has been carried out in line with the applicable legal and administrative framework. Some of these include:

- National Policy on the Environment (1988);
- EIA Act Cap E12 LFN, 2004,
- National Policy on Solid Waste Management (NPSWM), 2020;
- National Climate Change Act 2021,
- Agriculture Transformation Agenda (2012);
- Land Use Act CAP L5 LFN 2004;
- Harmful Waste (Special Criminal Provisions, etc) Act,
- Cap H1, LFN, 2004;
- Standards Organization of Nigeria (SON) Act, Cap S9, LFN 2004;
- Federal Ministry of Environment guideline,
- Forestry Act, Cap F 36, LFN, 2004,
- Plateau State Ministry of Environment.
- World Bank environmental and social framework guideline.

- The IFC Performance Standards and
- Environmental and Social Safeguards Policies (African Development Bank) amongst others.

ES 1.8 The Structure of the EIA Report

This EIA report is presented in nine (9) chapters following standard report format as specified by the FMEnv.

- Chapter one contains the introduction with background on the project and the project's proponent's terms of reference, brief description and location of the project, review of the legal and administrative framework for EIA, EIA objectives, methodology and the structure of the prepared EIA report.
- Chapter two discusses the justification, the need of the project, the value of the project, the project alternatives, and the envisaged sustainability of the proposed project.
- Chapter three gives a detailed description of the entire proposed project, the raw materials, input and outputs, technological layout, waste management strategy.
- Chapter four contains the description of existing environmental factors of climate (Rainfall, Wind Speed and direction, Temperature, and relative Humidity), Geography of the location, land use and landscape patterns, Hydrogeology (ground water, surface water, soil), air quality, noise level, biodiversity, socio-economic conditions and built-up areas.
- Chapter five contains the details of the identification, quantification, and evaluation of the predicted Associated and Potential Environmental Impacts that may affect the project implementation.
- Chapter six presents cost-effective mitigation measures to minimize or eliminate identified negative impacts of the proposed project.
- Chapter seven presents a robust comprehensive Environmental Management Plan (EMP) for the proposed project and the decommissioning schedule.
- Chapter eight highlights the remediation plan after de-commissioning/closure and de-commissioning schedule
- Chapter nine ends with the recommendations and conclusion.

These nine chapters are preceded by a Cover Page, Tables of Content, and List of Abbreviations/Acronyms. List of Tables, List of Figures, List of Plates, List of EIA Preparers, Acknowledgement and Executive Summary and are then followed by references and Annexure such as Survey Plan and Methodology for field sampling and Analytical Methods and others.

ES 2.1 Justification for the Project

The country is endowed with vast arable land, a conducive climate, and different agro-ecological zones. Over the past 20 years, value-added per capita in agriculture has risen by less than 1 percent annually. It is estimated that Nigeria has lost USD 10 billion in annual export opportunity from groundnut, palm oil, cocoa, and cotton alone due to a continuous decline in the production of those commodities. (*National Report of Wet Season Agricultural Performance in Nigeria 2021, NAERLS, FMARD).* It is against this background the Federal Republic of Nigeria, engaged in a radical transformation of the sector through new funding arrangement, institutional realignment, administrative strengthened and market reforms to reposition the sector. Agriculture is the principal source of livelihood in Nigeria, and the sector employs nearly three-quarters of the nation's workforce.

Nigeria is Africa's largest producer of rice and is among the top 15 producers globally. Rice productivity is around 2 MT/ha, much below the global average of 4.7 in 2021 (FAOSTAT). There is a need to bridge the productivity gap to make rice production remunerative. The level of processing in the State is insufficient with most of raw paddy going out of the State for milling.

ES 2.2 Need for the Project

Suppose agricultural production continues to expand as expected, and fiscal policies are not in place to manage the growth of the downstream processing and trading industries. In that case, the result will be reduced prices at the farm and in the primary market. Thus, the initial growth will not be sustainable, and the confidence of farmers will be lost. Therefore, growth and expansion must be managed to comply with prevailing industrial opportunities, which requires thoughtful planning by governments. The establishment of the Plateau State Special Agro-Industrial Processing Zone is one of such contingency planning by the State. It is anticipated that the project when implemented will bridge the deficit of agricultural produce such as Yam and Cassava wasted due lack of sophisticated storage facility in the area and the state at large.

ES 2.3 Benefit of the Project

The proposed project will offer several benefits which include:

- boost farm incomes, reduce poverty, create clusters of economic growth, and increase tax revenue through value additions.
- encourage longer-term private sector investment, thereby assuring the sustainability of industrial development, through Government's intervention in creating and maintaining enabling environments
- create wealth for rural farming communities
- stimulate private-public partnership

- revenue generation to government and, Technology transfer
- increase food and nutritional security, create new/green jobs, and thereby reduce rural-urban migration through enhancement of productivity at the farm level
- promote private sector investment in climate-smart and green technologies, enabled by investment in public goods, policy interventions and the provision of pertinent support services and skills development.

ES 2.4 Value of the Project

The proposed project cost is estimated at Two Billion Naira (N2Billion) only to be funded through equity contribution by the project proponent and bank loan. It is envisaged that a large percentage of the total cost will be injected into the local economy for procurement of project designs, approvals/permits, construction materials, services, etc.

ES 2.5 Sustainability of the Project

The proposed project's sustainability is viewed as ensuring that the benefits realized are maintained and continue to influence positively into the foreseeable future. The project's sustainability is addressed under four key areas: it's economic, technical, social, and environmental sustainability potentials.

Economic Sustainability

Plateau State Government shall ensure standard business ethics and transparency; preventing corruption, encourage public advocacy and lobbying, transparency in payment of taxes, encouraging human rights and security. Proceeds accruing from the agro-processing activities will continually contribute additional revenue to the State and the Federal Government of Nigeria.

Technical Sustainability of the Project

The proposed Agricultural Industrial Hub (AIH) under the Special Agro-industrial Processing Zone (SAPZ) Project shall adopt the principle of Best Available Techniques (BAT) for design, construction, and operation. To ensure technical sustainability, the following principles shall be enshrined in the project:

- Local content will be generously utilized in the design, construction, and operation.
- Skills transfer will be encouraged between expatriates' engineers and local engineers to close the gap in knowledge throughout the project life.
- The State Government shall ensure the training and retraining of its local Engineers.

Social Sustainability of the Project

To ensure the social sustainability of the project, the State Government shall ensure:

- ***Robust and sustained stakeholder engagement:*** The State Government shall ensure sustained and effective Stakeholder Engagement in a structured and culturally appropriate manner with affected communities.
- ***Establish a grievance mechanism:*** This shall be designed to receive and facilitate the resolution of concerns and grievances about the project's environmental and social performance as part of its Environmental and Social Management System (ESMS).
- ***Security Surveillance of the Facility:*** Encroachment and breach of Agro-processing facility security by a third party that can typically cause safety and environment incidents shall be monitored.

  Environmental Sustainability of the Project

  The proposed Special Agro-industrial Processing Zone (SAPZ) Hub Project shall be environmentally sustainable because agro-processing activities shall continually be guided by applicable environmental regulations such as Environmental and Social Safeguards Policies (African Development Bank), FMEnv policies and World Bank Guidelines on Environmental Assessment. Also, incorporating the findings and recommendations of this ESIA and subsequent implementation of the Environmental & Social Management Plan (ESMP) for the project‘s activities will ensure the desired environmental sustainability.

ES 2.6 Project Options and Alternatives

The benefits of evaluating alternatives are for the selection of the best project design, selection of the best project location, and most efficient use of resources which will aid avoidance of adverse impacts and achievement of sustainable development goals. Therefore, the following options and alternatives were appraised:

- Project options: No project options; Delayed project options; and Go-ahead option
- Project alternatives: Alternative location/site, alternative design/technology.

ES 3.1 Project Description

ES 3.2 The Project

The Special Agro-Industrial Processing Zones are integrated development initiatives designed to concentrate agro-processing activities within areas of high agricultural potential to boost productivity, integrate production, processing and marketing of selected commodities such as Yam and Cassava). These zones will enable agricultural producers, processors, aggregators and distributors to operate in the same vicinity to reduce transaction costs and share business development services for increased productivity and competitiveness. By bringing adequate infrastructure (energy, water, roads, ICT, etc.) to rural areas of high agricultural potential, SAPZs will attract investments from private agro-industrialists/entrepreneurs to contribute to the economic and social development of rural areas.

ES 3.3 The Project Location

The area acquired for the project covers total land area of 543.98 Hectares (Ha) and a Perimeter of 10.82 Kilometers. The site is located close to the airport and is adjacent to the Jos dry port and is well connected by road network. The land is generally flat and devoid of any perineal vegetation and has been used for agriculture.

ES 3.4 Project Description

The Special Agro-Industrial Processing Zones are integrated development initiatives designed to concentrate agro-processing activities within areas of high agricultural potential to boost productivity, integrate production, processing, and marketing of selected commodities. These zones will enable agricultural producers, processors, aggregators, and distributors to operate in the same vicinity to reduce transaction costs and share business development services for increased productivity and competitiveness. By bringing adequate infrastructure (energy, water, roads, ICT, etc.) to rural areas of high agricultural potential, SAPZs will attract investments from private agro-industrialists/entrepreneurs to contribute to the economic and social development of rural areas. It is on this background that Plateau State Government proposes to establish an Agro-Industrial Hub (AIH) at Heipang as part of the Special Agro-Processing Zones (SAPZ II) programmed. The Hub will mainly rely on the output from the Agricultural Transformation Centres (ATC) which serves as the supporting structure of the AIH. The following facilities shall be established for the project.

Physical Infrastructure

- Road network
- Water Supply System
- Sewerage and effluent collection system
- Storm Water Drainage System

Common Facilities

- Administration office
- Residential Training Center
- Cold Storage
- Farm Input Store
- Warehousing facilities with Weigh Bridge
- Guest house & Recreation facilities

Industrial Units

- Wholesale and Retail Market
- Yam Processing unit
- Standard design factories for value addition

Environmental Infrastructure

- Sewage Treatment Plant

- Common Effluent Treatment Plant

ES 3.5 Overview of Project Phases and Activities

Pre-construction activities include

- Site Preparation,
- Engineering Design,
- Materials Delivery

Construction activities include

- Installation of Various Equipment Compressors;
- Power Generation Equipment, Waste treatment plant, Etc.)
- Building of the storage Structures
- Construction of Office Complex
- Civil and plumbing Works

Operational activities include

- Operation of the Agricultural and Transformation Center
- Operation of Aggregation Center,
- Packaging and Supply of Same to Customer Locations Etc.

The decommissioning activities include

- The decommissioning/closure stage entails stoppage of all operations, demolition of structures and removal of equipment as well as preparation of the site back to what it was before project activities.

Facilities/Utilities

Site Development: Site grading will include cutting, filling, and compacting the filled-up earth to integrate the micro drainage pattern of the site to the proposed storm water drainage system. The Site will be protected by boundary fencing and an aesthetically designed entrance plaza is proposed.

Storm Water Drainage: The entire storm water drainage system for the SAPZ has been planned to utilize the natural slopes wherever possible and an economically graded slope in other locations, to design an economical and sustainable surface drainage system with integration of rainwater harvesting.

Office and Training Centre: A full-fledged office and training center is proposed in the SAPZ which is located at its entrance. The center is designed for a capacity of 50 trainees and will have training halls, accommodation for staff, trainees, guests etc. A food court, bank, testing lab is proposed in this zone. Demo Plots for farm training is also proposed as part of the training center.

Common Warehouse: A common warehouse for a capacity of 20000 MT is proposed with support facilities such as weigh bridge, truck parking and driver amenities.

Custom Hiring Center and Workshop: This center will provide farm machinery on hire for the farmers and will also house a full-fledged workshop for general maintenance of farm equipment. The centre will also impart training for the maintenance and operations of farm machinery and equipment.

Farm Input Sale Counter: This center is proposed to cater to the supply of quality farm inputs such as seeds, fertilizers etc. for the farmers.

Sewerage Collection and Treatment System: An underground sewerage network has been designed to collect sewage from each plot and convey it to a sewage treatment plant (STP). At the STP, the sewage would be treated to acceptable standards and the treated sewage will be used for irrigation purpose for which pipe network is considered.

ES 4.1 Description of the Existing Environment

The environmental baseline (physical, chemical, biological, socio-economic and health) characteristics of the proposed project area are presented in this chapter. The baseline characteristics are required to establish the existing environmental status of the proposed project area and to serve as a reference data for future studies and environmental monitoring. It will also be used as a basis for which the anticipated impacts of the proposed project would be determined for appropriate mitigation measures to be put in place.

ES 4.2 Baseline Data Collection

The baseline data gathering for the project was conducted between 16th to 17th May 2024, while the socio-economic studies was conducted on 22nd of May, 2024. The data obtained include information on receptors and resources that were identified as having the potential to be significantly affected by the construction and operation of the Agricultural Industrial Hub (AIH). The ESIA report provided description of the existing environmental and socio-economic conditions as a basis against which the impacts were assessed. The parameters sampled include Climate and Meteorology, Air Quality/Noise, Groundwater/Surface Water, Soil, vegetation as well as Socio-economic/Health baseline of the study environment.

ES 4.3 Quality Assurance/Quality Control

Standard methods and procedures were strictly adhered to during 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.

ES 4.4 Climate and Meteorology of the Study Area

Plateau State falls within the tropical wet and dry (Aw) climatic belt of Nigeria as obtained in the Koppen-Geiger (1928) world climates classification system. Like any other part of the Aw climatic area, the entire state is marked by distinct wet and dry seasons. However, owing to high relief nature of the Jos plateau landscape, places situated on it exhibit considerable variations in climatic characteristics compared to other places down the plateau. The Heipang area of Barkin Ladi LGA is among the list of places with such relief influenced climatic characteristics. In Heipang area, the wet season is warm, humid, and overcast, while the dry season is hot and partly cloudy. Through the year, the temperature typically varies from 12°C to 32°C and seldom falls below 9°C or above 35°C (Weather Spark, 2024). The *hot season* lasts for about *3 months* (from late *January through April),* with an average daily high temperature above *30°C*. The hottest month of the year in in the area is *March,* with an average maximum temperature of *32°C* and an average minimum of *17°C.* The *cool season* also lasts for *3 months* from early *July* to early *October,* with average daily maximum temperature falling below *25°C.* The coldest month of the year is *August,* with average minimum temperature of *16°C* and maximum of *23°C* (Weather Spark, 2024).

ES 4.5 Air Quality and Noise Level

The relative concentrations of ambient air pollutants (suspended particulate matter - SPM), Nitrogen oxides (NOx), sulphur oxides (SOx), carbon monoxide (CO), etc, are within tolerable limits in the atmosphere. Generally, the results indicated low concentration that was within standard limit.

ES 4.6 Soil Quality

Below is the analysis of the soil test results for Pwomol, Heipang, covering samples SS1 to SS10. Each sample's physical, chemical, and microbial parameters are evaluated against the Federal Ministry of Environment (FMEnv) and World Health Organization (WHO) standards. The findings are assessed for their implications on agricultural usability, aquatic life, and livestock health.

Color: The colour of the soil varies across samples, indicating differences in organic matter and mineral content. The colours suggest varying levels of iron oxides and organic content, important for nutrient availability in the soil.

pH: The pH levels across samples range from 5.64 to 6.25, indicating slightly acidic to neutral soil conditions. The values are within the acceptable range for most crops as per FMEnv and WHO standards, suggesting suitable conditions for agricultural activities and livestock health. Details of the result are presented in chapter four of this report.

ES 4.7 Groundwater Result

The groundwater test results for the Special Agro-Industrial Processing Zones (SAPZ) in GW1 (Pwomol Heipang), Barkin Ladi LGA Plateau State have been analyzed in accordance with the standards set by the Federal Ministry of Environment (FMEnv), Nigeria, and the World Health Organization (WHO).

Appearance*:* The appearance was measured as 5.00 TCU which is well within the FMEnv standard of 15 TCU for colorless water. According to WHO guidelines, water should be visually acceptable, meaning it should not be colored. This result indicates that the water is clear, making it suitable for all uses without aesthetic concerns. Clear water is essential for agricultural practices as it ensures the absence of visible contaminants that could harm crops and livestock.

Odour*:* All samples were odorless, meeting the FMEnv standard of being odorless (threshold number 3.5). The WHO also recommends water to be free of any offensive odors to ensure it is acceptable for consumption and other uses. This confirms the absence of organic pollutants, making the water safe for drinking, agricultural irrigation, and livestock use.

Dissolved Oxygen (DO)*:* DO levels value is 2.10 mg/L While FMEnv does not specify a standard for DO, WHO indicates that higher DO levels are better for aquatic life, with a minimum of 4-5 mg/L generally required to support a healthy aquatic ecosystem.

***Turbidity**: The* turbidity levels were very low, at 0.36 NTU meeting the FMEnv standard of 1.0 NTU and WHO's recommendation of less than 5 NTU. Low turbidity indicates minimal presence of suspended particles, beneficial for both agricultural and drinking purposes.

***Total Suspended Solids (TSS)**:* TSS levels were extremely low, at 0.03 mg/L, well below the FMEnv limit of 10 mg/L. Low TSS is favorable for irrigation systems and livestock watering, as it reduces the risk of clogging and ensures better water quality.

***Oil and Grease**:* All samples had undetectable levels of oil and grease (<0.001 mg/L), meeting the FMEnv standard of 0.05 mg/L. WHO also advises water to be free from oil and grease. This ensures that the water is clean and safe for all uses, particularly in agriculture where oil contamination can harm soil and plants.

***Chemical Oxygen Demand (COD)**:* COD values is 25.30 mg/L. Though FMEnv does not provide a specific limit, WHO recommends that lower COD levels are preferable as they indicate fewer pollutants. These levels suggest that the water is relatively free of harmful organic substances.

***Nitrate (NO3)**:* Nitrate concentrations were very low, at 0.32 mg/L well below the FMEnv limit of 10 mg/L and WHO's guideline of 50 mg/L for drinking water. Low nitrate levels are essential to prevent health issues such as methemoglobinemia in infants and are beneficial for agricultural purposes as high nitrate can lead to soil degradation.

***Phosphate (PO4)**:* Phosphate levels were 0.78 mg/L, with no specified FMEnv limit. WHO does not set a specific limit but advises monitoring to prevent eutrophication. The detected levels are not likely to cause eutrophication, making the water safe for agriculture and aquaculture.

***Total Alkalinity and Acidity**:* Alkalinity levels were between 11.20 mg/L, and acidity ranged from 10.00 mg/L, with no specified FMEnv standards. WHO advises balanced alkalinity and acidity to prevent water from becoming corrosive or overly basic. These levels are within acceptable ranges for agricultural and livestock use.

***Potassium (K)**:* Potassium levels at 24.01 mg/L While no specific FMEnv or WHO limits are set, these levels are typical for natural waters and safe for all uses, providing essential nutrients for plant growth.

***Magnesium (Mg)**:* Magnesium levels were low, <0.001 mg/L.Both FMEnv and WHO suggest maintaining magnesium within 30-150 mg/L for drinking water. These low levels pose no risk and are beneficial for agricultural use, preventing soil hardening.

***Calcium (Ca)**:* Calcium concentrations ranged at 0.05 mg/L within safe limits as per WHO's recommendation of 75-200 mg/L for drinking water. These levels are suitable for agricultural, and livestock use, providing essential nutrients without causing hardness issues.

Iron (Fe)*:* Iron levels were low, 0.01 mg/L within the FMEnv limit of 1.00 mg/L and WHO's guideline of 0.3 mg/L. Low iron levels prevent staining and are safe for all uses, ensuring good water quality.

Lead (Pb)*:* Lead levels were undetectable (<0.001 mg/L) in all samples, well below the FMEnv and WHO standard of 0.01 mg/L. Absence of lead makes the water safe for drinking, agricultural, and livestock use, as lead contamination can cause severe health issues.

Copper (Cu)*:* Copper levels were 0.01 mg/L below the FMEnv limit of 1.00 mg/L and WHO's guideline of 2.0 mg/L. These levels are safe and beneficial, providing essential nutrients without toxicity risks.

Fecal Coliform*:* No growth was observed in any samples, meeting the WHO and FMEnv standard of zero fecal coliforms. This ensures the water is safe from fecal contamination, suitable for all uses.

Overall, the groundwater quality in the SAPZ - Pwomol Heipang, Barkin ladin LGA of Plateau State is generally within the acceptable limits set by FMEnv and WHO, with some exceptions. The water is mostly clear, odorless, and within the acceptable pH range, making it suitable for agricultural use, livestock health, and to some extent, drinking after appropriate treatment. Parameters such as TDS, EC, turbidity, and various chemical constituents indicate good quality for agricultural irrigation and livestock watering.

ES 4.8 Surface Water Quality

This analysis evaluates the surface water quality in Pwomol Heipang, focusing on upstream (SW1), midstream (SW2), and downstream (SW3) locations. The results are compared against the Federal Ministry of Environment (FMEnv) standards for aquatic life and livestock watering, as well as World Health Organization (WHO) guidelines for water quality. The parameters assessed are crucial for agricultural usability, aquatic life sustainability, and livestock health.

Appearance*:* The water appearance, measured in True Colour Units (TCU), ranged from 20.00 TCU (SW1) to 25.00 TCU (SW2 and SW3). While there is no specific FMEnv or WHO limit for appearance, clearer water (lower TCU) is typically preferred for both aquatic life and livestock.

Odour*:* All samples were odourless, indicating the absence of contaminants detectable by smell, which is favorable for both aquatic ecosystems and livestock health.

pH*:* The pH values ranged from 6.91 (SW3) to 7.30 (SW1), within the FMEnv standard range of 6.00-9.00 for aquatic life and the WHO guideline of 6.5-8.5. This neutral pH is ideal for sustaining aquatic ecosystems and is suitable for livestock consumption.

Dissolved Oxygen (DO)*:* DO levels varied from 4.80 mg/L (SW1) to 5.20 mg/L (SW2), below the FMEnv standard of 6.80 mg/L. According to WHO, a DO level above 5 mg/L is necessary to support aquatic life. The slightly lower levels observed here suggest potential oxygen depletion, which could affect fish and other aquatic organisms.

Total Dissolved Solids (TDS)*:* TDS values ranged from 6.97 mg/L (SW2) to 43.20 mg/L (SW3), well within the FMEnv livestock watering standard of 3000 mg/L and the WHO guideline of 1000 mg/L for drinking water. Low TDS levels are beneficial for both aquatic life and livestock health, indicating minimal dissolved substances that could affect water quality.

Total Coliform Count*:* Coliform levels ranged from no growth (NG) in SW2 to 20.00 CFU/ml in SW1, indicating varying levels of microbial contamination. While specific FMEnv or WHO standards are not provided, coliform presence indicates potential contamination, necessitating treatment for safe use.

Total Bacteria Count*:* Bacteria counts ranged from 10.00 CFU/ml (SW2) to 470.00 CFU/ml (SW3). High bacterial counts suggest microbial contamination, requiring treatment before use.

Fecal Coliform*:* No growth (NG) was detected in all samples, indicating an absence of fecal contamination, which is favorable for water quality.

In summary, the surface water quality in Pwomol Heipang generally meets the standards set by FMEnv for aquatic life and livestock watering, with some parameters requiring attention. Dissolved Oxygen levels are slightly below the standard, and Iron in SW1 exceeds the standard, indicating the need for monitoring and potential remediation. The microbial contamination, as indicated by total coliform and bacteria counts, necessitates treatment before use. Overall, the water is largely suitable for agricultural and livestock purposes with appropriate management and periodic monitoring to ensure sustained water quality.

ES 4.9 Geology

The Heipang area falls within the Nigerian part of the Pan African Ring Complex which dates back to the Paleozoic Pan Afriacn Orogeny. According to Udi et al., (2023), this orogeny had been documented as the most pervasive of all the tectonic events that affected the Nigerian Basement Complex rocks because the younger granites of this orogeny are structurally controlled intrusions in the host rock sequence. The Heipang site is characterized to a greater extent by the Pan African Younger Granitoids which include the Biotite Granites (JyG) and Granite and Granite porphyry (yG) of the Jurassic origin (The Nigeria Geological Surveys, 2004). In addition, the north-western part of the site is characterized by the eminences of Tertiary younger basalt intrusions of Oligicene to Pleistocene origins. These basaltic geologic forms are products of recent tertiary volcanics that are presently extinct.

Relief and Drainage

The relief map of Plateau State showing the proposed projects sites is presented in Figure 6. The general relief of Heipang area is high and ranges between 1144 and 1752 meters above sea level (m.a.s.l.). However, the proposed site is characterized by a near level to gentle undulating plain with elevations ranging from 1250 to 1278 m.a.s.l. Thus, the site is an upland characterized by slight undulating surface.

Soil

Soils of the Heipang proposed site are derived from undifferentiated Basement Complex, and younger granitoids and younger basaltic rock material (saprolite) of the area. They commonly are referred to as Ferruginous Soils on Crystalline Acid Rocks as described the Land and Water Development Division, FAO (1964) or Ustisols according to the USDA Soil Classification. They also described as very deep, zonal soils of tropical savanna and bushlands, morphologically characterized by dark red-brown A horizons with weak crumbling structures and B horizons stained by red ferruginous gravel. The soils are chemically acidic with appreciable amounts of silicate clays minerals (mainly kaolinite) and abundant content of the sesquioxides of iron and aluminum which give rise to their lateritic status and hard pan concretions (Duricrustal surfaces) in some parts of the site. Crops cultivated on the soils include maize, ground nut, fornio, rice, yam, potatoes, and vegetables (mostly around the dam site).

ES 4.10 Vegetation

The vegetation of the entire Jos Plateau is typically that of the Guinea Savanna which is characterized by largely grasses and sparsely distributed shrub and tree plant forms. The vegetation characteristic reflects the plants interactions with climate, soil, and the activities of man (Benette 1978). Although the original vegetation cover of the area has been depleted by prolonged anthropogenic activities such prolonged cultivation, fuel wood exploitation and settlement development, little of it remains to this day. The complex Heipang project site in particular is predominantly of grass/herb plan forms which cover a larger proportion of the land area. A gallery forest of shrub/tree forms dominates the stream valley that makes up part of the northern boundary.

ES 4.11 Socio-economic and Health Profile of Host Community

The Socio-economic and Health study had the following objectives;

- To obtain relevant secondary socio-economic and health data through conducting literature reviews on the study area and the healthy sector.
- To undertake field assessment visits to the proposed project area.
- To conduct interviews and discussions with stakeholders in the proposed project area, and obtain primary data, perceptions, concerns and suggestions on potential impact enhancement and mitigation measures.

- To administer questionnaire in the proposed project area and obtain primary data from stakeholders.
- To analyse and interpret data obtained from primary and secondary sources.
- To determine livelihoods and dependence on the natural environment for sustenance in the proposed project area.
- To determine the potential impacts of the proposed project on the socio-economic and health environment in the proposed project area.
- To outline enhancement and mitigation measures for the potential impacts.

Sampling Process.

Purposeful sampling strategies were used to select the study communities base on nearest proximity within five kilometers from the proposed project site, where Pwomol-heipang and Chit villages were selected. A Quota sampling that allows for classifying study population based on the community they live, and subgroups of people within further classified based on neighbourhood in the communities were identified; within which members of social groups and association in the neighbourhood were identified and noted. Each of the groups had their members later clustered into male and female. The number of males and females in the subgroups were proportionally selected according to the determined sample size and were interviewed.

Demographic Characteristics

This entails basic attributes that describes human populations and their identities that relate to biological or locational status**.** These are name of their locality, gender, age groups, main languages spoken, social, groups, and duration of stay in the community. The result shows that Pwomol Heipang had a frequency of 59, representing 53.6% study participants and Chit village, 51 (46.4%) of the total respondents.

Gender: There were 62 females, accounting for 42.7% and 47 males, representing 56.4% of the total respondents

Age Group

On age distribution shows that there were 42 respondents (38.2%) aged 18-30 years, 27 (24.5%) aged 31-43 years, 25 respondents (22.7%) aged 44-55 years, and 15 respondents (13.6%) were aged 56 years and above.

Languages Spoken

The most spoken language in the community is Berom, with all respondents (100%) reporting proficiency in it. Over half (53.6%) can speak English while Hausa is spoken by a 21.8% of the respondents and Mwaghavl is spoken by a small percentage (3.6%) and the less commonly spoken language in the communities. Results imply that the community has diverse language usage, with

some languages being more dominant than others. This diversity in language indicates cultural diversity within the community and the need for language support services or translation resources to facilitate communication in the project sensitisation and mobilization.

Occupation

The result shows that in the localities, farming is the most common occupation with 73 (66.3%) people said they engaged in. This implies that a significant portion of the population surveyed are involved in farming. Business was the second common occupation with 26 (23.6%). Those in Civil Service had a small representation of 5 (4.5%).

Monthly Income

The most common income range was between ₦5,000-₦10,000 accounting for 34.5%. This implies the respondents earned low-income range. Furthermore, those earning ₦11,000 - ₦20,000 represent 30.0 %, while 18.22% and 12,7% earned ₦11,000 - ₦ 20,000 and ₦31,000 and above.

Education Status

Education of the respondents shows that 41 (32.7%) had secondary school education, 30 (27.3%) primary school education and 24.6% had tertiary education, with the least 11 (10.0%) experienced an informal schooling.

ES 4.12 **Historical Background**

Barkin Ladi is one of the 17 Local Government Areas (LGA) and situated in the northern Senatorial zone of Plateau State, Nigeria. The LGA has its headquarters in Barkin Ladi town located at 9°32′00″N 8°54′00″E with a land area of 1,032 km². The population of the LGA is estimated at 175,267 in the 2006 census. Barkin Ladi LGA is a subtropical highland climate with an average annual temperature ranging between 18°C (64°F) to 26°C (79°F) and receives an average of 1,200mm of rainfall annually. Its rich volcanic soil of the Jos Plateau makes the land fertile and suitable for agriculture. Major crops cultivated include maize, beans, cassava, Irish potatoes, and various fruits such as mango and pear. Farming is the primary occupation for about 66.3% of the population, providing the main source of income and sustenance for many households. In addition to agriculture, the people in the area engages in crafts, hunting, and tapping resource for additional sources of income.

The people in Barkin Ladi value their cultural traditions. Predominantly Berom people, they have a rich cultural heritage characterized by traditional dances, festivals, and a deep respect for spiritual and sacred places. The community strictly observes traditional laws and maintains a strong connection to their ancestral roots. These cultural practices are not only vital for the community's identity but also play a role in social cohesion and stability. Sacred places exist and the adherence to traditional beliefs underscore the importance of cultural sensitivity in any developmental

initiative. Any projects or interventions in the area must respect and integrate these cultural aspects to ensure community acceptance and support.

ES 4.13 Social Structure and Organization

A basic social unit is the family, and everyone is a member of both a nuclear family and an extended family. Individuals are identified by their family names, making the family an important identity in the lives of residents. The nuclear family is a single unit commonly headed by a father or mother with the children as members. Widows and single parents who do not have grown up adult male children head their nuclear families. The extended family incorporates several nuclear families. Members are believed to descend from a common ancestry, which may go back to various generations. The extended family is headed by a male member, usually the oldest male member.

Traditionally, each indigenous member of the community belongs to an age grade. The age grade system recognizes children born within a three-year period as mates. It is managed in such a way that nobody falls into two grades. The age grade system provides cohesion, and it is a vehicle for mobilization especially towards community development. However, effectiveness of the age grade system has been weakened by increasing urbanization and consequent in-migration of people of different ethnic groups. Among community-based organizations (CBOs) are the Council of Chiefs, the CDC, Women's and Youth groups and the pressure groups.

Socio-cultural groups further social interactions among residents beyond filial relationships. They constitute a very important aspect of the social capital in the community as they are avenues for community development and welfare provisions for their members and the elderly.

ES 4.14 Land Ownership and Tenure

The Land Use Act of 1978 gave ownership of all lands to the government, and it provides the framework for payment of compensation for land acquisition for development purposes in Nigeria. The provision that gives land ownership to government has been challenged across communities in Nigeria. The rejection stems mostly from the socio-cultural significance of lands. Therefore, despite the law, traditional land ownership practices still prevail. Lands in the communities are owned by families. Families allocate, lease, and sell parts of their lands to individuals. Such lands can be put to any use including housing, infrastructural and industrial development. Family lands are managed by males in the family.

The major land uses in the community include farming, housing, and infrastructural development. These account for more than 90% of land use. They include houses used for residence, commercial and other business purposes. The infrastructural use is represented by lands used for roads, public schools, and other public infrastructural amenities.

ES 4.15 Health Characteristics

This section reviews the relevant baseline information concerning health issues in the project area. It evaluates the demographic, social, biological, economic, and environmental determinants of health with reference to the project area. Although, it relied more on pieces of information collected on health and other relevant issues during the baseline survey, it nevertheless took cognizance of other relevant pertinent pieces of information from literature and other sources to provide a comprehensive picture.

The result of research and interviews indicate that majority of residents enjoy 'good' health status. The most common health problem in the communities is malaria. Other health problems include diarrhea and typhoid.

ES.4.16 **Perceived Views on the Proposed Project**

Large proportion of the respondents (93.6%) reported to observing traditional laws strictly, and 74.5% still have spiritual/sacred places in their communities. The positions of the community on traditional beliefs should be handled with care to limit the tendency of being resistant to modernization, which industrialization brings.

On whether the local community heard about the new project coming to their community, 68.2% reported being aware. While 69.1% of them said, there is need to create more awareness through organizing stakeholder's workshops for the proposed project. As such, their excitement and curiosity about the project and want to be involved in the implementation process. This suggests that the local communities are expectant and interested in shaping their own development and ensuring their needs and perspectives are considered. Hence, about half (47.3%) of the respondents and nearly one-quarter (31.8%) said their communities are happy and thankful towards the new development project.

ES 5.1 Potential and Associated and Impacts

The assessment considers both normal operational impacts and potential effects arising from abnormal occurrences. The identified impacts are categorized as either threats or opportunities to human and environmental wellbeing. Project activities and their environmental interfaces encompass a wide array of concerns, such as air and water pollution, impacts on employment, and land use change, among others. These concerns have been thoroughly examined to determine the potential impacts of the proposed project on environmental receptors. This section outlines the overall approach to impact assessment and mitigation. The impact evaluation methodology is based on sectoral guidelines provided by FMEnv. It involves:

- Screening of potential impacts associated with each project phase using a Risk Assessment Matrix.

- Detailed evaluation of impact-producing factors within each project phase, with the significance of potential impacts quantified using consistent criteria.

The assessment approach involves aligning the proposed project's activities with the existing environmental components, identifying, and evaluating potential changes in the environment resulting from these interactions, and proposing mitigation measures to address such changes. At this stage of the Environmental Impact Assessment (EIA), both negative and positive impacts of the proposed SAPZ – AIH, Heipang project on the existing environment have been identified. Various references, including the EIA Procedural Guidelines, the ISO 14001 approach, and the Hazard and Effect Management Process (HEMP), were utilized in the identification process. The Risk Assessment Matrix (RAM) was employed to determine risks posed by identified potential impacts and to propose appropriate mitigation measures. In predicting impacts, a practical 'worst-case scenario' approach was utilized to assess extreme effects, while a 'consensus of opinions' method was employed to determine the importance of affected environmental components. Evaluation of impacts was conducted using specific criteria such as legal/regulatory requirements, magnitude of impact, risk posed, public perception, and importance of affected environmental components.

ES 5.2 Impact Methodology Description

The Impact Methodology Description provides a structured framework for assessing and evaluating the potential environmental and social impacts of proposed projects. This document outlines the methodologies, criteria, and tools utilized in conducting the Environmental and Social Impact Assessment (ESIA). The primary goal is to identify, predict, and mitigate adverse impacts while maximizing positive outcomes. The methodology overview includes:

Baseline Data Collection:

The assessment begins with comprehensive data collection to establish baseline conditions of the project area. This includes gathering information on environmental, social, economic, and cultural aspects through field surveys, interviews, and literature reviews.

Impact Identification:

Utilizing the collected baseline data, potential impacts associated with the project are identified. These impacts are categorized into environmental (e.g., air quality, water quality, biodiversity), social (e.g., community displacement, cultural heritage), and economic (e.g., employment opportunities, income generation).

Impact Prediction:

Various tools and models are employed to predict the magnitude, extent, and significance of identified impacts. Techniques such as Geographic Information Systems (GIS), environmental

modeling, and stakeholder consultations are utilized to forecast potential impacts under different scenarios.

Impact Assessment:

Impacts are assessed based on predetermined criteria including severity, duration, reversibility, and spatial extent. Qualitative and quantitative methods are employed to evaluate both positive and negative impacts, considering their significance on the affected environment and communities.

Risk Assessment:

Risks associated with project activities are identified and analyzed, considering the likelihood and potential consequences of adverse events. This includes assessing risks related to natural hazards, project operations, and socio-economic factors.

Mitigation and Management Measures:

Based on the identified impacts and risks, appropriate mitigation and management measures will be developed to avoid, minimize, or compensate for adverse effects. These measures aim to enhance the AIH project sustainability and promote environmental and social responsibility.

Monitoring and Evaluation:

A monitoring and evaluation plan will be established to track the implementation of mitigation measures and assess the effectiveness of impact management strategies. Regular monitoring ensures compliance with regulatory requirements and enables adaptive management based on real-time data and feedback.

ES 5.3 Project Phases, Associated Activities and Potential Impacts

The proposed projects will engage with the environment through different avenues referred to as "development aspects," which may lead to alterations in the existing environmental conditions. These alterations are termed as "impacts." The activities associated with the phases of the SAPZ – AIH, Heipang project and the identified environmental aspects of the proposed development that may induce impacts on the environment comprises The Preconstruction phase, Construction phase, Operation phase and Decommissioning phase.

Identified Impacts for Pre-Construction Phase

A. Environmental Impacts

Positive

- Stakeholder consultation and engagement is carried towards informing identified stakeholders about project activities and providing them with an opportunity to contribute to project development.
- Sensitization and training on the ESMP implementation and monitoring.
- Job opportunities from hiring unskilled labor for vegetation clearing, security etc.

Negative

- Loss of biodiversity and vegetation through site clearing.

- Air quality pollution from site excavation and land bulldozing.
- Site workers, products suppliers and goods seller's influx causing pressure on existing social infrastructure.

B. Occupational Health Impacts

Positive

- Conduction of Occupational Health and Safety (OHS) awareness programs for PMU (Project Management Unit) and third-party contractors inducting them on safety guidelines and practices.

Negative

- Increased traffic during mobilization with risk of accidents leading to possible casualties.
- Trips, falls, dust inhalation and injuries from open excavations and working at heights.

C. Socio-Economic Impacts

Positive

- The project will conduct socioeconomic stakeholder consultations to educate the residents of the host communities about the project's social safeguard components.
- Generation of jobs (skilled and unskilled) during site preparation.
- Increased demand for goods and services from retail vendors and canteens as a result of job opportunities made available for host community, locals especially the youths.
- Increased revenue for suppliers as some materials will be sourced locally.

Negative

- Stock piling and dust from materials and vehicular activity may affect the facility's visual aesthetics for personnel and visitors.
- Conflicts over employment issues

Identified Impacts for Construction Phase

A. Environmental Impacts

Positive

- Employment opportunities for people within the host communities for both skilled and unskilled workers.
- Installation of Effluent Treatment Plant (ETP) will avoid the disposal of wastewater generated to the nearest water body.
- Increased livelihood from employment opportunities among host communities, locals, youth, increasing demand for goods and services from retail vendors.

Negative

- Emissions generated from vehicle exhaust, dust and machinery engine emissions could potentially pollute air.
- Introduction of invasive species through negligence during equipment importation.
- Site runoff resulting from dust suppression sprays, cement works, oils, grease from machinery and vehicles.

B. Occupational Health Impacts

Positive

- Reinduction of all site staff and personnel on OHS awareness, safety guidelines and practices.

Negative

- Increased dust in the ambient air in working zones.
- Heat stress from increased exposure of construction workers to the sun.
- Work site accident and injuries, trips, falls and burns.

C. Socio-Economic Impacts

Positive

- Recruitment of skilled, semi-skilled and unskilled labour will be observed.
- Improved livelihood from job opportunities for locals especially the youths.

Negative

- Construction activities may also bring about noise pollution, thus, being a nuisance to neighbours near-by, and others.
- Possibility of conflict between contractor and working personnel.

Identified Impacts for Operations and Maintenance Phase

A. Environmental Impacts

Positive

- Creation of substantial agricultural and agro-allied infrastructure and products within the region.
- Operation of the ETP will avoid the disposal of wastewater generated to the nearest water body, the treated wastewater will be reused in-house for domestic purpose.
- Increased livelihood from employment opportunities among host communities, locals, youth, increasing demand for goods and services from retail vendors.

Negative

- Air Pollution by volatile and gaseous emission (CO, CHCO2, NOx, etc.) from diesel generators and other pollutant emissions from industrial activities in the AIH.
- The operations of the generators and power plants, and industrial operations will generate noise pollution.

- Water and Soil contamination in the event of an accidental oil spill, or contaminants from serviced generators and vehicles can seep into ground and groundwater, which may contaminate the aquifer.

B. Occupational Health Impacts

Negative

- Workplace accidents/incidents resulting from slips, trips and fall from height, cuts and bruises during operation and maintenance.
- Accidental fire outbreak with resultant smoke and soot from the facility

C. Socio-Economic Impacts

Positive

- Offers graduates employment opportunities as well as a channel for knowledge transfer to help skill up the workforce.
- Improve tertiary institution educational curriculum as partnerships will be formed with corporates and local/international academic institutions to improvement tertiary institution educational curriculum and, sensitization programs in universities to change perception and promote innovation and technology among potential graduates with the aim of increasing talent supply.

Negative

- Influx of people into the host community, thereby putting pressure on the existing infrastructure and available resources.
- Increased traffic and road accidents from increased vehicle transit.

Identified Impacts for Decommissioning and Abandonment Phase

A. Environmental Impact

Positive

- Regrowth of new vegetation and return of species that have migrated away from the area.
- Restoration of the project land to the state close to its original state.

Negative

- Disturbance to soil profile, and potential contamination from surface runoff during abandonment.
- Ground water contamination from Site runoff resulting from dust suppression sprays, oils and grease from machinery and vehicles as well as wastewater from dismantling works.
- Pollution resulting from improper management of waste.

B. Socio-Economic Impacts

Negative

- Loss of business/employment/source of income and means of livelihood due to SAPZ – AIH, Heipang Project activity closure. Thus, indirectly impeding other small business activities banking on the project activities.
- Social vices like theft and vandalism because of job loss by host community youths.
- Increased traffic impact while moving demobilized equipment and personnel.

C. Occupational Health Impacts

Negative

- Air quality pollution resulting in illnesses such as swollen eyes, difficulty in breathing, catarrh, and bronchitis (respiratory tract infections).
- On-site traffic congestion and risk of accident during dismantling of the AIH facilities.

ES 5.4 Residual Impact Description

The Residual Impact Description provides a comprehensive evaluation of the ongoing environmental and social impacts that persist despite the implementation of mitigation measures outlined in the Environmental and Social Management Plan (ESMP) for the SAPZ Agro-Industrial Hub (AIH) in Heipang. This section is crucial as it identifies and assesses the impacts that cannot be fully eliminated but can be managed to acceptable levels through continuous monitoring and adaptive management strategies.

The implementation and operation of the SAPZ – AIH project will interact with various environmental and social components, resulting in certain residual impacts. These impacts are the remaining effects on the environment and society after all planned mitigation measures have been applied. The goal of this assessment is to ensure that even these residual impacts are managed in a way that minimizes their significance and promotes sustainable development.

ES 6.1 Mitigation Measures

The measures provided in this section aim to reduce impacts to As Low as Reasonably Practicable (ALARP). Residual impacts that may occur despite these mitigation measures are also acknowledged. Subsequently, Chapter Seven will detail management plans to oversee and monitor these mitigation measures through an effective Environmental and Social Management Plan (ESMP). The acceptability or suitability of a project is contingent on various factors, one of which is the mitigation of negative environmental and social impacts to tolerable levels. Typically, reducing impact significance involves implementing mitigation measures to address identified negative impacts.

ES 6.2 Mitigation Objectives and Hierarchy

The primary objectives of mitigation measures are prevention, reduction, and possible control of impacts. For clarity, the following definitions are provided:

- **Avoidance:** Methods aimed at preventing the occurrence of negative impacts or impeding such occurrences from resulting in harmful environmental or social outcomes.
- **Minimization:** Limiting or reducing the degree, extent, magnitude, or duration of adverse impacts. Reduction can be achieved by scaling down, relocating, or redesigning project elements.
- **Control:** Ensuring that occurring impacts are reduced to a level as low as reasonably practicable.
- **Compensation:** Recompense for residual impacts through offsets.

ES 6.3 Implementation of Mitigation Measures

- Ensure strict adherence to the Environmental and Social Management Plan (ESMP) throughout all project phases.
- Establish a dedicated team responsible for implementing and monitoring mitigation measures outlined in the ESMP.
- Conduct regular training sessions for project staff and contractors on environmental and social responsibilities and best practices.
- Integrate environmental and social criteria into procurement processes to ensure compliance with standards and regulations.

Stakeholder Engagement and Communication

- Develop a comprehensive stakeholder engagement plan to foster transparency, trust, and collaboration among all stakeholders.
- Organize regular meetings, workshops, and consultations with affected communities, local authorities, NGOs, and other relevant stakeholders to address concerns and gather feedback.
- Establish effective communication channels, such as hotlines and grievance mechanisms, to promptly address community grievances and complaints.

Monitoring and Evaluation

- Implement a robust monitoring and evaluation system to track the effectiveness of mitigation measures and identify any emerging environmental or social issues.
- Conduct regular environmental and social impact assessments to assess project performance and compliance with regulatory requirements.
- Review and update the ESMP based on monitoring results and stakeholder feedback to ensure continuous improvement.

ES 6.4 Proffered Mitigation Measures

This section summaries mitigation and adjustment measures for the project's identified potential and associated impacts. It presents the mitigation measures for individual project activities outlined in Chapter 5

Air Quality

Potential impacts include dust and emissions of gaseous pollutants from stockpiled materials, vehicles, heavy machinery, and power generators.

Pre-construction/Construction Phase

The construction site, including excavated and leveled areas, shall be watered regularly under warm, dry, and windy weather conditions to suppress dust. A speed limit of 10 km/hr shall be enforced on unpaved roads and the tops of trucks shall be covered while carrying excavation materials out of the site.

Operational Phase

To reduce the magnitude of emission of harmful gases, the diesel power generators shall be retrofitted with exhaust filters and catalytic converters (to reduce NO_X, CO_X, and SO_X). The generators shall be maintained regularly according to manufacturer specifications. High output solar panels combined with energy storage solutions shall be considered as a measure to generate cleaner energy and reduce emissions.

Residual Impact: Residual impact during operations would be low if the proposed mitigation measures are implemented.

Closure/Decommissioning Phase

The measures that shall be applied to mitigate impacts on air quality during project decommissioning will be the same as those during the preconstruction/construction phase.

Noise and Vibrations

Noise and vibrations occur mainly from the civil works, and the machineries operations and movement of vehicles and equipment.

Pre-construction/Construction Phase

Construction shall be restricted to the daytime to avoid disturbance to residents. All noise generating equipment and vehicles shall be properly maintained. Wherever practicable, construction equipment shall be fitted with noise control devices.

Residual Impact: The significance of any residual impact after implementation of these mitigation measures is medium, as some noise will still be generated by construction activities.

Operational Phase

The major sources of noise would be electric power generating, processing plants and vehicles. Sound-proof generators shall be installed in the centre and its associated facilities, and the

building/associated facilities shall be designed to fulfil WHO guideline values for community noise of 35 dBA and 40 dBA (Leq) for closed window and open window, respectively (Berglund and others, 1999). Vehicle's engine idling and car horn blaring at the car park shall be discouraged and a mechanism shall be developed to record and respond to noise complaints from neighbours.

***Residual Impacts**:* The significance of residual noise and vibration during operations will be low after implementation of the proposed mitigation measures.

Closure/Decommissioning Phase

The measures that shall be applied to mitigate the noise levels during project decommissioning will be the same as those during the pre-construction/construction phase.

Soil and Land Use

Project activities may result in soil erosion or contamination due to removal or compaction of the soil, and spillage or leakage of harmful substances. Measures to reduce the impact in each project phase are discussed below.

Pre-construction/Construction Phase

Any removed topsoil shall be stored in an appropriate area on the project site and be used for landscaping after construction. The stored soil shall be covered by tarpaulins or gravel and the slope of the soils shall not be over 5% to avoid surface runoff. Temporary cross ditches shall be constructed to redirect surface runoff.

Operational Phase

Chemicals used during maintenance of the power transformer and diesel generators such as transformer oil and lubricants, shall be stored and handled appropriately to minimize spills or leaks. Secondary containment shall be built around the underground diesel storage tanks and any chemical storage areas.

Workers shall be trained in proper handling techniques and shall fully conversant with the material safety data sheet (MSDS) accompanying every chemical.

Closure/Decommissioning Phase

The measures that shall be applied to mitigate impacts on soil during decommissioning of the building will be the same as those in the preconstruction/construction phase.

Groundwater

Project activities may result in groundwater contamination from seepage, spillage, and leakage of contaminants. Measures to reduce the impact in each project phase are discussed below.

Pre-construction/Construction

Water to be used for construction activities and washing/cleaning will be abstracted from groundwater boreholes. Rainwater shall be harvested during the wet season for use in washing of equipment to reduce groundwater consumption. Groundwater may be contaminated from oil spillage during maintenance of vehicles and construction equipment, as well as improper disposal of solid waste at the construction site. The mitigation measures for potential groundwater contamination during construction phase shall be as for soil described above.

Operational Phase

The facility would supplement onsite water abstraction with water received from public utilities. Plateau State Government shall take reasonable measures to minimize water consumption. The measures shall include installing where practicable, equipment that eliminate the use of water such as air-cooled equipment & systems, electric vacuum pumps for steam sterilizer equipment, and non-water using air compressors and pumps.

Closure/Decommissioning Phase

The measures to mitigate impacts on groundwater during decommissioning/closure will be the same as those during the preconstruction/construction phase.

Waste Management

Plateau State Government shall establish, operate, and maintain a Waste Management System (WMS) adequate for the scale and type of activities and identified hazards for the centre. Plateau State Government shall undertake regular assessment of waste generation quantities and categories to facilitate waste management planning and investigate opportunities for waste minimization on a continuous basis.

Pre-construction/Construction Phase

Waste bins shall be provided at the construction site for the collection of domestic solid wastes. The wastes shall be segregated and transported to regulatory approved facilities by licensed waste management operators. Any excavated material shall be stored in an appropriate area and be used for landscaping after construction.

Operational Phase

Waste Minimization: As far as reasonably practicable, materials such as paper, plastics, metal cans, and glass shall be reused to reduce waste loads. These shall also be sold to recyclers wherever possible.

Waste Segregation: Domestic waste, hazardous waste shall be segregated at source and collected in appropriately labelled bins, held temporarily at the onsite general waste depot, and transported at suitable planned intervals (weekly for domestic waste and 2 days for hazardous waste) to Plateau State Waste Management Agency approved sites using licensed waste management operators. Used batteries and electronics (ACs, fridges, computers, etc.) shall be sold to licensed recycling firms.

Waste Handling: Waste containers shall be colour coded and puncture resistant. All workers shall be trained on the proper waste management and provided with appropriate PPE which usage shall be enforced for required class of personnel. Proper documentation and handover-takeover along with chain of custody protocol shall be established and maintained for waste consignments transported to licensed facilities.

Hazardous Waste Disposal: Hazardous wastes shall be appropriately packaged and adequately labelled according to the waste category (e.g.: sharps, pharmaceuticals, radioactive, flammable, pathogenic, cytotoxic, hazardous, etc.) for transport to an approved off-site waste treatment facility that can effectively treat the waste.

Residual Impact: The generation of solid wastes during facility operations cannot be avoided. However, the significance of residual impacts will be medium upon mitigation and waste management measures implementation.

Closure/Decommissioning Phase

The same applied during the preconstruction/construction phase shall be applied at decommissioning impacts.

Population and Demography

Pre-construction/Construction Phase

The impacts of the project on demography/population during the pre-construction/construction phase would be low; hence no mitigation measures have been recommended.

Operational Phase

The project impacts on demography/population during the operation phase would be low; hence no mitigation measures have been recommended.

Closure/Decommissioning Phase

The impacts of the project on demography/population during the decommissioning phase would be low and similar to impacts during the construction phase. No mitigation measures have been recommended.

Employment

Pre-construction/Construction Phase

The impacts of the project on employment during the pre-construction/construction phase would be positive and low, and no mitigation measures have been recommended.

Plateau State Government shall enhance the positive impact by sourcing workers and materials locally from the project area and environs.

Operational Phase

The impacts of the project on employment during the operation phase would be positive. Hence, no mitigation measures have been recommended.

Plateau State Government shall enhance the positive impact by as much as possible, sourcing clinic personnel and other workers locally from the project area/environs.

Closure/Decommissioning Phase

The impacts of the project on employment during decommissioning would be medium.

Plateau State Government shall ensure that adequate notice is given to workers prior to decommissioning, and that contract severance agreements are fully complied with.

Vehicles and construction equipment shall be maintained in good working condition to reduce harmful exhaust emissions.

Mobilization of Materials/Equipment to site: Heavy trucks shall, to the extent possible, utilize existing roads and routes to minimize soil compaction. Wastes generated at construction camps shall be collected properly and disposed of by an accredited waste management agency.

Construction camps and stacking areas shall be limited to designated project areas to minimize vegetation loss. Noise attenuation measures, such as fencing and the use of mufflers, shall be implemented to mitigate noise effects on wildlife.

Adequate consultations shall be conducted with host communities, with the active involvement of the Plateau State government, to minimize the occurrence of conflicts.

Civil/Structural works and facility installations: Piling and foundation activities shall be conducted meticulously, adhering to international best practices. Additional hydrogeological studies shall be conducted to ensure adequate groundwater resources.

Proper machinery maintenance shall be implemented to reduce noise levels. Noise attenuation methods like barriers or mufflers shall be utilized. Erosion control measures shall be implemented to prevent soil disturbance and vegetation damage. Disturbed areas shall be re-vegetated promptly.

Operation/Maintenance Phase

Operation of the Facility: AIH will establish a policy promoting the recruitment of workers from local/host communities, with positions open to job seekers from outside the host communities only if local candidates are unavailable. This approach will help deter the influx of job seekers to some extent.

ES 7.1 Environmental and Social Management Plan

The Environmental and Social Management Plan (ESMP) serves as a stand-alone tool utilized to monitor the effectiveness of mitigation measures and project commitments outlined in the Environmental and Social Impact Assessment (ESIA). It is integrated into the project implementation process to minimize or eliminate adverse impacts and ensure compliance with environmental regulatory standards and corporate HSE policies. The ESMP outlines the

commitments to implementing mitigation measures incorporated into the project design, as well as additional mitigations recommended in the ESIA. It also delineates the roles and responsibilities of various stakeholders. Furthermore, the ESMP emphasizes all biophysical and social environmental attributes to be monitored throughout the lifecycle of the proposed project, aiming to curtail associated negative, residual, and cumulative impacts, and identify any impacts not addressed in the ESIA report arising from project implementation.

ES 7.2 Scope and Objectives of ESMP

The ESMP is designed to meet required standards and regulations on environmental and social management performance, aligning with ISO 14001: Environmental Management System (EMS) guidelines. It encompasses the entire project lifecycle from pre-construction to decommissioning phases and undergoes reviews and updates before activities commence. The main objective of the ESMP is to integrate environmental and social considerations into daily decision making, ensuring that environmental risks are managed throughout the project lifecycle. It serves as a working document for tracking, evaluating, and communicating environmental and social performance, with objectives including monitoring compliance, ensuring best practices management, and raising awareness of potential impacts.

ES 7.3 Stakeholders Engagement Plan

Consistent with the African Development Bank Group Environmental and Social Policies and Guidelines, the stakeholder's engagement plan is designed to establish an effective platform for productive interaction with the potentially affected parties, disadvantaged groups, and others with interest in the implementation outcome of the Project. The stakeholder engagement plan will provide meaningful stakeholder engagement throughout the project cycle. The consultation is aimed to solicit views, concerns, comments, and inputs from a wide range of stakeholders and project affected parties regarding project implementation.

The primary objectives of the Stakeholder Consultation are summarized below:

- Provide project related information and materials to affected and interested parties.
- Solicit feedback from stakeholders to inform project design, implementation, monitoring, and evaluation.
- Enhance project acceptance by clarifying project objectives and scope at an early stage and manage stakeholders' expectations.
- Assess and mitigate project environmental and social impacts and risks.
- Enhance project benefits.
- Address project grievance.

ES 7.4 Environmental Health and Safety Plan

A Health and Safety Plan will be prepared for the construction, operation, and decommissioning phases of the project to ensure compliance with the Ministry of Health Guidelines for Occupational Health and Safety and IFC guidelines.

To ensure the health and safety of its employees, the SAPZ – AIH, Heipang plan will address the following topics:

- Safety devices to protect employees from injuries or hazardous conditions.
- Provision of safe drinking water.
- Immunizations, as applicable.
- Maintenance of a clean eating area.
- Availability of first aid facilities.
- Maintenance of sanitary conditions.
- Waste management, including bathrooms and proper disposal procedures.
- Provision of appropriate signage.
- Installation of fire prevention facilities, along with training and awareness programs.
- Provision of Personal Protective Equipment (PPE).

ES 7.5 Emergency Response Plan

An Emergency Preparedness and Response Plan (EPRP) will be prepared to assist project staff in effectively responding to emergencies associated with project hazards. The EPRP will comply with the Federal Ministry of Environment, Nigeria, EIA Procedural Guidelines, the ISO 14001 approach, and the Hazard and Effect Management Process (HEMP), International Labour Organization (ILO), Nigeria, Occupational Safety guidelines and performance standards. The EPRP will include:

- Roles and responsibilities of emergency personnel.
- Emergency contacts and communication systems/protocols, including procedures for interaction with local and regional emergency authorities.
- Specific emergency response procedures.
- Design and implementation of an emergency alarm system audible across the entire site and at the sub-stations.
- An evacuation plan will be read and practiced by all employees and contractors. The evacuation plan will include emergency escape routes, procedures for accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation.

- Identification of supplies and resources to be utilized during an emergency event, including emergency equipment, facilities, and designated areas.
- A training plan, which includes specific training and drill schedules for personnel who are responsible for rescue operations, medical duties, spill response, and fire response.

ES 7.6 Waste Management Plan

Waste management guidelines and disposal options is very necessary for the running of a plant. The continuous use of the principle of waste reduction, recycling, recovery and reuse will make the company to be more environmentally friendly.

The Heipang, SAPZ – AIH will develop a project-specific waste management plan to ensure proper management of all waste generated during project activities, including agricultural waste and waste from agro-allied industrial development, in accordance with applicable laws, regulations, and international standards relevant to the power distribution industry. The Waste Management Plan will encompass:

- Description of the types of waste generated, including agricultural waste and agro-allied industrial development related waste.
- Opportunities for waste minimization, including strategies tailored to agricultural and agro-allied industrial activities.
- Methods for waste management, addressing the unique characteristics of agricultural waste and agro-allied industrial development related waste.
- Good housekeeping practices, including manifest and waste tracking forms specific to agricultural and agro-allied industrial waste.

In addition to the previously mentioned waste categories, agricultural waste like crop residues, processing by-products, and packaging materials, will be considered. These waste types will be managed through appropriate methods, including composting, recycling, and reuse, where feasible and environmentally sound. During the construction phases, efforts will be made to minimize agricultural waste generated from land clearing activities and to properly manage any waste produced. Similarly, waste generated from agro-allied industrial development activities, such as processing operations, will be managed according to the Waste Management Plan's guidelines.

ES 7.7 Climate Management Plan

Using the Climate and Disaster Risk Screening Tool, a comprehensive assessment was conducted for the proposed site, enabling the consideration of both short- and long-term climate and disaster risks during the early stages of project design. Integrating resilience-building measures against climate and geophysical hazards is crucial in combating poverty and promoting sustainable

development. By screening for risks associated with these hazards, the likelihood and longevity of project success are significantly enhanced.

The project-level Climate and Disaster Risk Screening facilitates preliminary evaluation of climate and disaster risks during the conceptual phase of project development.

ES 7.7 Environmental Management Plan

The primary object of environmental monitoring is to ensure that mitigation measures are implemented, and the potential negative impacts are reduced, minimized to acceptable levels. The primary objective of the Special Agro-Industrial Processing Zone Monitoring Plan includes the following:

- To assess the changes in environmental conditions.
- To assess performance and the effectiveness of the mitigation measures adopted.
- To determine project compliance with regulatory requirements and adopt remedial action.
- To identify potential gaps and promptly implement of corrective measures.

The project monitoring scope is divided into two (2) main phases namely;

1. Impact detection monitoring which includes periodic sampling to assess the impact of project operations on the environment and human health, and to ensure progress towards minimizing project's negative impact. This is also referred to as Institutional monitoring which be conduct by the project Environmental Officer and team of sustainable staff.
2. Compliance monitoring is conducted to ensure that all project and sub-project activities are in full compliance with the Environmental Protection Agency regulations and standards. It is usually commissioned by a Third-Party Evaluator accredited by the FMEnv.

Monitoring Parameters

The receptors required monitoring include:

a) Air Quality
b) Water Resources
c) Soil Quality
d) Waste Generation & Management
e) Occupational Health and Safety
f) Odor
g) Noise Quality
h) Landscape and Visual
i) Biodiversity

ES 8 Decommissioning, Abandonment and Remediation Plans

The design life of the proposed facility is 50 years. However, the useful life may extend beyond that. During operations, the performance, and the integrity of the systems component of the facilities will be monitored with respect to project operations and maintenance procedures. A decommissioning team will be established to plan and execute a safe and environmentally acceptable decommissioning program within the approved guidelines and standards. The procedure will be developed for approval by management and will include risk assessment. The decommissioning plans will be reviewed by the FMEnv and other relevant regulatory agencies.

ES 9 Conclusion and Recommendations

Although the existing environmental conditions of the project area are not in a pristine state, they present no overriding environmental constraint to the project. From the report (and indeed the study) the following inferences could be made:

i. The proposed project is most desirable because of the obvious environmental and socio-economic benefits. These far outweigh the negative impacts that could arise during implementation.

ii. Potential impacts of sufficient magnitude that could interrupt the execution of the project were not detected. Although there were a few negative impacts that may occur due to the activities associated with the proposed project, adequate measures have been provided to address them.

iii. Mitigation measures and management plans have been suggested and developed for the negative impacts.

iv. An appropriate institutional framework shall be set up to implement the mitigation measures recommended while the proposed monitoring programmes shall be set in motion as soon as possible.

It is recommended that a comprehensive stakeholder engagement plan be developed and implemented to address the concerns of all parties and to ensure transparent communication throughout the project's lifecycle.

ACKNOWLEDGEMENT

Plateau State Government through the Plateau State Ministry of Agriculture and Rural Development wishes to acknowledge the Government of the Federal Republic of Nigeria, African Development Bank (AfDB), the Federal Ministry of Environment (FMEnv.), Plateau State Ministry of Environment, and all other relevant stakeholders and the host communities for their support during this Environmental and Social Impact Assessment (ESIA) study for the "proposed Special Agro-Industrial processing Zone II (SAPZ II) Agricultural Industrial Hub (AIH) at Heipang community, Barkin Ladi LGA, Plateau State".

The Contributions of the Environmental Consultant, Bolben Energy and Environmental Services Limited commissioned to execute this ESIA study is also well acknowledged and commended.

CHAPTER ONE
INTRODUCTION

1.1 Project Background

The Government of the Federal Republic of Nigeria through the Federal Ministry of Agriculture and Food Security with assistance from the African Development Bank (AfDB), Islamic Development Bank (IsDB) as well as International Funds for Agricultural Development (IFAD) seeks to increase value addition to some staple agricultural products in Nigeria through the introduction of Special Agro-Industrial Processing Zones (SAPZ) Programme.

The Special Agro-industrial Processing Zones (SAPZ) is a major investment program of the Federal Government of Nigeria (FGN), driven by the Federal Ministry of Agriculture and Food Security (FMAFS) in collaboration with the State Governments, Development partners, relevant Federal Ministries, Departments and Agencies (MDAs) and private investors to develop agro-processing clusters in areas of high agricultural production across the country. It is a strategic move to rapidly develop modern agro-processing capacity to serve the vast and growing local market, create sustainable market for farmers and reduce postharvest losses of local agricultural produce and thereby create wealth for farmers, promote import substitution and create sustainable agriculture related jobs for women and youth.

This approach is to help address investment challenges in the development of agro-processing enclaves across Nigeria, including poor access to quality infrastructure, inadequate feedstock supplies and other challenges confronting agro-processing environment. SAPZs, therefore, will be developed with requisite infrastructure like road, power, water for agro-processing environment which will help reduce cost absorptions and engender competitiveness in agro-industrial production that is critical to further unlocking the potentials of Nigeria's Agriculture to create ready markets and wealth for farming communities and reduce rural poverty.

The SAPZ Program is aligned with the national policies and priorities. It seeks to sustainably contribute to poverty alleviation, zero hunger and inequality while providing opportunities for economic diversification, job creation, building climate resilience and improved livelihoods in Nigeria. It will also contribute to rural infrastructure development, improved access to agricultural markets, increased farm productivity, the adoption of agricultural technology, climate smart agricultural production and processing practices, increased value addition and agro-processing, increased skills acquisition, and job creation, for all actors along the value chain, including the small holder farmers, women and youth, people with special needs and vulnerable groups.

The first Phase of Special Agro-Industrial Processing Zone (SAPZ) Program was implemented in seven (7) states, namely: Cross River, Imo, Kaduna, Kano, Kwara, Ogun, and Oyo, and the Federal Capital Territory (FCT).

Plateau State has shown interest and commitment to participate in this second (II) phase of the Special Agro-Processing Zones programme. The SAPZ II will be made up of two major components which are the Agricultural Transformation Centers (ATCs) and the Agro-Industrial Hubs (AIHs) across all the participating states.

1.2 Overview of the SAPZ II intervention program

Generally, the proposed SAPZ II intervention program covers the following infrastructure;

- The Agro Industrial Hub (AIH) at Heipang will have the manufacturing and related service units from Training, farm inputs, procurement and value addition of the identified agriculture products as a forward or backward integration to each other. It is also proposed to have 3 aggregation centers with cleaning, grading, packing with pre-cooling facilities in its catchment areas.
- It is proposed that as part of the backward integration, Agriculture Transformation Centers (ATC) at Mangu and Shendam will be developed.
- The proposed ATC at Mangu and Shendam is planned in an area of around 100 hectares and 100 hectares respectively. Both the ATCs will have 3 aggregation centers each with cleaning, grading, packing with pre-cooling facilities in its catchment areas.
- At Mangu it is also proposed to develop a modern market for agricultural produce both for wholesale and retail.

1.2.1 Special Purpose Vehicle

- A Special Purpose Vehicle (SPV) is proposed to be promoted by the Government for overall implementation of the project at State level
- SPV is a legal entity created for a specific objective and can take any legal form such as a company (private limited/ public limited), corporation, trust/society etc
- SPVs are viewed as vehicles for facilitating private investment for infrastructure development
- Principles of PPP to be incorporated

Figure 1.1: Functions of SPV

Research tools

- Preliminary consultations
- Collection, review & research of available relevant and recent secondary data, reports and information
- Multi-stakeholder consultations and assessments - FGDs, stakeholder meetings etc
- Information from the field assessment and stakeholder meetings was triangulated with the secondary data
- Situational and context analysis was undertaken that highlights the need and objectives of the activities

1.3 The Proponent

Plateau State Government through the State Ministry of Agriculture and Rural Development is the proponent of the proposed project. However, as a result of the potential environmental and scio-economic effects that could result from the proposed project activities and in line with emerging global trends on the benefit of an environmentally sustainability as well as compliance with all relevant regulatory requirements, Plateau State Government has Commissioned **Messr Bolben Energy and Environmental Services Limited** to conduct the Environmental and Social Impact Assessment (ESIA) Studies for the Proposed Agro-Industrial Hub at Heipang, Plateau State.

1.4 Project Location

Plateau state is the twelfth-largest state in Nigeria, and it is in the north-central part of the country. It is geographically unique in Nigeria due to its boundaries of elevated hills surrounding its capital and the entire Plateau itself and the name was derived from the Jos plateau.

Plateau State is celebrated as "The Home of Peace and Tourism". With natural formations of rocks, hills, and waterfalls. The state is bordered on the Northeast by Bauchi State, on the Northwest by Kaduna State, on the Southwest by Nasarawa State and on the Southeast by Taraba State.

The proposed site for the Agro-Industrial Hub (AIH) at Heipang is located between Latitudes 09°38′30″N and 09°40′00″N of the Equator, and longitudes 8°51′00″E and 8°53′30″E of the Prime Meridian. The site is located close to the airport and is adjacent to the Jos dry port and is well connected by road network. The land is generally flat and devoid of any perineal vegetation and has been used for agriculture. A land area of around 543.9 hectares has been identified at Heipang community, Barkin Ladi LGA for the development of an AIH. Out of the 543.9 hectares, an area of 100 hectares is being developed as an industrial zone and the remaining 443.9 hectares is being allocated for commercial cultivation of focus crops and seed multiplication.

Figure 1.2 is the Map of Nigeria showing Plateau State, Figure 1.3 is the map of Plateau State showing Barkin Ladi Local Government Area.

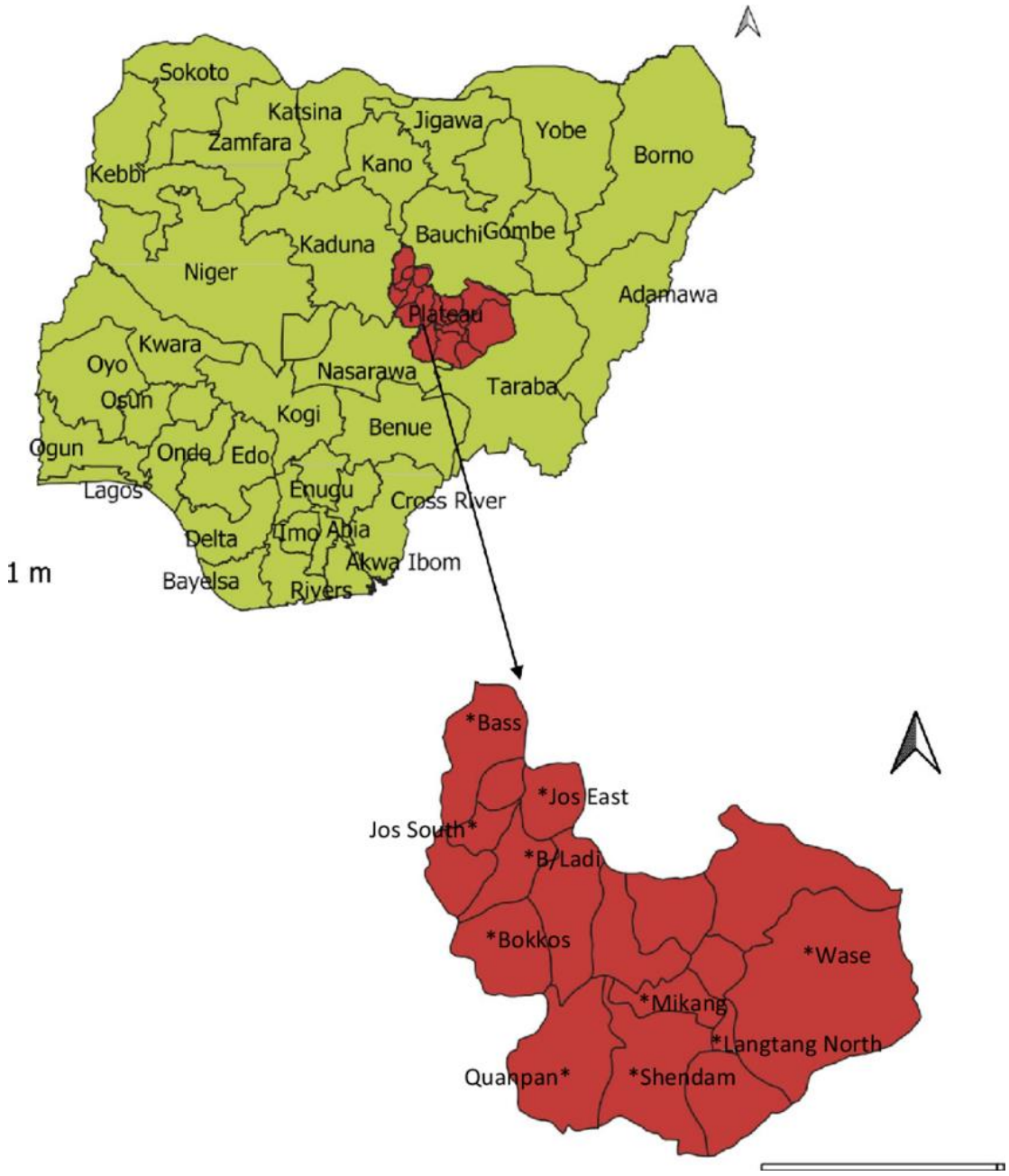

Figure 1.2: Map of Nigeria showing Plateau State

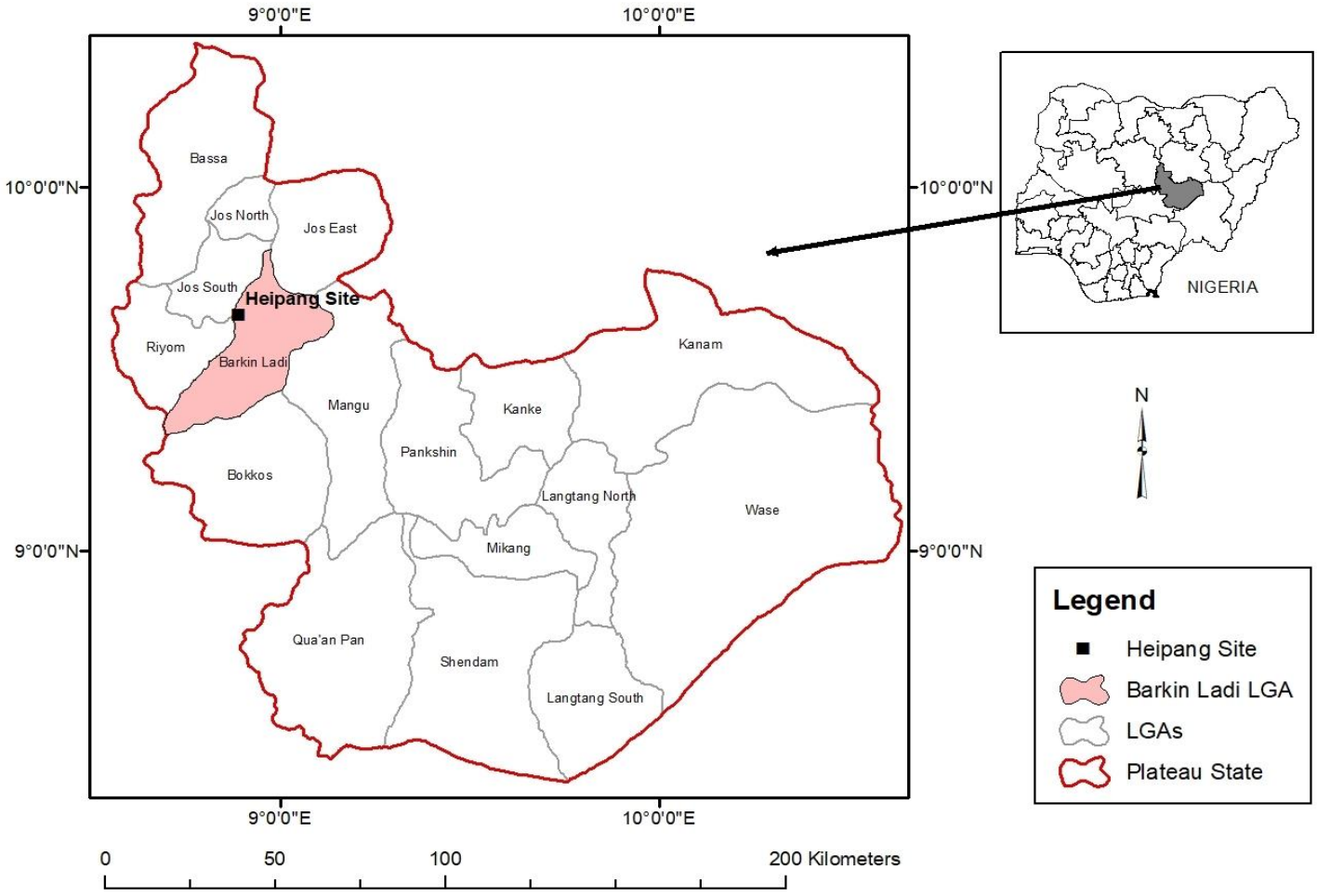

Figure 1.3: Map of Plateau State showing Barkin Ladi LGA

1.5 Project Objectives

The SAPZ II Program goal is to increase household income, foster job creation in rural agricultural communities and enhance food and nutritional security in Nigeria. The development objective is to support inclusive and sustainable agro-industrial development. The SAPZ Program interventions will seek to enhance the competitiveness of selected value chains which include Rice, Yam, Cassava, and some Perishables. This will be achieved through increased productivity, aggregation and reliable.

1.6 ESIA Objectives and Terms of Reference (ToR)

1.6.1 Objectives of the ESIA Study

The main objectives of the ESIA for the proposed SAPZ II Agro-Industrial Hub (AIH) project were:

- Ensure compliance with Nigeria National Environmental Regulations and Policies, African Development Bank and IFAD Standard Industry best practices.
- Provide all necessary environmental baseline data that will form the basis for determining the state of the environment in the project area and identify all environmental aspects of the project that may positively or negatively impact on the environment;
- To identify the associated and potential physical, biological, health, socio-economic and or cultural impacts of the proposed project within the project area.
- To suggest cost effective impact mitigation/remedial measures to ensure successful implementation and sustainability of the project.
- Incorporate the findings from the ESIA study into a detailed and final project design and decisions.
- Develop plans and procedures for effective environmental management of the project throughout its life cycle.
- To produce an EIA report in consonance with the FMEnv laid down procedural and sectorial guidelines and procedures for environmental impact assessment reports.

1.6.2 Terms of Reference (ToR)

The Terms of Reference for the ESIA study is as approved and in accordance with the FMEnv EIA Process guideline. The highlights are as follows, to:

- Establish the baseline environmental data for ecological and socio-economic condition of the project area;
- Identify, evaluate and predict the project's impacts on the environment;
- Develop control strategies with a view to mitigate and ameliorate significant impacts of the project; and
- Recommend an environmental management plan for the entire life cycle of the project.

1.6.3 Scope of Work (SoW)

The scope of the EIA study includes, among others, the following:

- Project definition and preparation of terms of reference;
- Field sampling of environmental components of the project area;
- Qualification of potential impacts, prediction and evaluation of their significance using appropriate assessment models;
- Identification of effective mitigation measures for the project's activities;
- Development of comprehensive environmental management plan including monitoring, decommissioning and remediation plans after closure of the project site; and
- Writing of report that conforms to standards and guidelines set by the regulations and international best practices.

The samples taken and analyzed for pollutants include, but not limited to:

1. Soil Samples;
2. Surface water samples and
3. Groundwater Samples

Similarly, the following were also established:

- Measurement of existing noise levels under representative conditions at the community closest to the site boundary for baseline data purposes.
- Acquisition of available climatic data to analyze the prevailing meteorological conditions of the project area.
- Determination of the location, approximate magnitude, and quality of runoff discharge to existing water body.
- Recommendation of a continuing program of air, water, and noise monitoring during operation of the project, including method of measurement, location and frequency.
- Conduct of a Public Panel Review in accordance with FMEnv regulatory guidelines.
- Presence at public hearing (if any) on the ESIA and response to any issues raised by the regulatory agencies and stakeholders during the panel review meeting.
- Capture and incorporate all the comments generated through the ESIA Panel Review into the Final Environmental and Social Impact Assessment (ESIA) report.

1.7 Administrative and Legal Framework

The EIA study was carried out within the framework of national and international laws, guidelines, and regulations. The international guidelines include those of the African Development Bank (AfDB), Islamic Development Bank (IsDB) as well as International Treaties and Conventions to which Nigeria is signatory, while the regulations, guidelines and standards, include those of the Federal Ministry of Environment (FMEnv), Plateau State Ministry of Environment, Plateau State Environmental Protection

and Sanitation Agency (PEPSA), Plateau State Ministry of Agriculture and Rural Development and the Project Host Local Government Areas. The overall legal and administrative framework within which the EIA was conducted is presented as follows:

1.7.1 National Regulations and Frameworks

National laws, regulatory requirements, guidelines, and standards are applied at the national level through regulatory bodies for the purpose of environmental protection and management in Nigeria. Several Acts, Policies and national regulations and international conventions guide preparation of environmental impact assessment activities in Nigeria. Some of these laws, regulations and international conventions are discussed as follows:

1.7.1.1 Federal Ministry of Environment

The Federal Government of Nigeria established Federal Ministry of Environment (FMEnv) in 1999 by a Presidential Directive with an overall mandate to protect, restore and preserve the entire ecosystem of the Nigerian environment. Twenty-one guidelines for pollution abatement in all categories of industries were drafted. Part of the guidelines make it mandatory requirement for environmental auditing of all existing industries and Environmental Impact Assessment (EIA) of new industries and major development projects.

The Federal Ministry of Environment (FMEnv) since inception has been empowered with the overall responsibility of environmental matters in Nigeria. It has developed instruments of intervention to halt environmental degradation in the form of policies, standards, guidelines, and regulations. With the initiation of these instruments, enforcement by FMEnv has become the most effective tool to bring industries and regulated communities into compliance through compliance promotions. These policies are as follows:

Revised National Policy on Environment (2016): The revised National Policy on Environment of 2016 sets out the following goals, objectives, and guiding principles:

Goals, Objectives, and Guiding Principles

Policy Goal: The goal of the National Policy on the environment is to *'ensure environmental* protection *and* the *conservation of natural resources for sustainable development'.*

Strategic Objectives: The strategic objective of the National Policy on the Environment is to coordinate environmental protection and natural resources conservation for sustainable development. This goal will be achieved by the following strategic objectives:

- Securing a quality of environment adequate for good health and well-being;
- Promoting sustainable use of natural resources and the restoration and maintenance of the biological diversity of ecosystems;
- Promoting an understanding of the essential linkages between the environment, social and economic development issues;

- Encouraging individual and community participation in environmental improvement initiatives;
- Raising public awareness and engendering a national culture of environmental preservation; and
- Building partnership among all stakeholders, including government at all levels, international institutions and governments, non-governmental agencies, and communities on environmental matters.

Guiding Principles: The following principles are central to the attainment of the strategic objectives of this Policy:

- ***The Public Trust Doctrine,*** which recognizes that the State is a trustee of all-natural resources, the enjoyment of which is subject to a measure of control necessary to protect the legitimate interest of all sections and stakeholders in the larger framework of strategic national interests;
- ***Environmental Right,*** which ensures that every Nigerian has a right to a clean and healthy environment and a duty to safeguard and enhance the environment;
- ***Environmental Offsetting,*** which requires that where for exceptional reasons of overriding public interest, the general obligation to protect threatened or endangered species and natural systems that are of special importance to sustaining life, providing livelihoods, or general well-being cannot be provided, such cost-effective offsetting measures must be undertaken by the proponents of an activity to restore as nearly as may be feasible the lost environmental services to the community;
- ***The Polluter Pays Principle,*** which prescribes that the polluter should bear the cost of preventing, and remediating pollution;
- ***The User Pays Principle*** in which the cost of a resource to a user must include all the environmental costs associated with its extraction, transformation and use (including the costs of alternative or future uses forgone);
- ***The Precautionary Principle,*** which holds that where there are threats of serious or irreversible damage, the lack of full scientific knowledge shall not be used as a reason for postponing cost-effective means to prevent environmental degradation;
- ***The Subsidiarity Principle,*** which reflects the preference for making decisions at the lowest level of government or social organization where the issue can be effectively managed – decisions made at the local level are often viewed as more likely to take account of local environmental conditions and the opinions of the local people who often bear the highest environmental costs of development;
- ***Pollution Prevention Pays Principle***, which encourages Industry to invest positively to prevent pollution;
- ***The Principle of Inter-generational Equity***, which requires that the needs of the present generation are met without compromising the ability of future generations to meet their own needs;

- ***The Principle of Intra-generational Equity***, which requires that different groups of people within the country and within the present generation Have the right to benefit equally from the exploitation of resources and that they Have equal right to a clean and healthy environment;
- ***The Principle of Participation***, which requires that decisions should, as much as possible, be made by the people or on their behalf by representatives chosen by them;
- ***International Cooperation*** in which the country will domesticate multilateral environmental agreements (MEAs) and regional instruments and implement them cooperatively for better environmental management of shared resources. In this regard, the country will take cognizance of all relevant international agreement on the environment and mainstream them in the protection of Nigeria's; environment
- ***Good Environmental Governance*** in which rule of law, effective institutions, transparency and accountability, respect for human rights and the meaningful participation of citizens will be integrated in environmental management;
- ***Integrated Ecosystem Approach*** in which conserving environmental resources is adopted and enhanced to ensure that all the country's ecosystems are managed to the benefits of the people.

1.7.1.2 Environmental Impact Assessment (EIA) Act CAP E12, LFN 2004

The EIA Act, Cap E 12, LFN, 2004, makes EIA mandatory for any major development project likely to have adverse impacts on the environment. It provides guidelines for activities for which an EIA is compulsory and prescribes the procedure for conducting and reporting EIA. Some of these activities include agriculture, construction of airport, drainage and irrigation, land reclamation, industry, infrastructure development, major building projects, coastal reclamation, ports, mining, petroleum, power generation etc. The required process involves the preparation of the mandatory EIA report and an assessment by a review panel.

The Act sets out to:

- Consider the likely impacts and the extent of these impacts on the environment before embarking on any project or activity;
- Promote the implementation of appropriate policy in all federal laws consistent with all laws and decision-making processes through which goal of the Act may be realized;
- Encourage the development of procedures for information exchange, notification and consultation between organizations and persons when the proposed activities are likely to have significant environmental effects on boundaries or inter-state or on the environment of bordering towns and villages.

An Environmental Impact Assessment (EIA) is an assessment of the potential impacts whether positive or negative, of a proposed project on the natural environment, dealing with the considerations of environmental impact in respect of public and private projects. This regulatory framework for EIA implementation in Nigeria confers the mandate on the FMEnv to ensure proponents of all new major

development activities carry out EIA on their proposed projects. There is also a provision for penalties in case of violation and non-compliance.

Some sections relevant to environmental emergency prevention under the EIA include:

(A) Part 1 Section 2 (1) requires an assessment of public or private projects likely to Have a significant (negative) impact on the environment.

(B) Part 1 Section 2 (4): *"All agencies, institutions (whether public or private) except exempted pursuant to this Decree, shall before embarking on the proposed project apply in Writing to the Agency (now FMEnv.), so that subject activities can be quickly, and surely identified and environmental assessment applied as the activities being planned."* This section establishes cases where an EIA is required.

(C) Part 1 Section 1(c): *"To encourage the development of appropriate procedures for information exchange, notification and consultation between organs and persons when proposed activities are likely to have significant environmental effects on boundary and trans-state or on the environment of bordering towns and villages."*

This provision forms part of the objectives of the EIA process. It provides that information exchange, notification and consultation would not only extend to communities but also persons affected in their individual capacity.

(D) Part I Section 4(h): The least minimum matters to be addressed by the EIA to include *"A brief and non-technical summary of the information provided under paragraph (a) to (g) of this section,"* which ought to be widely circulated. Thus, communities ought to have ready access to EIA reports.

(E) Part I Section 7: Requiring the giving of *"opportunity to government agencies, members of the public, experts in any relevant discipline and interested groups to make comment on environmental impact assessment of the activity."*

(F) Part I Section 9 (2, 3 & 4): *"The report of the Agency shall be made available to interested person or group. If no interested person or group requested for the report, it shall be the duty of the Agency to publish its decision in a manner by which members of the public or persons interested in the activity shall be notified. The Council may determine an appropriate method in which the decision of the Agency shall be published to reach interested persons or groups, in particular the originators or persons interested in the activity subject of the decision".*

This section requires an application in Writing to the Agency before embarking on projects for their environmental impact assessment to determine approval.

(G) Part 1 Section 13: *"(1)When a project is described on the Mandatory Study List specified in the Schedule to this Decree or is referred to mediation or a review panel, no Federal, State or Local Government or any of their authority or agency shall exercise any power or perform any duty or functions that would permit the project to be carried out in whole or in part until the Agency EIAs taken a cause of action conductive to its power under the Act establishing it or EIAs taken a decision or issue an order that the project could be carried out with or without conditions".*

(H) Part II Section 16 & 17: Participation in *"every screening or mandatory* study," which requires *"comments concerning those effects received from the public..."*

(I) Part II Section 22 (3): *Before taking a course of action in relation to a project pursuant to subsection (1) of this section, the agency shall give the public an opportunity to examine and comment on the screening report and any record that EIAs been filed in the public registry established in respect of the project..."*

(J) Part II Section 25 (1 & 2): *"After receiving a mandatory study report in respect of a project, the Agency shall, in any manner it considers appropriate, publish in a notice setting out the following information:*

- The *date on which the mandatory study report shall be available to the public*
- *The place at which copies of the report may be obtained; and*
- *The deadline and address for filing comments on the conclusions and recommendations of the report. "Prior to the deadline set out in the notice by the Agency, any person may file comments with the agency relating to the conclusions and recommendations of the mandatory study report."*

(K) **Part II Section 31***: "Where a project is to [be] referred to mediation or a review panel under the Decree, the Council shall, within a prescribed period, refer the Council project to mediation if the Council is satisfied that:*

- *The parties who are directly affected by or have direct interest in the project Have been identified and are willing to participate in the mediation through representatives, and*
- *The mediation is likely to produce a result that is satisfactory to all the parties."*

(L) Part II Section 34 (1 & 2): *"A mediator shall not proceed with a mediation unless the mediator is satisfied that all of the information required for a mediation is available to all of the participants.* "*Mediation shall, in accordance with the provisions of the Decree, and the terms of reference of the mediation help the participants to reach a consensus on:*

- *The environmental effects that are likely to result from the project*
- *Any measures that would mitigate any significant adverse environmental effects, and*
- *An appropriate follow-up programme"*

(M) **Part II Section 37***: "A review panel shall, in accordance with the provisions of the Decree and its terms of reference*

- ✓ *ensure that the information required for an assessment by a review panel is obtained and made available to the public*
- ✓ *hold hearing in a manner that offers the public an opportunity to participate in the assessment..."*

(N) Part II Section 39: *"On receiving a report submitted by a mediator or review panel, the Agency shall make the report available to the public in any manner the Council considers appropriate and shall advise the public that the report is available."*

(O) Part II Section 41 (2) (b): *"The agency shall advise the public of*

- ✓ *its course of action in relation to the project*
- ✓ *any mitigation measure to be implemented with respect to the adverse environmental effects of the project*
- ✓ *the extent which the recommendations set out in any report submitted by a mediator, or a review panel Have been adopted..."*

(P) Part II Section 47: *"The Council shall not approve a substitution pursuant to subsection 46 (1) of the Decree unless the Council is satisfied that (b) the public EIAs been given an opportunity to participate in the assessment..., and (d) the report EIAs been published."*

(Q) Part II Section 57*: "For the purpose of facilitating public access to records relating to environmental assessment, a public registry shall be established and operated in accordance with the provisions of the Decree in respect of every project for which an environmental assessment is conducted..."*

(R) Part III Section 62: *"Any person who fails to comply with the provisions of this Decree shall be guilty of an offence under this Decree and on conviction in the case of an individual to N100,000 fine or to five years imprisonment and in the case of a firm or corporation to a fine of not less than N50,000 and not more than N1,000,000".* This section creates a legal liability for contravention of any provision. Consequently, the environmental management activities at each phase of the project should be guided by environmental standards including those imposed by legislations and those established by self-regulating industrial codes of practice, industry standards and company policy.

1.7.1.3 National Interim Guidelines and Standards for Environmental Pollution Control in Nigeria

This document was drafted in March 1991 to serve as a basic instrument for monitoring and controlling industrial and urban pollution. These guidelines were initiated sequel to the drafting of the National Environmental Policy in 1989. The guidelines and standards relate to six (6) areas of environmental concern, thus:

- ✓ Effluent limitations
- ✓ Water quality or industrial water uses at points of intake
- ✓ Industrial emission limitations
- ✓ Noise exposure limitations.
- ✓ Management of solid and Hazardous waste
- ✓ Pollution abatement in industries.

1.7.1.4 National Environmental Protection (Effluent Limitations) Regulations, 1991

The National Effluent Limitation Regulation, S.1.8 of 1991 (No. 42, Vol. 78, August,1991) makes it mandatory for industries as waste generating facilities (including research institutes, clinics, hotels etc.) to install anti-pollution and pollution abatement equipment on site. The regulation is specific for each category of waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem. Appropriate penalties for contravention are specified also in the regulation.

1.7.1.5 National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2011

The purpose of these regulation is to restore, preserve and improved the quality of air. The standards contained herein provide for the protection of the air from pollutions, as well as take into account amongst others:

a. Citizens right of access to clean air;
b. Reducing and preventing air pollution through the improvement of the quality of automobiles that operate on the road way; and
c. Improve the health of Nigerians especially in the Urban areas with high incidence of air pollution due to increased number of automobiles that ply the roads.

1.7.1.6 National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991

Where and when applicable, the pollution abatement regulation, S.1.9 of 1991 (No. 42, Vol. 78, August, 1991) imposes restrictions on the release of toxic substances and stipulates requirements for pollution monitoring units, machinery for combating pollution and contingency plan by industries; submission of lists and details of chemicals used by industries to FMEnv, requirement of permit by industries for the storage and transportation of Harmful or toxic waste; the generator's liability; strategies for waste reduction; permissible limits of discharge into public drains; protection of workers and safety requirements; (environmental audit for existing industries or Environmental Impact Assessment for new industries) and penalty for contravention.

1.7.1.7 National Environmental Protection (Management of Hazardous and Solid Wastes) Regulations, 1991

The management of hazardous and solid waste regulation, S.1.15 of 1991 (No. 102, Vol. 7, August, 1991) defines the requirements for groundwater protection, surface impoundment, land treatment, water piles, landfills, incinerators etc. It also describes the hazardous substances tracking programme with a comprehensive list of acutely hazardous chemical products and dangerous waste constituents. It also states the requirements and procedure for inspection, enforcement, and penalty.

1.7.1.8 Environmental Impact Assessment Procedures and Charges Regulations, 2021

The objective of these Regulations is to indicate the procedure in the Environmental Impact Assessment (EIA) process from project conception to commissioning and follow-up activities to ensure that the project is implemented with maximum consideration for the environment.

1.7.1.9 National Environmental Standards and Regulations Enforcement Agency (NESREA) Act, 2007

In order to show its readiness to ensure compliance, the Federal Government has in July 2007 released an official gazette establishing the National Environmental Standards and Regulations Enforcement Agency (Establishment) Act, 2007. The agency is charged with the enforcement of environmental standards, regulations, rules, laws, policies and guidelines. Above all, the agency was saddled with the responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources in general and environmental technology, including coordination and liaison with relevant stakeholders within and outside Nigeria on matters of enforcement of environmental standards, regulations, rules, laws, policies, and guidelines.

The NESREA Regulations relevant to the proposed development include the following:

- ✓ National Environmental (Ozone Layer Protection) Regulations, 2009. S. I. No. 32. These provisions seek to prohibit the import, manufacture, sale, and the use of ozone-depleting substances.
- ✓ National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35. The main objective of the provisions of this Regulation is to ensure the tranquility of the human environment or surroundings and their psychological well-being by regulating noise levels.
- ✓ National Environmental (Soil Erosion and Flood Control) Regulations, 2010. S. I. No. 12. The overall objective of these Regulations is to check all earth-disturbing activities, practices, or developments for non-agricultural, commercial, industrial, and residential purposes.
- ✓ National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2010. S. I. No. 20. The purpose of these regulations is to restore, preserve, and improve the quality of air. The standards contained herein provide for the protection of the air from pollutants from vehicular emission.

- ✓ National Environmental (Watershed, Mountainous, Hilly, and Catchments Areas) Regulations, 2009. S. I. No. 27: This makes provisions for the protection of water catchment areas
- ✓ National Environmental (Desertification Control and Drought Mitigation) Regulations, 2010. S. I. No. 13: This Regulation seeks to provide an effective and pragmatic regulatory framework for the sustainable use of all areas already affected by desertification and the protection of vulnerable lands
- ✓ National Environmental (Protection of Endangered Species in International Trade) Regulations, 2010. S. I. No. 16: The major objective of this Regulation is to protect species of endangered wildlife from extinction through the prohibition of trade, importation, etc.
- ✓ National Environmental (Surface and Groundwater Quality Control) Regulations, 2010. S. I. No. 22: The purpose of this Regulation is to restore, enhance, and preserve the physical, chemical, and biological integrity of the nation's surface waters, and to maintain existing water uses.

1.7.1.10 National Climate Change Act 2021

The Climate Change Act was signed by Mr President in November 2021 to provide Nigeria with a legal framework to achieve its climate goals, achieve long-term social and economic sustainability, and resilience. The law sets a target for net zero GHG emissions for year 2050 - 2070. The Act mandates the government to set a National Climate Change Action Plan and a five-year carbon budget (with quantified annual objectives) accordingly. Both are to be validated by the Federal Executive Council.

1.7.1.11 National Policy on Solid Waste Management (NPSWM), 2020

The National Policy on Solid Waste Management (NPSWM) was approved by the Federal Executive Council of the Nigerian Government on 15th of July 2020 as a shared national vision of how solid waste should be managed more sustainably with relative and loose uniformity across states of the Federation. Developed in close consultation with stakeholders, the policy is expected to increasingly garner the active participation of numerous players in the management of solid waste including governments at all levels, the private sector, NGOs, CBOs, FBOs, and partnerships resulting in projects and programmes implementation. In essence, until recently, an integrated system that will provide a holistic framework for the scale-up of SWM value-chain to create a country-wide impact was lacking. It is necessary for Nigeria to tackle the issue of solid waste expeditiously firm and to align with international best practices and adopt solid waste management trends that will:

- Result in substantial reduction in volume of waste generated;
- Increase re-use, recovery and recycling activities while targeting the elimination of non-sanitary dumpsites and landfills;
- Encourage private sector participation in SWM;
- Create enabling environment for improved investments in the sector;
- Promote job creation and improved economic activities by establishing waste to wealth schemes;

- Comply with international best practices in environmental health and safety standards for the sector;
- Embed modern technologies in all SWM activities (recovery, transport, disposal, etc) in country; and,
- Comply with international treaties and protocols on waste management.

The policy aims to promote a decentralized and integrated SWM system which allows for the participation of multi-sectoral stakeholders including the public sector (Federal, State and Local governments), the private sector (investors, service providers, waste generators such as markets, schools, hospitals, etc.) including CBOs, FBOs and NGOs, religious and community leaders, youth and women organizations, informal waste workers and recyclers, waste related SMEs, etc. The policy recognizes the Federal Ministry of Environment (FMEnv) as the apex body with the responsibility of articulating and championing the NPSWM 2020.

1.7.1.12 Federal Ministry of Agriculture and Food Security (FMAFS)

The Federal Ministry of Agriculture and Food Security (FMAFS) is responsible for the development of Nigeria‘s agriculture sector. Current programmes in this regard focus on improving agriculture value chains to transform small scale subsistence agriculture into a growing business sector that will create jobs, wealth and ensure food security. In particular, FMAFS is responsible for implementing the Staple Crop Processing Zone (SCPZ) programme, Special Agro-Industrial Processing Zones (SAPZ) which were initiated to attract private sector investment in agriculture processing and encourage rural farmers thereby providing them with all the necessary infrastructures and technology for processing their agricultural produce.

1.7.1.13 Agriculture and Rural Development

The National EIA Guidelines for Agriculture and Rural Development were published by FEPA in 1995 and provide a detailed set of guidelines for the evaluation and mitigation of environmental impacts from a wide range of agricultural activities. Of particular relevance to the present Project, these include:

- ✓ Agricultural land management (bush clearing, land preparation and consolidation);
- ✓ Large-scale farming;
- ✓ Agro-industrial projects;
- ✓ Dams and reservoirs;
- ✓ Irrigation and drainage programmes; and
- ✓ Use of agro-chemicals and fertilizers.

1.7.1.14 The Nigerian Agricultural Policy

The agricultural policy document was launched in year 2001, with the following objectives:

- The achievement of self-sufficiency in basic food supply and the attainment of food security;
- Increased production of agricultural raw materials for industries;

- Increased production and processing of export crops, using improved production and processing technologies;
- Generating gainful employment;
- Rational utilization of agricultural resources, improved protection of agricultural land resources from drought, desert encroachment, soil erosion and flood, and the general preservation of the environment for the sustainability of agricultural production;
- Promotion of the increased application of modern technology to agricultural production; and, Improvement in the quality of life of rural dwellers.

1.7.1.15 Agriculture Transformation Agenda (2012)

The Agriculture Transformation Agenda is the flagship policy of the FMAFS. The Strategy aims to drive growth in the agriculture sector and in particular aims to:

- Generate employment;
- Accelerate the achievement of food and nutritional security;
- Transform Nigeria into a leading player in global food markets; and
- generate wealth for millions of farmers.

To achieve this vision, the FMAFS acknowledges that the traditional approach in the agriculture sector needs to change. There is recognition of the need for fertilizer procurement and distribution to farmers, marketing institutions, financial value chains and the restructuring of the agriculture investment framework. These objectives have been incorporated into specific policies under the Strategy. The Strategy also aims to move subsistence farmers to a more commercialized system of farming through a market-oriented approach facilitated by a Nigerian Incentive-based Risk Sharing for Agricultural Lending (NIRSAL), encouraging trade and competitiveness Improvements in commodity value chains have been considered through the varying Nigeria geo-political zones. Plateau State is part of the North-Cental geo-political zone where priority crops have been identified as Rice, Sugarcane, Livestock and Fisheries.

1.7.1.16 Federal Ministry of Trade and Investment

The Federal Ministry of Industry, Trade and Investment was created to play a decisive role in diversification of the resource base of the economy by promoting trade and investment with special emphasis on increased production and export of non-oil and gas products that will lead to wealth and job creation, poverty reduction and ensure enhanced service delivery in a manner that will stimulate growth of the economy for self-reliance. The Federal Ministry of Industry, Trade and Investment was restructured in 2011 to drive the growth of the Nigerian economy, using the model being implemented in both developed and emerging economies like the United Kingdom, Malaysia, and Singapore. This transformation expanded its portfolio to include investment that hitherto was not part of its original mandate as the Federal Ministry of Commerce and Industry.

Vision

To promote economic growth, create jobs and generate wealth.

Mission

To formulate and implement policies and programs to attract investment, boost industrialization, increase trade and exports and develop enterprises.

Mandate

1. To create enabling environment to stimulate domestic investment and attract foreign direct investment in all sectors of the economy and make Nigeria the most preferred investment destination.
2. To facilitate trade in goods and services and maximize the benefits of international trade through functional bilateral and multilateral trade relations with other countries.
3. To accelerate the growth of the industrial sector and enhance productivity.
4. To boost the development of Micro, Small and Medium Enterprises (MSME) as the engine of economic growth.

The execution of the mandate of the Ministry are facilitated through its various programmes such as the Nigerian Industrial Revolution Plan (NIRP), National Enterprise Development Programme (NEDEP), Trade Policy, enabling environment for the promotion of investment, industrialization of the country; etc.

The Federal Ministry of Trade and Investment is the Notification Authority on World Trade Organization (WTO) rules in Nigeria and therefore EIAs role to play in both local and international trade in Aquaculture.

1.7.1.17 Factories Act, Cap F1, LFN, 2004

The Factories Act promotes the safety of workers and professionals exposed to occupational hazards. Under this Act, it is an offence to use unregistered premises for factory purposes. In particular, **Section 13** allows an inspector to take emergency measures or request that emergency measures are taken by a person qualified to do so in case of pollution or any nuisance.

1.7.1.18 Forestry Act, Cap F 36, LFN, 2004

This Act of 1958 provides for the preservation of forests and the setting up of forest reserves. It is an offense, punishable with up to 6 months imprisonment, to cut down trees over 2ft in girth or to set fire to the forest except under special circumstances.

1.7.1.19 Land Use Act, Cap L 5, LFN, 2004

The Land Use Act of 1978 provides that the rights of all Nigerians to use and enjoy land in Nigeria and the natural fruits thereof in sufficient quantity to enable them to provide for the sustenance of themselves and their families be assured, protected and preserved.

1.7.1.20 Harmful Waste (Special Criminal Provisions, etc) 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 persons who have suffered injury as a result of his offending act.

1.7.1.21 Business Facilitation (Miscellaneous Provisions) Act, 2023 ("the Omnibus Act")

The Act is part of the Federal Government's initiatives to foster an enabling environment for micro, small and medium-sized enterprises (MSMEs) in Nigeria. The Omnibus Act is a legislative intervention by the Presidential Enabling Business Environment Council (PEBEC) to amend 21 business-related laws and remove bureaucratic barriers to conducting business in Nigeria.

1.7.1.22 Standards Organization of Nigeria (SON) Act, Cap S9, LFN 2004

The SON Act, Cap S9, Laws of the Federation of Nigeria 2004 is the enabling Act that empowers the Standards Council to designate, establish and approve standards in respect of metrology, materials, commodities, structures and processes for the certification of products in commerce and industry throughout Nigeria and to carry out any other functions imposed on it under this Act or any other written law; power to make rules. Section 4 details out the functions of the Council, etc while section 12 provide for procedure for establishment of industrial standards. Section 14 makes provision for certification marks while section 15 provides for offences in relation to standards.

1.7.1.23 National Agency for Food and Drug Administration and Control (NAFDAC) Act, Cap N1, LFN 2004

NAFDAC was established by Decree 15 of 1993 as amended by Decree 19 of 1999 and now Cap N1 Laws of the Federation of Nigeria (LFN) 2004, to regulate and control the manufacture, importation, exportation, distribution, advertisement, sale and use of food, drugs, cosmetics, chemicals, medical devices and packaged water (known as regulated products).

In accordance with the enabling laws, NAFDAC is authorized to:

- Regulate and control the importation, exportation, manufacture, advertisement, distribution, sale and use of regulated product;
- Conduct appropriate tests and ensure compliance with standards and specifications;
- Undertake appropriate investigation of the production premises and raw materials of regulated products;
- Compile standards and specifications, regulations and guidelines for the production, importation, exportation, sale and distribution of regulated products;
- Control the exportation and issue quality certification of regulated products intended for export;
- Establish and maintain relevant laboratories for the performance of its functions;
- Undertake the registration of food, drug, medical devices, bottled water and chemicals;

- Undertake inspection of important regulated products; and
- Pronounce on the quality and safety of regulated products after appropriate analysis.

1.7.1.24 Consumer Protection Council Decree 66 of 1992

The goal of the Consumer Protection Council Decree is to protect consumers‟ right in Nigeria, and in particular to:

- ✓ Provide speedy redress to consumers complaints through negotiations, mediation and conciliations;
- ✓ Seek ways and means of removing or eliminating from the market hazardous products and causing offenders to replace such products with safer and more appropriate alternatives;
- ✓ Publish from time to time, list of products whose consumption and sale have been banned, withdrawn, severally restricted or not approved by the Federal Government or foreign governments;
- ✓ Cause an offending company, firm, trade, association or individual to protect, compensate, provide relief and safeguards to injured consumers or communities from adverse effects of technologies that are inherently harmful, injurious, violent or highly hazardous;
- ✓ Organize and undertake campaigns and other forms of activities as will lead to increased public consumer awareness;

1.7.1.25 The National Biosafety Management Agency Act 2015

This Act establishes the National Biosafety Management Agency as a body corporate. The Agency shall be the national authority on biosafety in Nigeria charged with the responsibility for providing regulatory framework institutional and administrative mechanism for safety measures in the application of modern

biotechnology in Nigeria with the view to preventing any adverse effect on human health, animals, plants and environment. The Agency shall also provide measures for the case-by-case assessment.

1.7.1.26 National Policy on Occupational Safety and Health, 2016

The policy is aimed at ensuring that all workers are safe at their workplaces across the country. This policy was derived from provisions of the Nigerian Constitution and the International Labour Organization ‘s (ILO) Convention.

1.7.1.27 Natural Resources Conservation Act CAP 349 LFN 1990

The Act was established to take steps that are necessary for the effective management of the physical environment of Nigeria to ensure the conservation, protection, and proper use of its natural resources. Also, to promote public awareness of the ecological systems of Nigeria and their importance to the social and economic life of the nation and to manage such national parks, marine parks, protected areas, and public recreational facilities as may be prescribed.

1.7.1.28 Local Content Act

Nigerian Content is the quantum of composite value added or created in the Nigerian economy through the utilization of Nigerian human and material resources for the provision of goods and services.

1.7.1.29 Employee Compensation Act, 2010

The Act provides compensation to employees who suffer from occupational diseases or sustain injuries arising from accidents at the workplace or in the course of employment. Payment of compensation (to the worker or his dependents in case of death) by the employer is as enshrined in the accepted principle that the employer has a duty of care to protect the health, welfare, and safety of workers at work.

1.7.1.30 Nigerian Urban and Regional Planning Act, CAP 138 LFN 2004

The Act is aimed at overseeing realistic, purposeful planning of the country to avoid overcrowding and poor environmental conditions. The Act establishes that an application for land development would be rejected if such development would harm the environment or constitute a nuisance to the community.

1.7.1.31 Nigerian Gender-Related Policies

Consideration of Gender-related policies is important to this project as Women are going to be parts of this proposed project during the subproject implementation. The project shall consider women improvement activities.

1.7.1.32 The Gender Policy Framework in Nigeria

The 1999 Constitution the Federal Republic of Nigeria prohibits discrimination based on places of origin, sex, religion, status, ethnic or linguistic association. Successive governments have always demonstrated commitment to upholding this and to promote gender equality and women's empowerment in varying degrees. To facilitate gender equality and women's empowerment, the FGN

created favourable national legal and policy frameworks and put in place institutional mechanisms in this regard. Moreover, Nigeria, as a member of the United Nations, signed and ratified the various relevant international instruments, treaties and conventions without reservation. These instruments have always emphasized that member nations put in place the necessary mechanisms needed to eliminate gender discriminations, ensure equality and human dignity to all men and women. The government of Nigeria in 2000 adopted a National Policy on Women; it was reviewed and upgraded in 2006 to become the National Gender Policy.

1.7.1.33 National Gender Policy, 2006

The overall goal of the National Gender Policy of Nigeria is to promote the welfare and rights of Nigerian women and children in all aspects of life: political, social, and economic. The policy seeks to plan, coordinate, implement, monitor, and evaluate the development of women in the country.

1.7.1.34 Penal Code Act CAP 53 LFN 2008

The Penal Code makes it an offence punishable with up to 6 months imprisonment for any person who:

- Violates the atmosphere in any place to make it noxious to the health of persons in general dwelling or carry on business in the neighborhood, or passing along a public way: or
- Does any act which is, and which he knows or has reason to believe to be likely to spread the infection of any disease dangerous to life, whether human or animals.

1.7.2 State Legislations

1.7.2.1 Plateau State Ministry of Environment and Climate Change

The Ministry of Environment was established in 1999. It started as Ministry of Environment and Solid Minerals then became Ministry of Housing and Environment and then Ministry of Tourism, Culture and Environment and since 2011 is known as the Ministry of Environment.

The Ministry initiates and advises higher levels of government on environmental matters. The Ministry oversee the followings: -

- Environmental Conservation:
- Environmental Health & Sanitation:
- Pollution Control:
- Environmental Assessment & Inspectorate Services
- Forestry And Wildlife Conservation

1.7.2.2 Plateau State Ministry of Agriculture and Rural Development

. The Ministry was created primarily for the following functions:

- ✓ Advise Government on Agricultural matters.
- ✓ Implement Agricultural Development Projects/Programs on behalf of the Government.
- ✓ Provision of Farm Inputs.

- ✓ Agricultural Extension Work and Farmer Education.
- ✓ Preservation, Storage, Quality Control and Marketing of Agricultural Produce.
- ✓ Quality Control of Farm Produce to meet International Grades and Standards.
- ✓ Implementation of State Buffer Stock Programme.
- ✓ Pest Control Services.
- ✓ Agricultural Credit Administration.
- ✓ Agro Data Collection, Collation and Dissemination.
- ✓ Agricultural Mechanization.
- ✓ Agricultural Land Protection and Management.
- ✓ Promote Cultivation and Varietal Improvement of Crop.
- ✓ Promote Livestock Development and Veterinary Services.
- ✓ Manpower Development and Capacity Building.

1.7.3 Barkin Ladi Local Government Area By-Laws

The Local Government By-Law is derived from the Fourth Schedule of 1999 Constitution of the Federal Republic of Nigeria (as amended). The Schedule is reproduced below:

- The Constitution of the Federal Republic of Nigeria, 1999 provides in the Fourth Schedule the main functions of Local Governments in Nigeria as follows:
  - (i) the consideration and the making of recommendations to a State Commission on Economic Planning or any similar body on:
  - (ii) the economic development of the State, particularly in so far as the areas of authority of the Council and of the State are affected, and
  - (iii) proposals made by the said Commission or body;
- collection of rates, radio and television licenses;
- establishment and maintenance of cemeteries, burial grounds and homes for the destitute or infirm;
- licensing of bicycles, trucks (other than mechanically propelled trucks), canoes, wheelbarrows and carts;
- establishment, maintenance and regulation of slaughterhouses, slaughter slabs, markets, motor parks and public conveniences;
- construction and maintenance of roads, streets, street lightings, drains and other public highways, parks, gardens, open spaces, or such public facilities as maybe prescribed from time to time by the House of Assembly of a State;
- naming of roads and streets, and numbering of houses;
- provision and maintenance of public conveniences and refuse disposal;
- registration of all births, deaths and marriages;
- assessment of privately-owned houses or tenements for the purpose of levying such rates as may be prescribed by the House of assembly of a State; and

- control and regulation of out-door advertising and hoarding;
- movement and keeping of pets of all descriptions;
- shops and kiosks;
- restaurants, bakeries and other places for sale of food to the public;
- laundries, and
- licensing, regulation, and control of the sale of liquor.

Apart from these exclusive functions, function of Local Governments shall include participation of such Councils in the government of a state with respect to the following matters:

- the provision and maintenance of primary, adult and vocational education;
- the development of agriculture and natural resources other than the exploitation of minerals;
- the provision and maintenance of health services; and
- such other functions as may be conferred on a Local Government Council by the House of Assembly of the State.

As provided for in the 1999 Constitution of the Federal Republic of Nigeria (as amended), Local Governments (LGs) have functions and responsibilities assigned. Some of these functions are performed exclusively by the Local Government (LG) like the maintenance of cemeteries, markets, and motor parks. On the other hand, some other functions and responsibilities are performed concurrently with the State Government. Among these concurrent functions are primary education, agriculture, health, and any other functions that may be conferred on Local Government by the House of Assembly of the State. As can be seen, these various functions and responsibilities of Local Governments are quite enormous and demanding. The tragedy of the situation is that LGs have very limited and circumscribed sources of revenue to enable them to execute meaningfully and effectively the functions and responsibilities assigned to them.

1.7.4 International Convention and Agreements, Best Practice Standards and Guidelines

Nigeria is signatory to several international conventions and agreements relating to industry, development, and environmental management. In certain cases, conventions and agreement have influenced policy, guidelines and regulations and must be compiled with during the planning, construction, and operation of the project. Among several of such conventions, treatises and agreement includes:

1.7.4.1 United Nations (UN) published guiding Principles on the Human Environment in 1972

Ten of these Guiding Principles were defined as formal declarations that express the basis on which an environmental policy can be built, and which provide a foundation for action. Some of the principles relevant to the projects are:

Principles Two

The nature resources of the earth, including the air, water, land, flora, and fauna and especially representative's samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management as appropriate.

Principles Six

The discharge of toxic substances or of other substances and the release of harmful substances, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted to ensure that serious or irreversible damage is not inflicted upon the ecosystems. The just struggle of the people of all countries against pollution should be supported.

Principles Seven

States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.

Principle Seventeen

This principle specifically states that *"Environmental Impact Assessment, as a National Instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a component National Authority"*.

1.7.4.2 United Nations Conference on Environment and Development (1992) (Popularly referred to as Agenda 21)

The United Nations Conference on the Environment and Development (UNCED) in 1992 led to the adoption of agenda 21, which recommended a set of 21measures for waste management. Some of the recommendations include the following:

- Prevent and minimize waste production.
- Reuse or recycle the waste to the extent possible.
- Treat waste by safe and environmentally sound methods.
- Dispose of the final residues by landfill in confined and carefully designated sites.
- Integrate environment into development planning at all levels of Government and the private sector.
- Commence a transition to sustainable development.
- Address sectorial priorities, plan policies and strategies for the major sectors of the economy; and
- Simultaneously foster regional and global partnership.

1.7.4.3 Convention on Biological Diversity (1992)

The objectives of the convention include the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

1.7.4.4 Basel Convention on the control of Trans-boundary Movements of Hazardous Wastes and Their Disposal (1987)

The convention focuses attention on the hazards of the generation and disposal of Hazardous wastes. The convention defines the wastes to be regulated and control their trans-boundary movement to protect human and environmental health against their adverse effects.

1.7.4.5 Convention on the Conservation of Nature and Natural Resources, 1986

This convention came into force in Nigeria on May 7th,1974. The objectives of the convention to encourage individual and joint action for the conservation, utilization and development of soil, water flora and fauna for the present and future welfare of mankind, from an economic, nutritional, scientific, educational, cultural, and aesthetic point of view.

1.7.4.6 Montreal Protocol on Substances that Deplete the Ozone Layer, 1987 (as Amended)

The objective of the convention is to protect the ozone layer by-taking precautionary measure to control global emissions of substances that deplete it. This convention is aimed at protecting workers against occupational Hazards in the working environment.

1.7.4.7 Convention on the Protection of workers against occupational Hazards on the working environment due to Air Pollution, Noise and Vibration

The objective of the convention is to prevent accidents and injury to health by minimizing the causes of hazards inherent in the working environment.

1.7.4.8 Convention on Occupational Safety and Health and the Working Environment

The convention EIAs the objective of enhancement of the existing legal framework for occupational safety regulating the management of chemicals in the workplace with the broad purpose of protecting the environment and the public, and with the specific objective of protecting workers from harmful effects of chemicals.

1.7.4.9 United Nations Convention on Climate Change

The Convention on the Climate Change was signed in 1992 during the Rio Earth Summit but was put into force in 1994. The Convention called on developed countries and economies in transition to limit

their emissions of the greenhouse gases which cause global warming, although it does not impose mandatory emissions on developing countries.

1.7.4.10 UNFCCC, Paris agreement of 2016 [The agreement was signed on 22 September 2016 and ratified by Nigeria on 16th May 2017]

The world is in a race to limit climate change and find workable, practical, and cost-efficient solutions (Renewable Energy, Circular Economy, and Natural Capital) to this emergency that is redefining global partnerships in a way not seen before. This is a race we, as humanity, can win. But for this to happen, unprecedented leadership, sacrifices, concessions from all nations big and small are needed. Nigeria has ratified the 2915 Paris Agreement. This is commendable considering it is one of the top six greenhouse gas emitters in Africa. The Paris Agreement builds upon the Convention and for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework, and an enhanced capacity-building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

1.7.4.11 Nationally Determined Contributions (NDCs)

Nationally Determined Contributions (NDCs) made under the Paris Agreement embodies the country‘s efforts to reduce national emissions and to adapt to the effects of climate change. If fully implemented, these efforts will pave way for a low carbon economy and result in about a 50 percent reduction in emissions. At the same time, the economy will grow at an average annual rate of five percent by 2030. This represents an important milestone in tackling the challenges of climate change.

1.7.4.12 Polluters Pays Principle (Adopted by Nigeria in 1999)

In environmental law, the polluter pays principle is enacted to make the party responsible for producing pollution responsible for paying for the damage done to the natural environment. It is regarded as a regional custom because of the strong support it has received in most Organization for Economic Co-operation and Development (OECD) and European Community (EC) countries. The polluter pays principle underpins environmental policy such as an ecotax, which, if enacted by the government, deters, and essentially reduces greenhouse gas emissions. Some eco-taxes underpinned by the polluter pays principle include: the Gas Guzzler Tax, in the US, Corporate Average Fuel Economy (CAFE) - a "polluter pays" fine. The U.S. Superfund law requires polluters to pay for clean-up of hazardous waste

sites when the polluters can be identified. Polluter pays is also known as extended producer responsibility (EPR). This is a concept that was probably first described by Thomas Lindhqvist for the Swedish government in 1990. EPR seeks to shift the responsibility for dealing with waste from governments (and thus, taxpayers and society at large) to the entities producing it. In effect, it internalized the cost of waste disposal into the cost of the product, theoretically meaning that the producers will improve the waste profile of their products, thus decreasing waste and increasing possibilities for reuse and recycling.

1.7.4.13 Stockholm Convention Against Persistent Organic Pollutants of 2004

Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty, signed in 2001 and effective from May 2004, that aims to eliminate or restrict the production and use of persistent organic pollutants (POPs). In 1995, the Governing Council of the United Nations Environment Programme (UNEP) called for global action to be taken on POPs, which is defined as "chemical substances that persist in the environment, bio-accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment‖. Following this, the Intergovernmental Forum on Chemical Safety (IFCS) and the International Programme on Chemical Safety (IPCS) prepared an assessment of the 12 worst offenders, known as the dirty dozen. The INC met five times between June 1998 and December 2000 to elaborate the convention, and delegates adopted the Stockholm Convention on POPs at the Conference of the Plenipotentiaries convened from 22–23 May 2001 in Stockholm, Sweden. The negotiations for the Convention were completed on 23 May 2001 in Stockholm. The convention entered into force on 17 May 2004 with ratification by an initial 128 parties and 151 signatories. Co-signatories agree to outlaw nine of the dirty dozen chemicals, limit the use of DDT to malaria control, and curtail inadvertent production of dioxins and furans. Parties to the convention have agreed to a process by which persistent toxic compounds can be reviewed and added to the convention if they meet certain criteria for persistence and transboundary threat. The first set of new chemicals to be added to the Convention was agreed upon at a conference in Geneva on 8 May 2009. As of June 2018, there are 182 parties to the Convention, (181 states and the European Union). Notable non-ratifying states include the United States, Israel, Malaysia, and Italy. The Stockholm Convention was adopted to EU legislation in REGULATION (EC) No 850/2004.

1.7.4.14 Cartagena Protocol on Biosafety of 2003

The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an international agreement on biosafety as a supplement to the Convention on Biological Diversity effective since 2003. The Biosafety Protocol seeks to protect biological diversity from the potential risks posed by genetically modified organisms resulting from modern biotechnology The Biosafety Protocol makes clear that products from new technologies must be based on the precautionary principle and allow developing nations to balance public health against economic benefits. It will for example let countries ban imports of genetically modified organisms if they feel there is not enough scientific evidence that

the product is safe and requires exporters to label shipments containing genetically altered commodities such as corn or cotton.

1.7.4.15 Vienna Convention for the Protection of the Ozone Layer

This Convention was instituted in 1985 and places general obligation on the countries to make appropriate measures to protect human health and the environment against adverse effects resulting from human activities which tend to deplete the ozone layer.

1.7.4.16 Convention on access to Information, Public Participation in Decision making and access to Justice in Environment Matters (Aarhus 1998)

Article 1 (Objective) notes that "in order to contribute to the protection of the right of every person of present and future generations to live in an environment adequate to his or her health and well-being, each Party shall guarantee the rights of access to information, public participation in decision-making, and access to justice in environmental matters in accordance with the provisions of this Convention."

1.7.4.17 Kyoto Protocol on the Reduction of Greenhouse Gases 1997

Kyoto Protocol is an international treaty adopted in 1997 that aimed to reduce the emission of gases that contribute to global warming. The protocol called for reducing the emissions of six greenhouse gases in 41 countries plus the European Union to 5.2 percent below 1990 levels.

International Best Practices

Other considerations of the ESIA include other international best practices. International institutions provide guidance on best practices for the ESIA process and place emphasis on achieving sustainable environmental, social, and health outcomes. They also provide environmental standards and limits for emissions and discharges. Some key project impact mitigation measures such as resettlement are also specified. The overall project design and this ESIA will align with international best practices such as guidelines published by the International Finance Corporation (IFC) and the World Bank. The following is a summary of the specific international requirements and standards that will be applied to this ESIA. It should be noted that, given the private-sector nature of the development, the IFC Performance Standards described below will be most directly applicable to the project in this case.

1.7.4.18 World Bank Guidelines on Environmental Assessment

The World Bank requires an Environmental Impact Assessment (EIA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable to improve decision making. Additionally, the policy specifies that the Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of EIA. The Bank classifies projects into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts. Details of World Bank EIA procedures and guidelines are published in the bank's EA Source Books Vols. II–III of 1991.

1.7.4.19 World Bank Operational and Safeguard Policies

The World Bank is committed to several operational and safeguards policies that aim to prevent and mitigate undue harm to people and their environment in any development initiative involving the bank. These policies provide guidelines for bank and borrower staff in the identification, preparation, and implementation of programs and projects. There are ten World Bank Environmental/Safeguard Policies. Not all these policies are triggered by the Special Agro-industrial Processing Zone (SAPZ) Hub development. The World Bank policies that have been triggered by the proposed Special Agro-industrial Processing Zone (SAPZ) Hub are:

Operational Policy (OP)/Bank Procedure (BP) 4.01: Environmental Assessment (last updated February 2011). This is the umbrella policy for the Bank's environmental 'safeguard policies' which among others include:

Operational Policy/Bank Procedure 4.04 (Natural Habitat) - seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society.

Operational Policy/Bank Procedure 4.36 –(Forests.) This policy aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development.

Operational Policy 4.09 (Pest Management) policy recognizes that pesticides can be persistent and harmful to the environment for a long time. If pesticides must be used, the policy requires that Pest Management Plan (PMP) be prepared by the borrower, either as a stand-alone document or as part of an Environmental Assessment.

Operational Policy /Bank Procedure 4.11 - Physical Cultural Resources seeks to avoid, or mitigate, adverse impacts on cultural resources from development projects that the World Bank finances.

The Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus improve decision making. Such EA is carried out by the borrower to evaluate a project's potential environmental risks and impacts in its area of influence. The EA process analyzes project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. The Bank favours preventive measures over mitigatory or compensatory measures, whenever feasible. EA looks at the interaction of the project with the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and where applicable, transboundary, and global environmental aspects.

1.7.4.20 The IFC Performance Standards

The IFC applies Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in the private sector. The IFC Performance Standards encompass eight topics:

Environmental and Social Assessment and Management System: Commercial clients/investees are required to manage the environmental and social performance of their business activity, which should also involve communication between the client/investee, its workers, and the local communities directly affected by the business activity. This requires the development of a good management system, appropriate to the size and nature of the business activity, to promote sound and sustainable environmental and social performance as well as lead to improved financial outcomes.

Labour and Working Conditions: For any business, its workforce is a valuable asset and a sound worker-management relationship is a key component of the overall success of the enterprise. By protecting the basic rights of workers, treating workers fairly, and providing them with safe and healthy working conditions, commercial clients/investees can enhance the efficiency and productivity of their operations and strengthen worker commitment and retention.

Pollution Prevention and Abatement: Increased industrial activity and urbanization often generate increased levels of pollution to air, water, and land that may threaten people and the environment at the local, regional, and global level. Commercial clients/investees are required to integrate pollution prevention and control technologies and practices (as technically and financially feasible as well as cost-effective) into their business activities.

Community Health, Safety, and Security: Business activities can increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failures, and releases of hazardous materials as well as impacts on a community's natural resources, exposure to diseases, and the use of security personnel. Commercial clients/investees are responsible for avoiding or minimizing the risks and impacts on community health, safety, and security that may arise from their business activities.

Land Acquisition and Involuntary Resettlement: Land acquisition due to the business activities of a commercial client/investees may result in the physical displacement (relocation or loss of shelter) and economic displacement (loss of access to resources necessary for income generation or as means of livelihood) of individuals or communities. Involuntary resettlement occurs when affected individuals or communities do not have the right to refuse land acquisition and are displaced, which may result in long-term hardship and impoverishment as well as environmental damage and social stress. Commercial clients/investees are required to avoid physical or economic displacement or minimize impacts on displaced individuals or communities through appropriate measures such as fair compensation and improving livelihoods and living conditions.

Biodiversity Conservation and Sustainable Natural Resource Management: Protecting and conserving biodiversity (including genetic, species, and ecosystem diversity) and its ability to change and evolve, is fundamental to sustainable development. Commercial clients/investees are required to avoid or mitigate threats to biodiversity arising from their business activities and to promote the use of renewable natural resources in their operations.

Indigenous Peoples: Indigenous Peoples are recognized as social groups with identities that are distinct from other groups in national societies and are often among the marginalized and vulnerable. Their economic, social, and legal status may limit their capacity to defend their interests and rights to lands and natural and cultural resources. Commercial clients/investees are required to ensure that their business activities respect the identity, culture, and natural resource-based livelihoods of Indigenous Peoples and reduce exposure to impoverishment and disease.

Cultural Heritage: Cultural heritage encompasses properties and sites of archaeological, historical, cultural, artistic, and religious significance as well as unique environmental features and cultural knowledge, innovations, and practices of communities embodying traditional lifestyles, which are protected for current and future generations. Commercial clients/investees are required to avoid significant damage to cultural heritage due to their business activities.

1.7.4.21 Environmental and Social Safeguards Policies (African Development Bank)

The African Development Bank issued its Environmental Assessment Guidelines (EAG) in 1992, but since then, many changes have occurred in the Bank's structure and operations. The revised Environmental and Social Assessment Procedures (ESAP 2015) have therefore been updated to reflect the more integrated approach addressing all cross-cutting themes as well as the new organizational structure. The main purpose of the Environmental and Social Assessment Procedures (ESAP) is to improve decision-making and project results to ensure that Bank-financed projects, plans, and programs are environmentally and socially sustainable as well as in line with Bank's policies and guidelines. The ESAP applies to the Bank's public-sector operations. Similar procedures were developed and approved for the Bank‘s private sector operations: AfDB Environmental Review Procedures for Private Sector Operations (2000). Other relevant AfDB policies are AfDB Policy on the Environment (2004), AfDB Environmental Review Procedures for Private Sector Operations (2000), AfDB Gender Policy (2001), AfDB Policy on Poverty Reduction (2004), and AfDB Policy on Involuntary Resettlement (2003). In the development of the ESIA, the AfDB ESAP guideline was used to address the following areas:

- Aims
- Brief project description and key components
- Major environmental and social impacts and climate change risk
- Enhancement/mitigation measures and complementary initiatives
- Environmental and social monitoring program

- Public consultations and disclosure requirements vii. Institutional arrangements and capacity building requirements
- Estimated costs
- Implementation schedule and reporting
- Conclusion
- References and contacts

1.7.4.22 The African Development Bank (AfDB) Integrated Safeguards System (ISS)

The E&S safeguards of the AfDB are a cornerstone of the Bank's support for inclusive economic growth and environmental sustainability in Africa. AfDB will apply the Integrated Safeguards System for the proposed Agro-industrial processing facilities considered under the AAU project. The Bank ISS is designed to promote the sustainability of project outcomes by protecting the environment and people from the potentially adverse impacts of projects. This requires that all the activities under the project will comply with the safeguard requirements of the ISS during projects preparation and implementation. The safeguards aim to:

- Avoid adverse impacts of projects on the environment and affected people, while maximizing potential development benefits to the extent possible.
- Minimize, mitigate, and/ or compensate for adverse impacts on the environment and affected people when avoidance is not possible.
- Help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage E&S risks.

The ISS consists of four interrelated components as summarized in Figure 1.4 below.

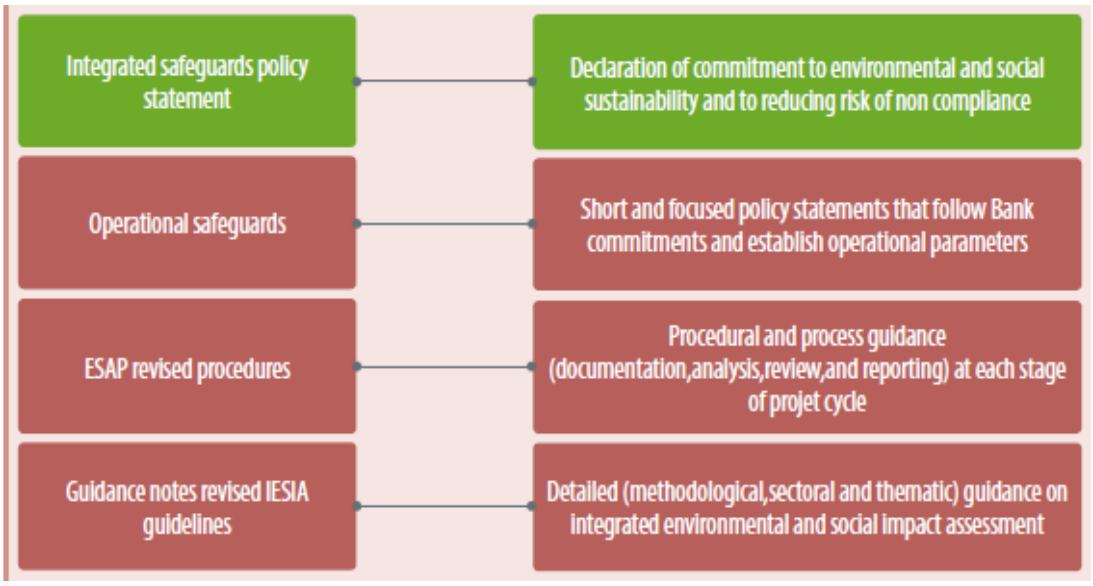

Figure 1.4: Structure of the AfDB ISS

The Integrated Safeguards Policy Statement

This describes common objectives of the Bank's safeguards and lays out policy principles. It is designed to be applied to current and future lending modalities, and it considers the various capacities and needs of regional member countries in both the public and private sectors. The Integrated Safeguards comprises of Policy Statement that sets out the basic tenets that guide and underpin the Bank's approach to environmental safeguards. The Bank's Integrated Safeguards Policy Statement sets out the Bank's own commitments to and responsibilities for delivering the ISS: to

i. ensure the systematic assessment of E&S impacts and risks.
ii. apply the OSs to the entire portfolio of Bank operations.
iii. support clients and countries with technical guidance and practical support in meeting the requirements.
iv. implement an adaptive and proportionate approach to E&S management measures to be agreed with clients as a condition of project financing.
v. ensure that clients engage in meaningful consultations with affected groups; respect and promote the protection of vulnerable groups, in a manner appropriate to the African context.

Operational Safeguards (OSs)

These are a set of five safeguard requirements that Bank clients are expected to meet when addressing social and environmental impacts and risks. Bank staff use due diligence, review, and supervision to ensure that, clients comply with these requirements during project preparation and implementation. Over time the Bank may adopt additional safeguard requirements or update existing requirements to enhance effectiveness, respond to changing needs, and reflect evolving best practices. The five OSs presented in table 1.1 were designed to:

- Better integrate considerations of E&S impacts into Bank operations to promote sustainability and long-term development in Africa.
- Prevent projects from adversely affecting the environment and local communities or, where prevention is not possible, minimize, mitigate and/or compensate for adverse effects and maximize development benefits.
- Systematically consider the impact of climate change on the sustainability of investment projects and the contribution of projects to global greenhouse gas emissions.
- Delineate the roles and responsibilities of the Bank and its borrowers or clients in implementing projects, achieving sustainable outcomes, and promoting local participation.
- Assist regional member countries and borrowers/clients in strengthening their own safeguards systems and their capacity to manage E&S risks.

Table 1.1: AfDB Operational Safeguards OS1-5

Operational Safeguard	Description	Triggered (Yes/No)
OS 1: *Environmental and social assessment*	This overarching safeguard governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements	**This OS is triggered.** The construction and operation of the Rice processing factory will have environmental interactions with potential negative impacts to the people and the environment.
OS 2: *Involuntary Resettlement: Land Acquisition, Population Displacement and Compensation*	This safeguard consolidates the policy commitments and requirements set out in the Bank's policy on involuntary resettlement and incorporates a few refinements designed to improve the operational effectiveness of those requirements	**This OS is triggered.** The construction activities took place on land previously being used for farming by Ishi-Ibohr and Okuku people. However, as at the time of ESMP, the economic displacement of affected farmers has occurred with compensation paid for land and land-based assets.
OS 3: *Biodiversity and Ecosystem Services*	This safeguard aims to conserve biological diversity and promote the sustainable use of natural resources. It also translates the commitments in the Bank's policy on integrated water resources management into operational requirements.	**This OS is not triggered.** The project is on a piece of land being used for farming activities with limited sensitive ecological receptors. Areas of ecological importance particularly the stream on the site will be conserved/enhanced as part of project landscaping activities to ensure the preservation of the natural habitat for aquatic organisms.
OS 4: *Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials and*	This safeguard covers the range of key impacts of pollution, waste, and hazardous materials for which there are agreed international conventions, as well as comprehensive industry-specific and regional standards, including greenhouse gas	**This OS is triggered.** The construction and operation activities will generate waste including hazardous waste which will require proper management to prevent environmental pollution.

Operational Safeguard	Description	Triggered (Yes/No)
Resource Efficiency	accounting, that other multilateral development banks follow.	
OS 5: *Labour Conditions, Health, and Safety*	This safeguard establishes the Bank's requirements for its borrowers or clients concerning workers' conditions, rights and protection from abuse or exploitation. It also ensures greater harmonization with most other multilateral development banks.	**This OS is triggered.** Many workers are envisaged to be engaged during the construction and operation of the rice processing factory. These workers would need to comply with HSE policies and requirements and be kept safe.

1.7.4.23 Islamic Development Bank (IsDB) Environmental and Social Safeguards

Islamic Development Bank (IsDB)'s ESSP is considered as an important tool for enhanced development effectiveness, with an overarching goal to facilitate achievement of the environmental and social soundness and sustainability of IsDB-financed projects. The ESSP demonstrates institutional values and commitment to:

- Address environmental and social risks and impacts in a structured operational framework across the project cycle,
- Ensure environmental and social soundness and sustainability of investments,
- Support integration of environmental and social aspects into the decision-making process, and
- Public consultation and disclosure of information.

1.7.4.24 International Funds for Agricultural Development (IFAD)'s Social, Environmental and Climate Sustainability.

Social, environmental and climate sustainability is critical for achieving IFAD's mandate. Projects and programmes that foster social, environmental and climate sustainability rank among the Fund's highest operational priorities. To meet these objectives, IFAD has updated its 2017 Social, Environmental and Climate Assessment Procedures (SECAP). This updated edition of SECAP lays out an improved framework and process for managing risks and impact and integrating mainstreaming priorities into new IFAD-supported investments. IFAD actively embraces the principles of sustainable development by:

- Adopting good international practices, including on climate change and environment;
- Working towards greater harmonization of safeguard practices among United Nations agencies, multilateral financial institutions, and other development partners; and
- Improving its own internal processes and capacity.

SECAP will:

(i) Help IFAD to identify social, environmental and climate risks and impacts, and their significance, and determine the level of risk management required to address the risks and impacts associated with IFAD-supported investments and global and regional grant-funded programmes;

(ii) Help to identify opportunities to mainstream climate resilience, environmental sustainability, nutrition, gender equality and the empowerment of women, youth and other vulnerable groups into IFAD strategies and programming;

(iii) Support borrowers/recipients/partners and IFAD in improving decision-making and promoting the sustainability of project and programme outcomes through ongoing stakeholder engagement;

(iv) Assist borrowers/recipients/partners in fulfilling their own international and national social, environmental and climate commitments;

(v) Ensure that IFAD's practices are aligned with its own policies and the procedures of other multilateral financial institutions; and

(vi) Enable IFAD to continue accessing environmental and climate financing.

1.8 The EIA Methodology

This EIA study was carried out in accordance with the Federal Ministry of Environment (FMENV) Procedural and Sectoral Guidelines 1995 and Plateau State Ministry of the Environment Guidelines. It involved a blend of a multidisciplinary team and standard methods from pure science, engineering, social and health sciences to obtain basic data for impact identification and establishment of mitigation and amelioration measures. It generally involved desktop studies, field research, consultation, impact assessment and proffering of mitigation measures and development of an ESIA Report as discussed below.

1.8.1 Desktop Studies

Desktop studies were undertaken to acquire information on climate and atmospheric condition, geology, soil, socio-economics, and other environmental components of the plant facility Catchment Area. It involved the review of existing literature particularly, from reports of previous EIA studies in the area and other relevant studies. Materials reviewed include internet sources, textbooks, reports,

survey maps, aerial photographs, articles, and other international journals. These serve as secondary data for environmental database for the EIA studies.

1.8.2 Reconnaissance Survey

A reconnaissance survey of the proposed project site was undertaken to familiarize the EIA team with the project area. This assisted in the concept design of field research execution.

1.8.3 Fieldwork Activities/Laboratory Analysis

Field research was used to verify and harmonize information gathered from desktop studies and fill data gaps identified. The fieldwork was carried out in line with the FMEnv Procedural Guidelines (1995) and Plateau State Ministry of Environment Guidelines on EIA. It covered all the relevant aspects of the ecological, socio-economic and health environment and was conducted for various aspect of the environment including, soil quality, land use pattern, terrestrial and socio-economic and ethnographic issues.

1.8.4 Validation

The systematic incorporation of expert opinions was used to identify potential environmental impacts and to predict their magnitudes and significance (empirical worst-case scenario) using the data gathered from the field investigation. Experts in the relevant fields (as listed in the list of report preparers) were consulted for their opinions on issues relating to the potential ecological impacts of the plant facility.

1.8.5 Consultation with Stakeholders

Stakeholder consultation is a very important aspect of ESIA study, this was carried out in and around the proposed project area of influence and stakeholders (especially the neighbouring communities) were consulted and interacted with. Some of these were consulted through questionnaire administration. This was done to ensure that the views and opinions of all the identified stakeholders regarding the proposed project and their associated potential impacts, are integrated into the ESIA.

1.8.6 Impact Assessment Methodologies

This involved impact identification, prediction, and evaluation. Impact evaluation was carried out using the Leopold Matrix methodology and ISO 14001 while the overall assessment was carried out using the ‘Strength of Relationship Matrix Approach’ method. This method defines, numerically, the degree of interdependence of the various environmental parameters that were considered. The 1 - 5 ratings were assigned to characterize the interrelationship by panel of experts. The impact evaluation results obtained form the basis for development of the Environmental and Social Impact Assessment (ESIA) report for the proposed project.

1.8.7 Reporting and Review

The findings of the EIA study of the proposed project were subsequently documented as contained in this draft report. The final version of this report shall be issued at the end of the review of the draft report by the Federal Ministry of Environment. This shall incorporate all pertinent issues and comments arising from the review meetings as shall be directed by the FMEnv.

1.8.8 Impact Mitigation and Compliance Monitoring (IMM)

Upon the grant of final EIA approval, the Ministry shall during the implementation of the project, monitor the progress of the project from site preparation to commissioning to ensure compliance with all stipulated mitigation measures and project specifications.

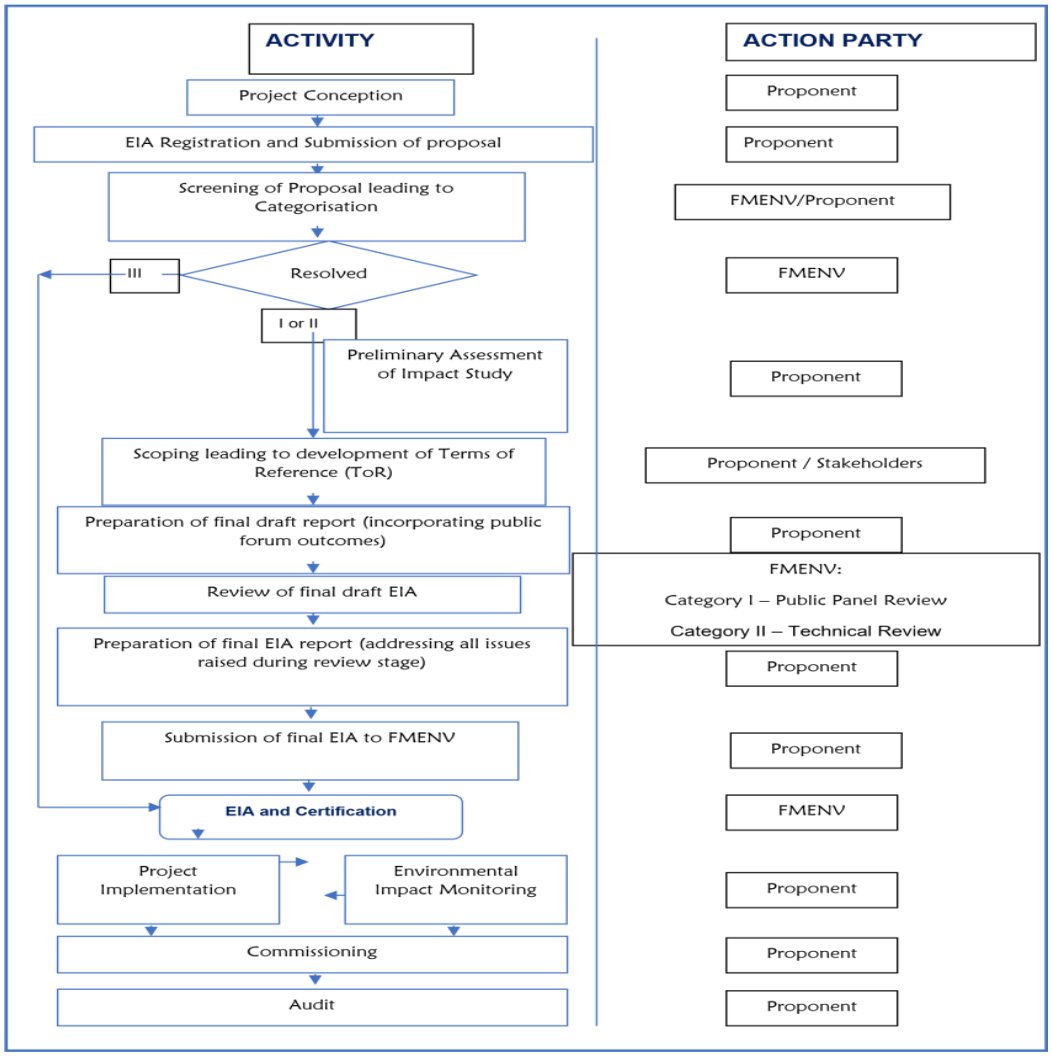

Figure 1.5: FMEnv EIA Process Flow Chart

1.9 The Structure of the EIA Report

This EIA report is presented in nine (9) chapters following standard report format as specified by the FMEnv.

- Chapter one contains the introduction with background on the project and the project's proponent's terms of reference, brief description and location of the project, review of the legal and administrative framework for EIA, EIA objectives, methodology and the structure of the prepared EIA report.

- Chapter two discusses the justification, the need of the project, the value of the project, the project alternatives, and the envisaged sustainability of the proposed project.
- Chapter three gives a detailed description of the entire proposed project, the raw materials, input and outputs, technological layout, waste management strategy.
- Chapter four contains the description of existing environmental factors of climate (Rainfall, Wind Speed and direction, Temperature, and relative Humidity), Geography of the location, land use and landscape patterns, Hydrogeology (ground water, surface water, soil), air quality, noise level, biodiversity, socio-economic conditions, and built-up areas.
- Chapter five contains the details of the identification, quantification, and evaluation of the predicted Associated and Potential Environmental Impacts that may affect the project implementation.
- Chapter six presents cost-effective mitigation measures to minimize or completely eliminate identified negative impacts of the proposed project.
- Chapter seven presents a robust comprehensive Environmental Management Plan (EMP) for the proposed project and the decommissioning schedule.
- Chapter eight highlights the remediation plan after de-commissioning/closure and de-commissioning schedule
- Chapter nine ends with the recommendations and conclusion.

These nine chapters are preceded by a Cover Page, Tables of Content, and List of Abbreviations/Acronyms. List of Tables, List of Figures, List of Plates, List of EIA Preparers, Acknowledgement and Executive Summary and are then followed by references and Annexure such as Survey Plan and Methodology for field sampling and Analytical Methods and others.

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 Introduction

Agriculture is the principal source of livelihood in Nigeria, and the sector employs nearly three-quarters of the nation's workforce. The country is endowed with vast arable land, a conducive climate, and different agro-ecological zones. Over the past 20 years, value-added per capita in agriculture has risen by less than 1 percent annually. It is estimated that Nigeria has lost USD 10 billion in annual export opportunity from groundnut, palm oil, cocoa, and cotton alone due to a continuous decline in the production of those commodities. Food crop production increases have not kept pace with population growth, resulting in rising food imports and declining levels of national food self-sufficiency. Some of the reasons for the failures of the agricultural sector in the country are poor Implementation of Government Policies; excessive postharvest loss due to poor postharvest handling; poor market access and value chain development; herders/farmers clash; lack of adequate farming equipment; lack of social amenities; Illiteracy; lack of access to agricultural financing; environmental degradation and other natural disasters; and inadequate to quality inputs such as fertilizer and improved seedlings. However, in recent years, the sector has been on a recovery curve, recording improvements, particularly in farm production volumes due to favourable Government intervention. A rapid increase in current agro-processing capacities, crops and livestock productivity enhancement and rural infrastructure provision are requirements to drive optimal agricultural production. It is against this background the Federal Republic of Nigeria, engaged in a radical transformation of the sector through new funding arrangement, institutional realignment, administrative strengthened and market reforms to reposition the sector.

The country is endowed with vast arable land, a conducive climate, and different agro-ecological zones. Over the past 20 years, value-added per capita in agriculture has risen by less than 1 percent annually. It is estimated that Nigeria has lost USD 10 billion in annual export opportunity from groundnut, palm oil, cocoa, and cotton alone due to a continuous decline in the production of those commodities. (*National Report of Wet Season Agricultural Performance in Nigeria 2021, NAERLS, FMARD).* It is against this background the Federal Republic of Nigeria, engaged in a radical transformation of the sector through new funding arrangement, institutional realignment, administrative strengthened and market reforms to reposition the sector. Agriculture is the principal source of livelihood in Nigeria, and the sector employs nearly three-quarters of the nation's workforce. See fig. 2.1 for the Agro-ecological Zones in Nigeria.

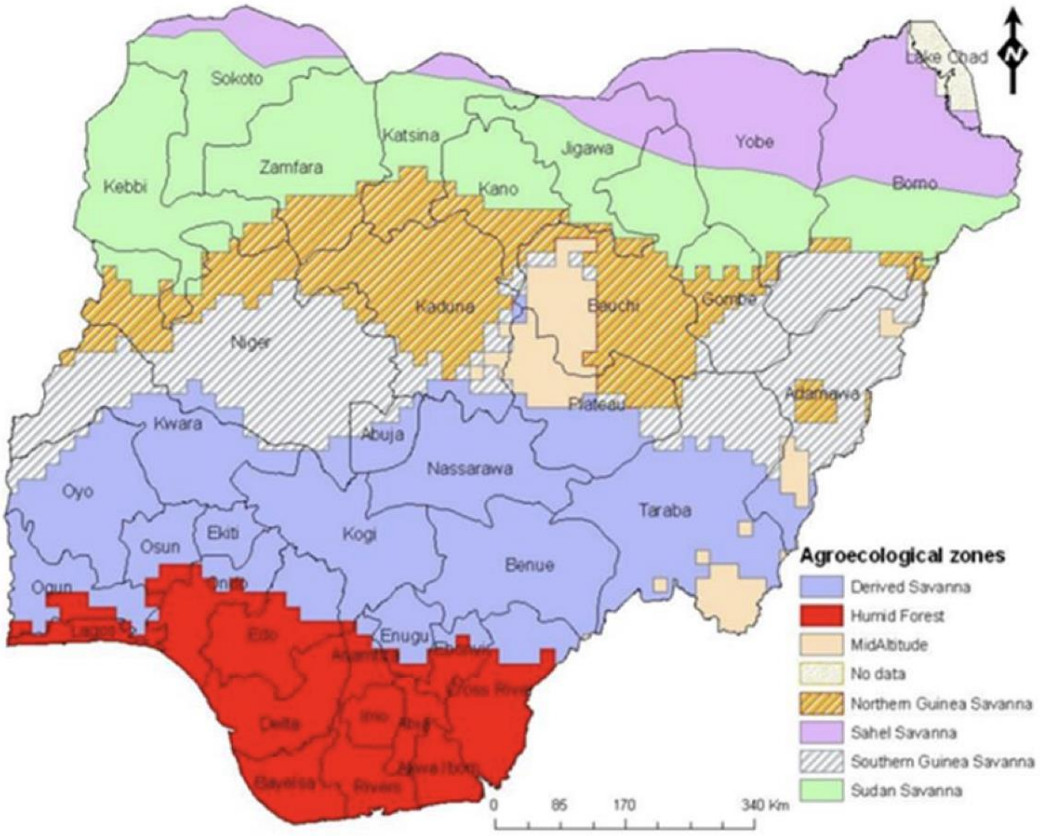

Figure 2.1: Agro-Ecological Zones in Nigeria

2.2 Need for the Project

Suppose agricultural production continues to expand as expected, and fiscal policies are not in place to manage the growth of the downstream processing and trading industries. In that case, the result will be reduced prices at the farm and in the primary market. Thus, the initial growth will not be sustainable, and the confidence of farmers will be lost. Therefore, growth and expansion must be managed to comply with prevailing industrial opportunities, which requires thoughtful planning by governments. The establishment of the Plateau State Special Agro-Industrial Processing Zone is one of such contingency planning by the State.

African Development Bank (AfDB), as part of the implementation of its Feed Africa Programme, will be providing financial and technical support to the FGN through the development of Special Agro-industrial Processing Zones "SAPZs" to concentrate agro-processing activities within areas of high agricultural potential, to boost productivity and integrate production, processing, and marketing of priority commodities.

SAPZ is defined as

- a demarcated area of land (or a corridor), developed with desirable infrastructure and dedicated to attracting and supporting investments in agro-processing and related activities (otherwise called the Processing Hub') and,
- it is complementary to the Agricultural Transformation Centres (ATCs) which are connected to the Processing Hub) usually 4 - 8 in number.

ATCs, themselves are centrally located within farming clusters enveloping the Processing Hubs, and they provide services to farmers including, technology, inputs, finance, production and, postharvest support and uptake markets through the arrangement of efficient, quality feedstock supply for the Processing Hub including, aggregation, storage, pre-processing. The SAPZs aim to develop competitive processing capacity by promoting private sector investment, enabled by investment in public goods, policy interventions and the provision of desirable support services and skills development. The Federal Government and host State Governments will facilitate the backbone infrastructure leading to the SAPZ. Simultaneously, the operator of the SAPZ will provide and manage infrastructure within the zone to attract a wide range of private sector investors' investments in agricultural production, processing, and the entire ecosystem from farm inputs to ancillary industries. Figure 2.2 presents the schematic structure the Agricultural Industrial Hub.

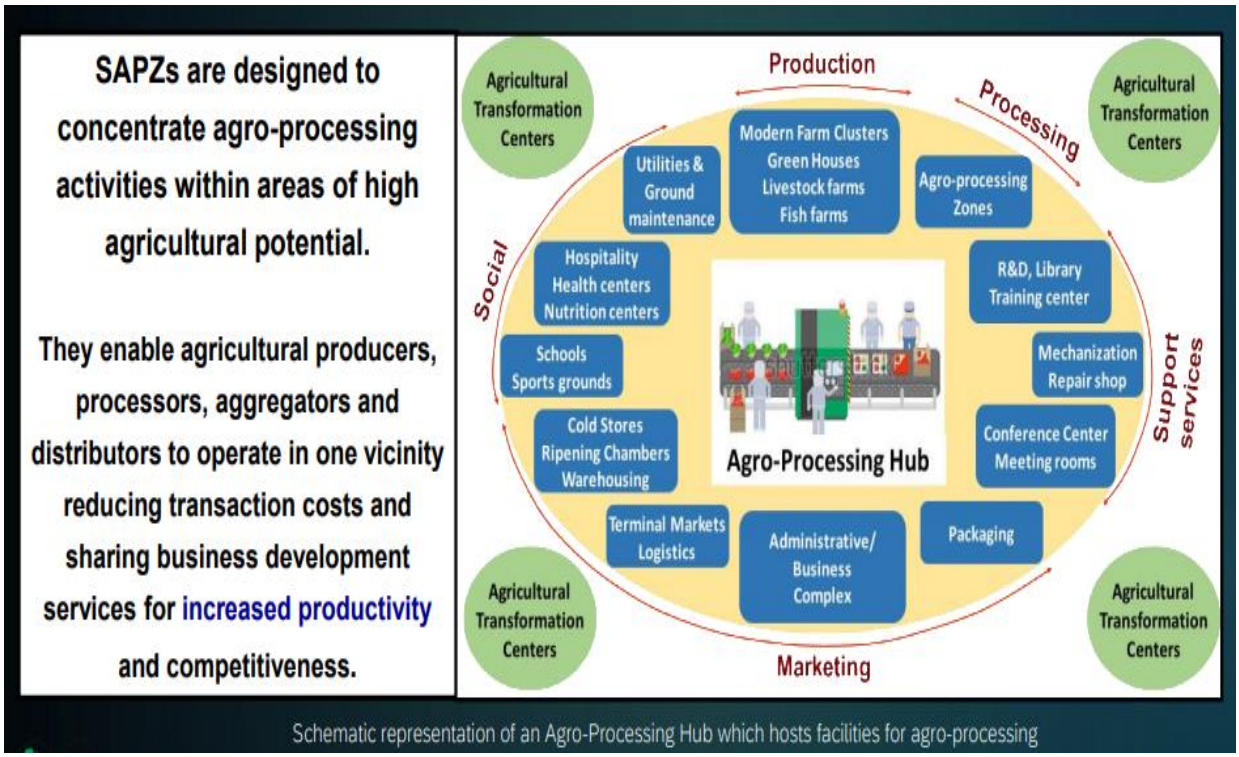

Figure 2.2: Schematic Representation of Agricultural Industrial Hub

2.3 Benefit of the Project

The proposed project will offer several benefits which include:

- boost farm incomes, reduce poverty, create clusters of economic growth, and increase tax revenue through value additions.
- encourage longer-term private sector investment, thereby assuring the sustainability of industrial development, through Government's intervention in creating and maintaining enabling environments.
- create wealth for rural farming communities.
- stimulate private-public partnership.
- increase food and nutritional security, create new/green jobs, and thereby reduce rural-urban migration through enhancement of productivity at the farm level.
- promote private sector investment in climate-smart and green technologies, enabled by investment in public goods, policy interventions and the provision of pertinent support services and skills development.
- reduce the low levels of post-harvest loss/deterioration of agricultural produce and increasing net profits to farmers.
- guarantee availability of feedstock for sustainable input supply to agro-processing plants
- General improvement of the standard of living for the populace.
- Facilitation of National Economic Diversification
- create new sustainable jobs, especially for the youth and, reduce restlessness and crime.
- boost rural livelihoods and reduce rural-urban drift.

2.4 Value of the Project

The proposed project cost is estimated at Two Billion Naira (₦2Billion) only to be funded through equity contribution by the project proponent, interested private investor and bank loan. It is envisaged that a large percentage of the total cost will be injected into the local economy for procurement of project designs, approvals/permits, construction materials, services, etc.

2.4 Envisaged Sustainability

The proposed project's sustainability is viewed as ensuring that the benefits realized are maintained and continue to influence positively into the foreseeable future. The project's sustainability is addressed under four key areas: it's economic, technical, social, and environmental sustainability potentials.

2.4.1 Economic Sustainability

Plateau State Government shall ensure standard business ethics and transparency; preventing corruption, encourage public advocacy and lobbying, transparency in payment of taxes,

encouraging human rights and security. Proceeds accruing from the agro-processing activities will continually contribute additional revenue to the State and the Federal Government of Nigeria. More jobs will be created and this in turn shall meet the State government financial, socioeconomic, and material obligations to the host communities. The favourable enabling environment ensures that the Agro-processing Zone shall continue to exist for decades as a business venture and as an industry.

2.4.2 Technical Sustainability of the Project

The proposed Special Agro-industrial Processing Zone (SAPZ) Project shall adopt the principle of Best Available Techniques (BAT) for design, construction, and operation. To ensure technical sustainability, the following principles shall be enshrined in the project:

- Local content will be generously utilized in the design, construction, and operation.
- Skills transfer will be encouraged between expatriates' engineers and local engineers to close the gap in knowledge throughout the project life.
- The State Government shall ensure the training and retraining of its local Engineers.

2.4.3 Social Sustainability of the Project

To ensure the social sustainability of the project, the State Government shall ensure:

- ***Robust and sustained stakeholder engagement****:* The State Government shall ensure sustained and effective Stakeholder Engagement in a structured and culturally appropriate manner with affected communities. The consultation process will be tailored to the risks and impacts of the Project; the Project's phase of development; the language preferences of the affected community; their decision-making processes; and the needs of disadvantaged and vulnerable groups.
- ***Establish a grievance mechanism:*** This shall be designed to receive and facilitate the resolution of concerns and grievances about the project's environmental and social performance as part of its Environmental and Social Management System (ESMS). Potential sources of grievances and acts of sabotage could include community youth groups, tribal conflicts, etc.
- ***Security Surveillance of the Facility:*** Encroachment and breach of Agro-processing facility security by a third party that can typically cause safety and environment incidents shall be monitored.

2.4.4 Environmental Sustainability of the Project

The proposed Special Agro-industrial Processing Zone (SAPZ) Hub Project shall be environmentally sustainable because agro-processing activities shall continually be guided by applicable environmental regulations such as Environmental and Social Safeguards Policies

(African Development Bank), FMEnv policies and World Bank Guidelines on Environmental Assessment. Also, incorporating the findings and recommendations of this ESIA and subsequent implementation of the Environmental & Social Management Plan (ESMP) for the project's activities will ensure the desired environmental sustainability.

In addition, At the early stages of conceptualization of this development, several visits to the study area were conducted to obtain first-hand information of the project area thereby understanding potential environmental receptors of the construction on its immediate environment. Innovative technologies that are economically viable and have minimal environmental, social and health impacts shall be utilized in the execution of the proposed project.

2.5 Project Options and Alternatives

Established ESIA processes including the requirements of Nigerian regulations call for an analysis of reasonable alternatives to various elements of the proposed project. To align with the Federal Ministry of Environment's (FMEnv) *National Environmental Protection (Effluent Limitations) Regulation of 1991* which mandates early selection of best engineering and operational options for new point sources, a range of alternatives and options were evaluated to facilitate identification of the most appropriate means of meeting the project's environmental objective. Project alternatives analysis in environmental assessment is designed to bring environmental and social considerations into project selection as well as the early stages of project planning, and the later stages of site selection, design, and implementation. The benefits of evaluating alternatives are for the selection of the best project design, selection of the best project location, and most efficient use of resources which will aid avoidance of adverse impacts and achievement of sustainable development goals. Therefore, the following options and alternatives were appraised:

- Project options: No project options; Delayed project options; and Go-ahead option
- Project alternatives: Alternative location/site, alternative design/technology.

2.5.1 Project Options

2.5.1.1 Option One: No Project Option

This option assumes that the project will not take place which means that no further development will take place in Heipang because of the non-viability of the feasibility studies. The No Project option will harm the local and national economies. The significant socio-economic and industrial development benefits associated with the proposed development such as increased business opportunities, increased revenue to the government, increased foreign exchange earnings, employment opportunities, etc. will be forfeited. As a result, the 'No Project option' was not considered to be a viable or acceptable option for the proposed project.

2.5.1.2 Option Two: Delayed Project Option

Due to some unfavorable conditions such as civil unrest or hostilities within the stakeholder communities, malicious public opinion, unfavorable government policies, prevailing bad economic conditions, or any force majeure, implementation of a proposed project may be delayed. Considering this option implies that the development's activities would be stalled until conditions become conducive. Interestingly, none of the above-mentioned or any related delaying factors currently exist against the proposed development, therefore the delayed project option was not considered a preferred option and thus was not selected.

2.5.1.3 Option Three: Go-Ahead Option

The Project option admits and emphasizes the vital need for the planned development. Considering its many benefits, this option was significantly weighed positively. This option will contribute to improved and increased production which will enhance the revenue base of Nigeria. It will also enhance job creation and many more direct and indirect socio-economic benefits. This Go-Ahead option was deemed viable and therefore considered. The proposed project should therefore be executed as planned.

2.5.2 Project Alternatives

The identification and investigation of alternatives is a key aspect of the ESIA process. Therefore, all reasonable and feasible alternatives were identified and assessed during the scoping phase to determine the most suitable alternatives to consider and assess during the ESIA phase. The preferred project alternatives are highlighted and presented here. Alternatives can typically be identified according to:

- Technology alternatives;
- Site/ Project Location alternatives

For any alternative to be considered feasible such an alternative must meet the need and purpose of the development proposal without presenting significantly high associated impacts. The alternatives are described, and the advantages and disadvantages are presented. It is further indicated which alternatives are considered feasible from a technical as well as environmental perspective. Incremental alternatives typically arise during the ESIA process and are usually suggested as a means of addressing identified impacts. These alternatives are closely linked to the identification of mitigation measures and are not specifically identified as distinct alternatives. This section provides information on the development of footprint alternatives, as well as the type of activity, activity layout, technological and operational aspects of the activity.

2.5.2.1 Alternative 1: Site/ Project Location Alternatives

Selection of the preferred location for the proposed Agricultural Industrial Hub (AIH) was because Heipang is already established marketplace due to the presence of an Inland Dry Port located just

adjacent to the proposed project site, processed product can easily be transported to various location across the country through the port. Hence Heipang is considered the best location for the Agricultural Industrial Hub (AIH).

2.5.2.2 Alternative 2: Technology Alternatives

Conventional Technology.

This technology is not environmentally friendly and has led to an increase in Greenhouse Gases (GHGs) in the atmosphere causing climate change.

Green Agro-Processing Technology

The proposed Special Agro-industrial Processing Zone (SAPZ) shall strictly adhere to international and national terminal engineering design, construction standards, and codes of practices of the green Agro-Processing Hub which shall include rainwater harvesting, recycling wastewater, installing solar panels which will help to leave tremendous carbon footprints. Going with Green Agro-Processing Hub technology shall help mitigate climate change and bring substantial benefits which shall include reduced operational costs, reduced capital asset life cycle costs, greater utilization of assets, improved benefits to the community, optimization of new and better technologies, as well as reduced environmental, health and safety risks.

Agricultural IoT Center System

The Hub will be monitored using the Agricultural Internet of Things technology. This is a system designed for Real-time monitoring display based on GIS map of climate, soil environment, water body, and other field conditions such as (seedling condition, moisture condition, disaster condition, insect condition) of the project environment. This is programmed at reasonable intervals and thresholds for various monitoring values automatically issues early warning (SMS message) to the system when issues arise, such as exceedance of values on the field condition of the area. It avoids the randomness of manual operations to a great extent, significantly reducing on-site labor occupation, helps users achieve precise control of on-site conditions, and provides a basis for the standardization of production processes.

The entire platform is seamlessly connected to a network camera surveillance equipment, allowing you to remotely view real-time video surveillance of the area and trace historical surveillance records. It supports 360-degree pan-tilt control of high-speed dome cameras and multi-fold zoom and expansion.

Protected Agriculture

- Plateau holds the potential for the promotion of high value agriculture crops like exotic vegetables.
- Promotion of protected agriculture would ensure year-round availability of these produce
- It would help production of safe food to tap emerging markets
- Protected agriculture with integrated cold chain can tap markets within the country and even for exports.
- Provides an opportunity to promote entrepreneurship.
- It would supplement processing facilities making them remunerative.
- It can ensure very high productivity.
- Flexibility for producing a range of crops and flowers.
- Cost-effective infrastructure and technology solutions available; can be adopted with need-based customization such as the options for vertical farming available with simple A-frame technology etc. The ecosystem being developed under SAPZ can be used to promote protected agriculture.

2.6 Summary

Having considered several of the project's options in terms of their social, economic, technical, and environmental implications/benefits both in the short and long run, the project option which gives credence to the execution of the proposed project was selected. To select the Best Available Technique (BAT) in line with the National Environmental Protection (Effluents Limitation) Regulations 1991, many alternatives were also considered which favours the selection of execution of the proposed project on the selected site based on its viability. Therefore, the proposed project should be executed as planned.

CHAPTER THREE
PROJECT DESCRIPTION

3.1 Background Information

This chapter presents the detailed description of activities on the proposed Special Agro-industrial Processing Zones (SAPZ II) Agro-Industrial Hub at Heipang, Jos, Plateau State. The activities entail construction, installation, and operational processes. The details cover the nature of the key project activities, facilities, equipment, operations, personnel, and the implementation schedule. The aim is to enable the scope and extent of the project to be understood, and for all potential sources of impacts to be identified. It is also to facilitate the selection of best available techniques (BAT) as required by the National Environmental Protection (Effluent Limitations Regulations) of 1991.

3.2 The Project

The Special Agro-Industrial Processing Zones are integrated development initiatives designed to concentrate agro-processing activities within areas of high agricultural potential to boost productivity, integrate production, processing, and marketing of selected commodities. These zones will enable agricultural producers, processors, aggregators, and distributors to operate in the same vicinity to reduce transaction costs and share business development services for increased productivity and competitiveness. By bringing adequate infrastructure (energy, water, roads, ICT, etc.) to rural areas of high agricultural potential, SAPZs will attract investments from private agro-industrialists/entrepreneurs to contribute to the economic and social development of rural areas. It is on this background that Plateau State Government proposes to establish an Agro-Industrial Hub (AIH) at Heipang as part of the Special Agro-Processing Zones (SAPZ II) programmed. The Hub will mainly rely on the output from the Agricultural Transformation Centres (ATC) which serves as the supporting structure of the AIH.

3.3 The Project Location

The proposed site for the Agro-Industrial Hub (AIH) at Heipang is located between Latitudes 09°38′30″N and 09°40′00″N of the Equator, and longitudes 8°51′00″E and 8°53′30″E of the Prime Meridian. The site is located close to the airport and is adjacent to the Jos dry port and is well connected by road network. The land is generally flat and devoid of any perineal vegetation and has been used for agriculture. A land area of around 543.9 hectares has been identified at Heipang community, Barkin Ladi LGA for the development of an AIH. Out of the 543.9 hectares, an area of 100 hectares is being developed as an industrial zone and the remaining 443.9 hectares is being allocated for commercial cultivation of focus crops and seed multiplication.

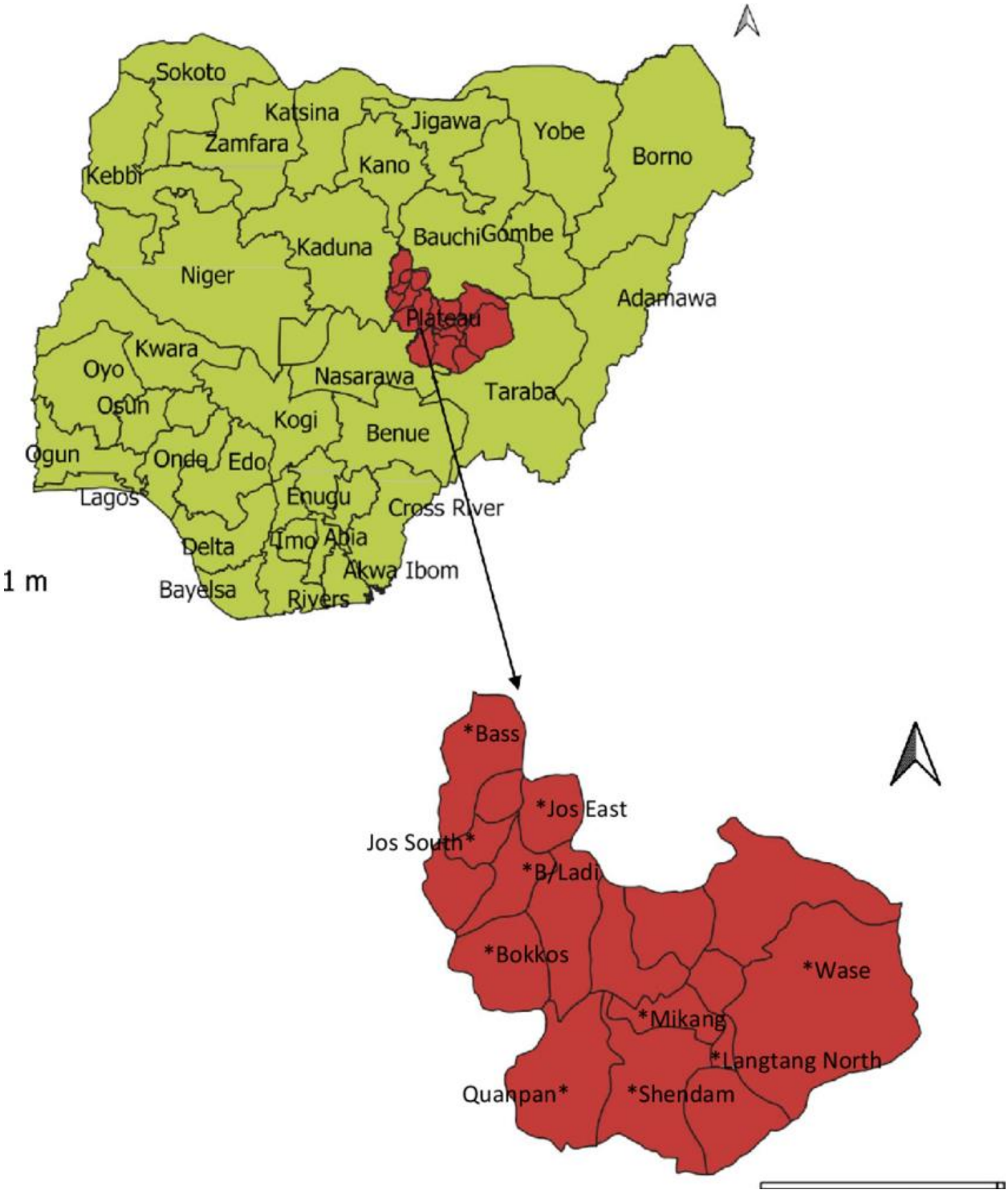

Figure 3.1: Map of Nigeria showing Plateau State

Figure 3.2: Map of Plateau State Showing the Proposed SAPZ-AIH Centre at Heipang, Barkin Ladi LGA

Figure 3.3: Google Map View of the Proposed Project Site at Heipang

Figure 3.4: Area Demarcation of the Proposed Project Site at Heipang

3.3.1 The Project Site

The area acquired for the project covers total land area of 543.98 Hectares (Ha) and a Perimeter of 10.82 Kilometers (Figure 3.4 and Figure 3.5)

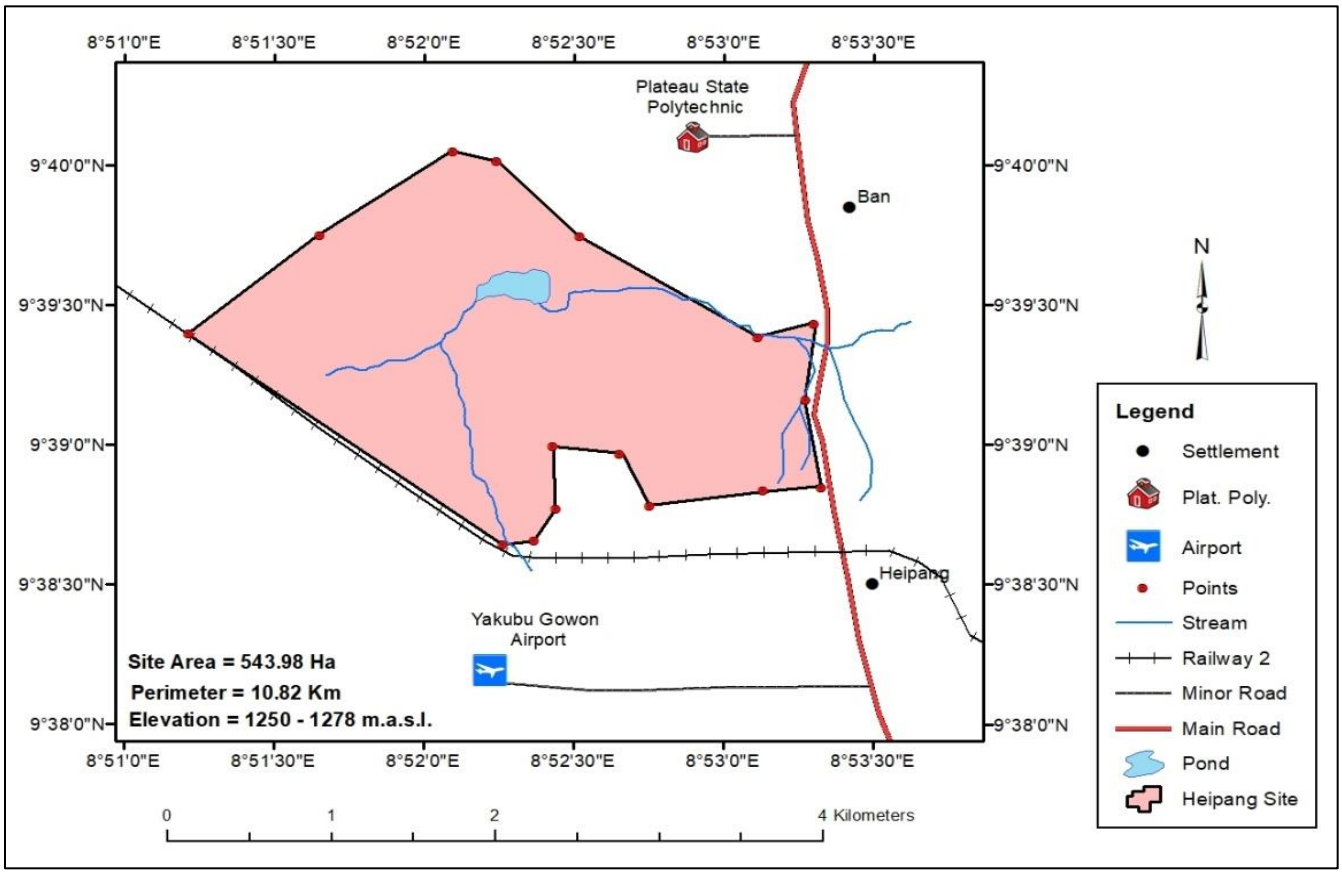

Figure 3.5: Layout of the AIH Centre at Heipang

The masterplan for the industrial zone of the AIH has been planned to accommodate the requirement of the interventions proposed for the SAPZ. The following facilities are being proposed.

Physical Infrastructure

- Road network
- Water Supply System
- Sewerage and effluent collection system
- Storm Water Drainage System
- Street Lighting
- Electrical Distribution System

Common Facilities

- Administration office
- Residential Training Center
- Cold Storage
- Farm Input Store
- Warehousing facilities with Weigh Bridge
- Parking Facilities
- Testing labs
- Custom Hiring Centre
- Farm Input Sale Depot
- Guest house & Recreation facilities

Industrial Units

- Casava Processing unit
- Cattle Feed Unit
- Yam Processing Unit
- Seed processing unit
- Integrated Cold Store with IQF
- Protective Agriculture Zone
- Standard design factories for value addition

Environmental Infrastructure

- Sewage Treatment Plant
- Common Effluent Treatment Plant

The Master Plan for the Proposed Agricultural Industrial Hub (AIH) at Heipang is presented on Plate 3.1 below.

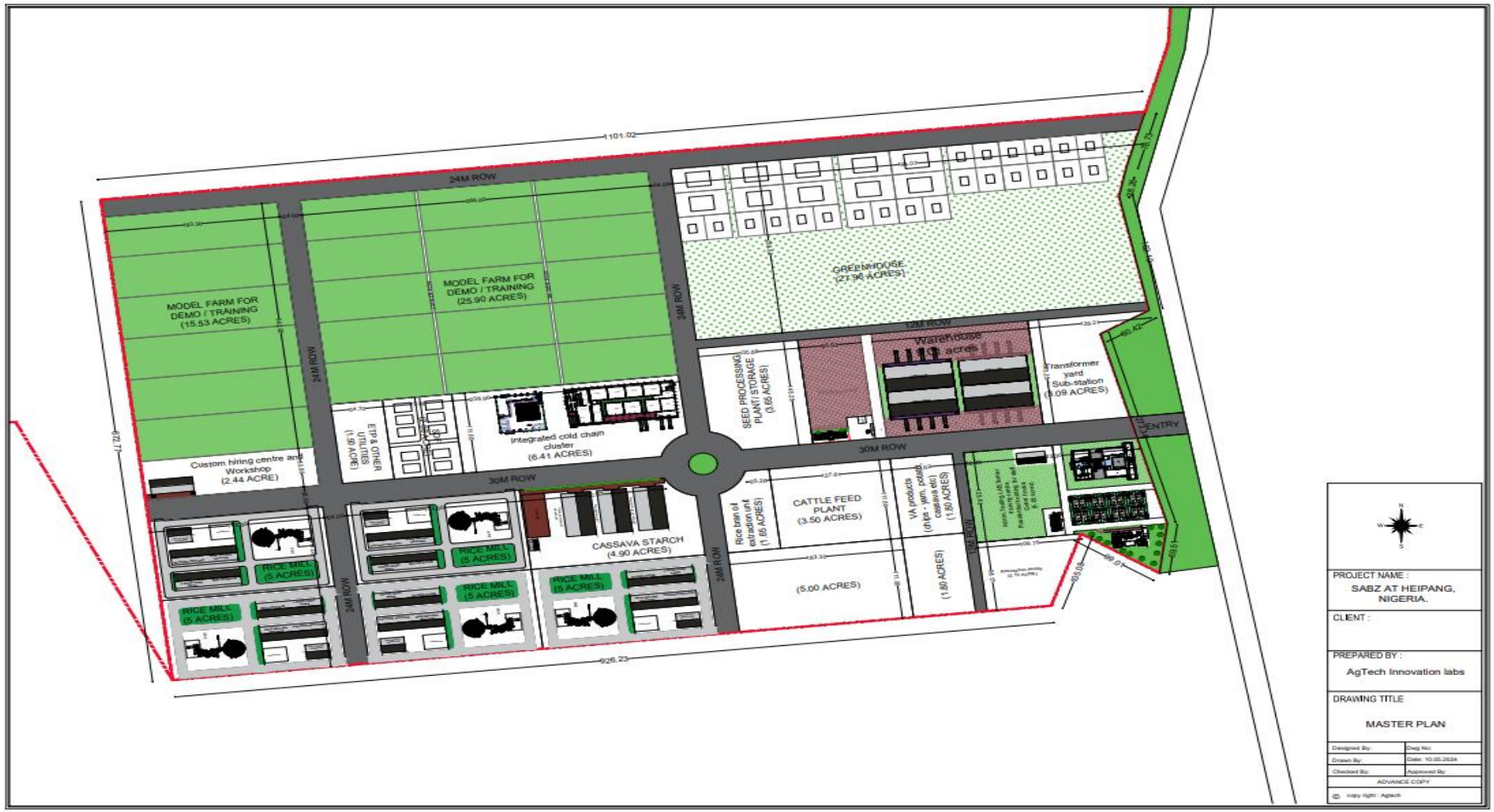

Plate 3.1: Facility Layout (Master Plan) at Heipang

3.4 Description of the Project Components

Casava Processing Plant: A casava value addition unit of 40 MT/day is proposed in the AIH mainly for starch extraction. The cassava starch plant will be of 2 MT/ hour capacity.

Cassava starch is produced primarily by wet milling of fresh cassava roots. Starch is the main constituent of cassava with about 25% starch obtained from mature, good quality tubers.

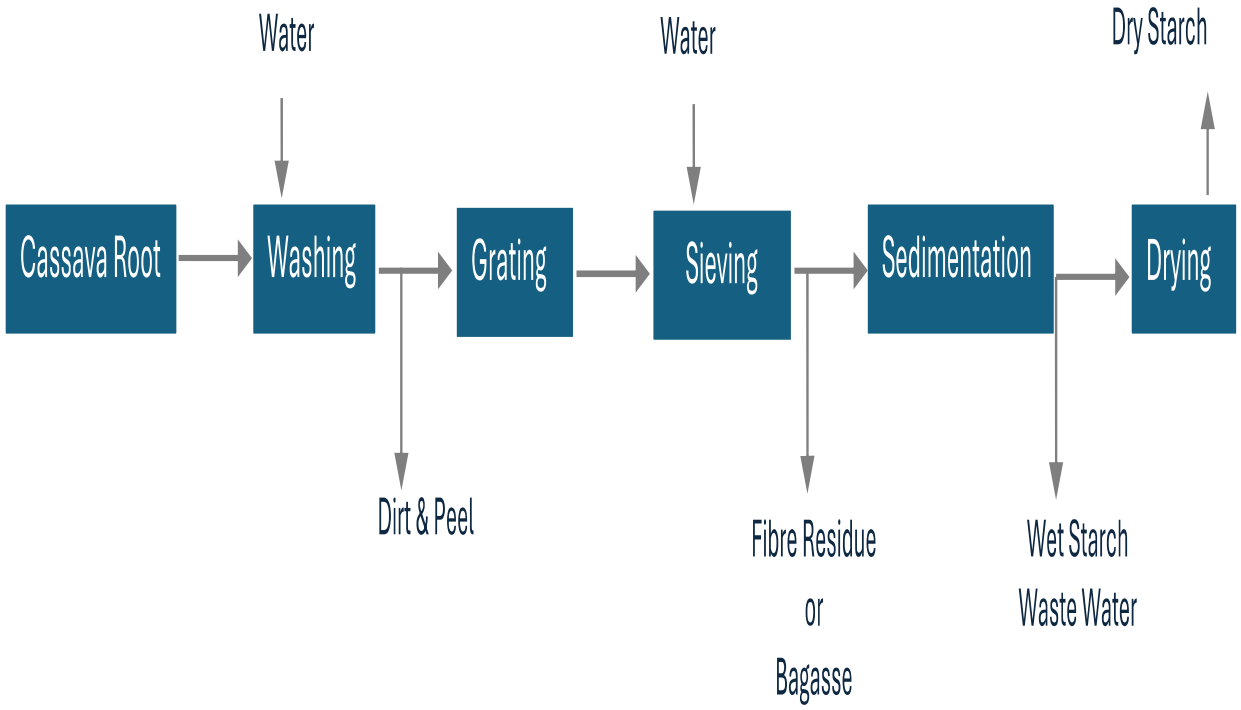

Figure 3.6: Cassava Starch Extraction Flow Diagram

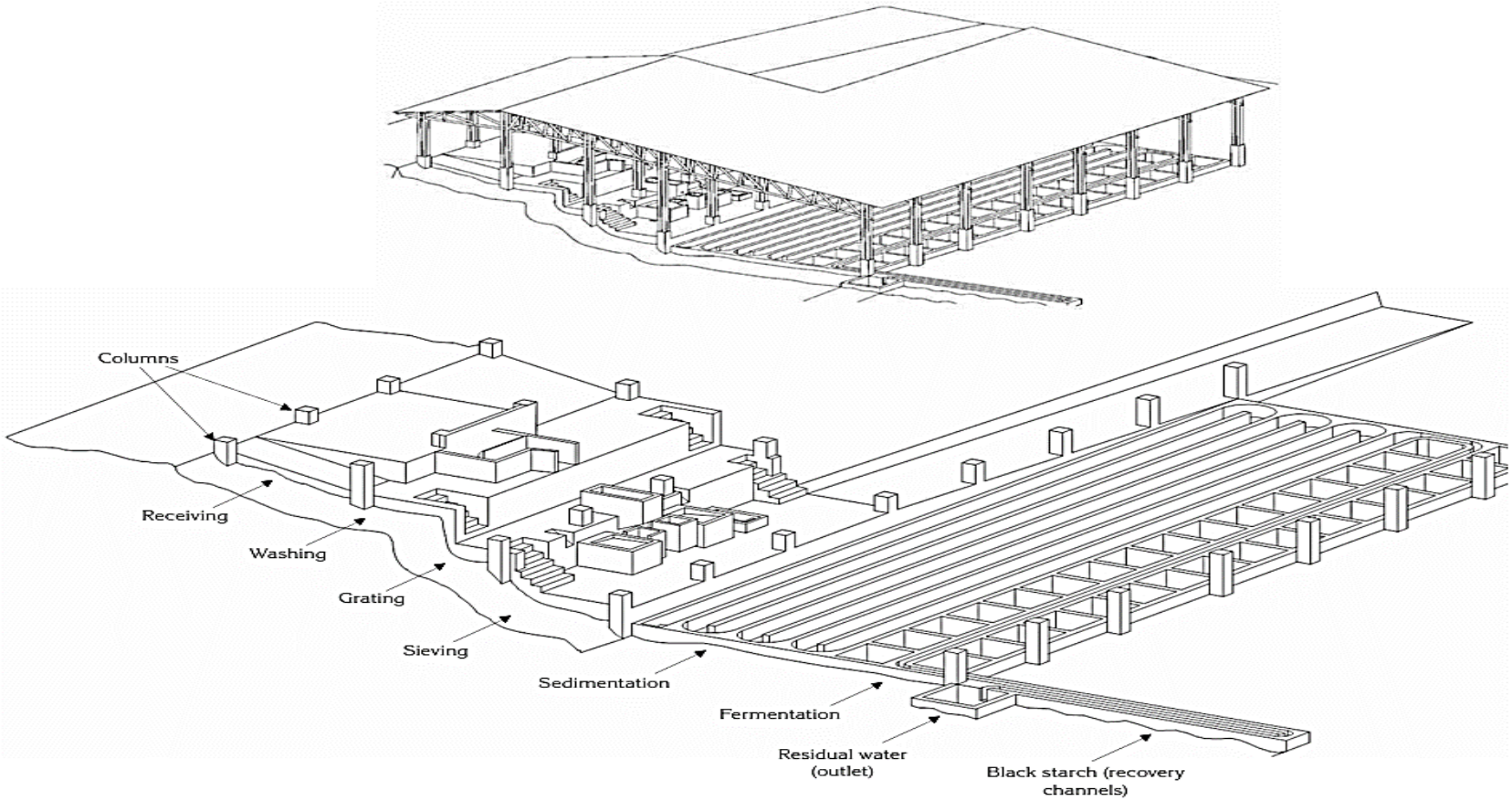

Figure 3.7: Extraction Plant Layout of Cassava Starch Extraction Process

Yam Processing Plant: It is proposed to develop a Yam primary processing plant in the AIH. This facility is expected to facilitate the value addition of the YAM being produced in the region.

Modern Market Complex: Modern market for Yam with facilities for marketing of other agricultural produce in an area of 35 acres is planned. The market will have 50 wholesale shops and 50 retail shops with well-designed roads for efficient circulation of trucks and people. The market complex is provided with a cold store, dry warehouse, weigh bridge, toilet facilities etc to provide a self-contained facility. It is expected that the market complex can handle 50,000 MT of fresh produce and dry commodities. Space is also provided to establish a modern compost yard to dispose of the agricultural waste generated in the market.

Maize processing Unit: Space is provided to set up a maize processing unit with silo arrangement within the AIH with the focus on seeds.

3.4.1 Common Infrastructures

Site Development: Site grading will include cutting, filling, and compacting the filled-up earth to integrate the micro drainage pattern of the site to the proposed storm water drainage system. The Site will be protected by boundary fencing and an aesthetically designed entrance plaza is proposed.

Road Network: The proposed road network in Bituminous Road in the AIH and would comprise 30 m and 24 m ROW for better circulation of large trucks and will be pedestrian friendly.

Storm Water Drainage: The entire storm water drainage system for the AIH has been planned to utilize the natural slopes wherever possible and an economically graded slope in other locations, to design an economical and sustainable surface drainage system with integration of rainwater harvesting.

Water Supply Network: The AIH comprises of agro-processing factories apart from common facilities. The water requirement is calculated based on the requirement for the processing and domestic usage. The total water demand is estimated at 0.8 million litres per day. The source of water will be ground water through a set of industrial borewells.

Sewerage Collection and Treatment System: An underground sewerage network has been designed to collect sewage from each plot and convey it to a sewage treatment plant (STP). At the STP, the sewage would be treated to acceptable standards and the treated sewage will be used for irrigation purposes for which pipe network is considered.

Effluent Collection and treatment system: The major effluent generated will be from the Yam processing plant through washing and from the casava processing plant generated through washing and from the centrifuge. The effluent treatment will be through a series of anaerobic and aerobic treatments. The treated effluent will meet the standard to be supplied back for washing and agriculture purposes.

Electrical Generation and Distribution: The aggregate power demand of the park is estimated to be the order of 4 MW for industrial and domestic use. Since the grid power does not cover this region, it is proposed to install a gas based captive power plant of 4 MW capacity and distributed to the entire AIH. Solar street lighting is proposed for the outdoor illumination.

3.4.2 Other Facilities

Office and Training Centre: A full-fledged office and training center is proposed in the SAPZ, which will be located at its entrance. The center is designed for a capacity of 50 trainees and will have training halls, accommodation for staff, trainees, guests etc. A food court, bank, testing lab is proposed in this zone. Demo Plots for farm training are also proposed as part of the training center.

Common Warehouse: A common warehouse with a capacity of 20000 MT is proposed with support facilities such as weigh bridge, truck parking and driver amenities.

Custom Hiring Center and Workshop: This center will provide farm machinery on hire for the farmers and will also house a full-fledged workshop for general maintenance of farm equipment. The centre will also impart training for the maintenance and operations of farm machinery and equipment.

Farm Input Sale Counter: This center is proposed to cater to the supply of quality farm inputs such as seeds, fertilizers etc. for the farmers.

Cold Storage Facility: A cold storage warehouse is a specialized storage facility equipped with temperature-controlled environments. Its primary function is to store temperature-sensitive products, often perishable goods like fresh produce, frozen foods, and more, ensuring their quality and extending their shelf life.

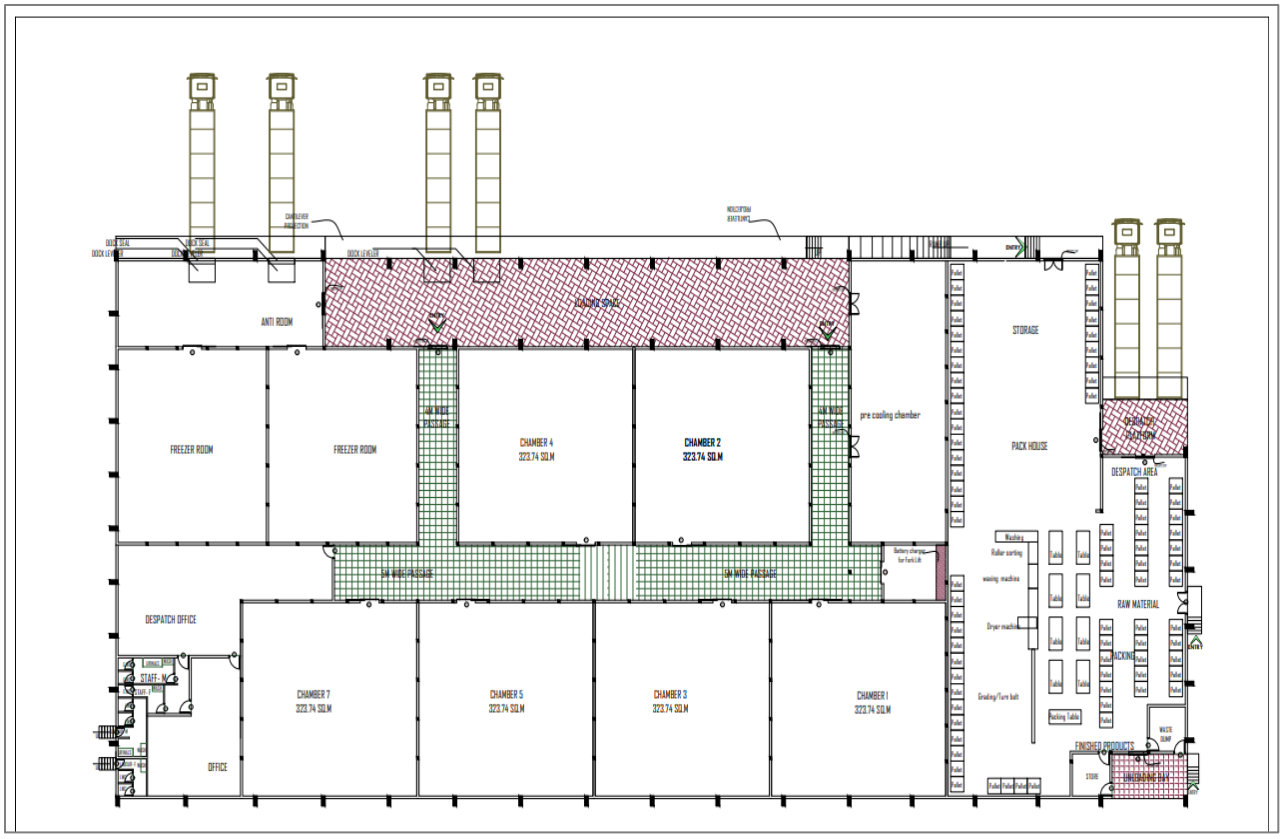

Figure 3.8: Plan for Pack House and Cold Store

3.5 The Project Activities

The project activities will broadly cover the following areas:

Pre-construction activities: This includes

- Site Preparation,
- Engineering Design,
- Materials Delivery, etc.

Construction activities: This includes

- Construction of Office Complex, Restaurant, Business Complex Car Park etc
- Installation of Various Equipment, Treatment Plant, Power Generation Equipment, Etc.
- Civil Works.
- Electrical Works
- Plumbing Works

Operational activities: This includes

- Operation of the Agro-Processing facilities,

- Packaging and Supply of Same to Customer Locations Etc.
- Movement of raw materials in and finished products out of the Centre.
- Maintenance of the Agro-Processing facilities and

The decommissioning activities: This includes

- Demolition and Removal of Agro-Industrial Hub components for relocation or sale
- Remediation of the site.

3.5.1 Preconstruction Phase

The pre-construction phase defines the set of activities that precedes full construction works. It also involves meetings, consultations, publications, and public information bureau management that must be put in place before the civil works. The start-up activities in this phase are essentially desktop, involving feasibility studies with environmental, technical, and financial considerations. These investigations are aimed at ensuring the viability and sustainability of the project, while having minimal negative impacts on the environment. Other aspect of the pre-construction activities shall be site preparation activities consisting of minimal site clearance and earthworks (topsoil removal and site grading). In addition, this phase involves movement and transport of equipment and materials.

3.5.2 Description of the Project's Construction Activities

Pre-construction Investigations*:* The implementation of the project's design and construction phase will start with a thorough investigation of the site's biological and physical resources to minimize any unforeseen adverse impacts during the project cycle.

Sourcing and Transportation of Building Materials: Building materials will be transported to the project site from their extraction, manufacture, or storage sites using transport trucks. The building materials to be used in the construction of the project will be sourced from neighboring areas. Greater emphasis will be laid on the procurement of building materials from within the local area, which will make both economic and environmental sense as it will reduce the negative impacts of transportation of the materials to the project site through the reduced distance of travel by the materials transport vehicles.

Vegetation Clearing: The site has some vegetation cover including grass growing in it. All cleared vegetation will be replaced through landscaping.

Storage of Materials: Building materials will be stored on site. Bulky materials such as rough stones, ballast, sand, and steel will be carefully piled on site. To avoid piling large quantities of materials on-site, Plateau State Government shall order bulky materials such as sand, gravel, and stones in bits. Materials such as cement, paints, and glasses among others shall be stored in temporary storage structures, which will be constructed within the project site for this purpose.

Excavation and Foundation Works: The soil cover in the proposed area is thin and the subsoils are exposed to the surface in some areas, with a thin layer of black cotton soil about 4 inches deep. However, this shall be excavated and disposed of in approved sites (preferably exhausted quarries).

Masonry, Concrete Work, and Related Activities: The construction of the agro-industrial centre walls, foundations, floors, pavements, drainage systems, perimeter fence, and parking area among other components of the project shall involve a lot of masonry work and related activities. General masonry and related activities will include stone shaping, concrete mixing, plastering, slab construction, construction of foundations, and erection of building walls and curing of fresh concrete surfaces. These activities are known to be labour intensive and will be supplemented by machinery.

Structural Steel Works: The agro-industrial centre and associated facilities will be reinforced with structural steel for stability. Structural steelworks will involve steel cutting, welding, and erection.

Roofing and Sheet Metal Works: Roofing activities will include sheet metal cutting, raising the roofing materials such as iron sheets and structural steel to the roof, and fastening the roofing materials to the roof. The constructed roof shall be insulated for noise just enough to maintain the good acoustic sensation for the spectators; but at the same time be adapted for climate.

Electrical Work: Electrical work during construction of the premises shall include installation of electrical gadgets and appliances including electrical cables, lighting apparatus, sockets, etc. Besides, there shall be other activities involving the use of electricity such as welding and metal cutting.

Plumbing: Installation of pipework for water supply and distribution shall be carried out within the entire agro-industrial Centre.

Landscaping: To improve the aesthetic value or visual quality of the site once construction ceases, the proponent shall carry out landscaping. This shall include the establishment of a theme garden and lush grass lawns where applicable and shall involve replenishment of the topsoil. It is noteworthy that Plateau State Government shall use plant species that are available locally preferably indigenous ones for landscaping.

Buildings Construction: The proposed Agro-Industrial Hub (AIH) is anticipated to be a steel-structured agro-industrial centre that would meet all state and local seismic standards. The overall design would meet national and international Standards and meet current state and local seismic standards. Additionally, the design would consider building user safety, security, and functionality. The technology used in the design and construction of the hub will be based on international standards, which have been customized by various agro-processing in Africa. The project will consist of a agricultural hub with associated facilities, parking lots, and infrastructure as presented in the project description.

The hub will be constructed as per the respective structural engineer‘s detail as provided for in the drawings presented in this chapter. The structures will consist of concrete appropriately reinforced with metal (steel and iron). The roof will consist of structural steel and roofing sheets.

Parking Lot: The parking lot shall be designed to improve access in and out of the proposed project area. The on-site collector roads shall be connected to preferred and general parking zones and to create safe passageways to the hub for the users to avoid interacting with inbound or outbound traffic flow.

Sustainable Design: The proposed hub would include energy efficiency, water conservation, low-impact development, and other green building practices, which shall be incorporated into the final design to meet national and international standards. Energy conservation measures would also include the use of solar photovoltaic energy. When coupled with a parking shade canopy, the photovoltaic system provides shade while generating electricity. Other energy-saving measures include the use of LED lighting inside and outside the hub. A comprehensive energy control system shall be included utilizing motion sensors and photocells to avoid over lighting. Other anticipated energy-saving features would likely include the building orientation, use of low-flow plumbing fixtures, use of high-efficiency electrical fixtures, and an integrated recycling program.

Fire Safety

Fire and Gas System: The F&G Detection System is designed and installed to provide detection of fire or leak of flammable gas, rapidly and reliably. It continuously monitors all areas where a fire or accumulation of a flammable/explosive gas mixture may occur. The Fire and Gas system is not generally related to any process but instead is divided into fire areas by location. Each fire area is designed to be self-contained, in that it should detect fire and gas by several types of sensors, and control fire protection and firefighting devices to contain and fight the fire within the fire area. A fire area protection datasheet shows what detection exists for each fire area, and which fire protection action should be taken in case of an incident. The type and number of the detection, protection, and fighting devices depends on the type of equipment and size of the fire area and they vary for different process areas. The key features of the F&G detection system are highlighted below.

- ***Fire detection:***
    - Gas detection: Combustible and toxic gas, electro-catalytic or optical (IR) detector.
    - Flame detection: Ultraviolet (UV) or infra-red (IR) optical detectors.
    - Fire detection: Heat and ionic smoke detectors.
    - Manual pushbuttons.
- ***Firefighting, protection:***
    - Gas-based firefighting, such as CO_2.
    - Foam-based firefighting.

- Water-based firefighting: sprinklers, mist (water spray), and deluge.
- Protection: Interface to emergency shutdown and HVAC fire dampers.
- Warning and escape: PA systems, beacons/lights, fire door, and damper release.

For fire detection, coincidence and logic are often used to identify false alarms. In such schemes, several detectors in the same area are required to detect a fire condition or gas leakage for an automatic reaction. This will include different detection principles, e.g., a fire, but not welding or lightning strike. Firewater trucks shall also be included in the hub.

3.5.3 Description of the Project's Operational Activities

Once the project construction is completed and fully operational, it is expected that it will have a lifespan of 50 years. Operation and maintenance activities will include the following:

Maintenance of Ancillary Facilities

The infrastructure and other ancillary facilities when completed will require routine and periodic preventative maintenance to keep them from undue deterioration and wear and to ensure safe, smooth, and uninterrupted operations. An optimal Maintenance Program will be developed to achieve this.

Civil Maintenance

This will include undertaking routine maintenance including prompt repairs of potholes, cracks, joints, drains, embankments, structures, pavement markings, lighting, road signs and other traffic control devices; and major maintenance such as resurfacing of pavements, repairs to structures and other equipment.

Electrical Maintenance

This will involve prompt repair & maintenance of dysfunctional high mast lights, streetlights, traffic signals, traffic signal controllers and flashing beacons.

Waste Generation

The proponent will provide facilities for handling solid waste generated within the facility. These will include dustbins/skips for temporarily holding waste within the premises before final disposal at the designated dumping site. The solid waste from each block will be assembled in the garbage collection point ready for disposal. Private waste disposal companies that are approved by the Ministry of Environment will be responsible for solid waste disposal.

Waste Water and Stormwater Management

Sewage generated from the hub will be discharged through Plateau State Environmental Protection and Sanitation Agency (PEPSA) with cradle to grave management of these wastes.

Cleaning The Plateau State Government shall be responsible for regular washing and cleaning of the entire hub. Cleaning operations shall involve the use of substantial amounts of water, disinfectants, and detergents.

General Repairs and Maintenance The hub and its associated facilities shall be repaired and maintained regularly during the operational phase of the project. Such activities shall include repair of agro-industrial machines, repairs and maintenance of electrical gadgets and equipment, repairs of leaking water pipes, painting, maintenance of flower gardens and grass lawns, and replacement of worn-out materials among others.

3.5.4 Description of the Project's Decommissioning Activities

Decommissioning is an important phase in the project cycle and comes last to wind up the operational activities of a particular project. It refers to the final disposal of the project and associated materials at the expiry of the project lifespan (50 years). If such a stage is reached, the proponent needs to remove all materials resulting from the demolition/ decommissioning of the site. The following should be undertaken to restore the environment.

- Remove all underground facilities from the site.
- The site should be well landscaped by flattening the mounds of soil and Planting. indigenous trees and flowers.
- All the equipment should be removed from the site.
- Fence and signpost unsafe areas until natural stabilization occur.
- Backfill surface openings if practical.

Dismantling of Equipment All processing machines and equipment including electrical installations, furniture partitions, pipework, and sinks among others will be dismantled and removed from the site on decommissioning of the project. Priority will be given to the reuse of this equipment in other projects. This will be achieved through the resale of the equipment.

Site Restoration Once all the wastes resulting from demolition and dismantling works is removed from the site, the site will be restored through the replenishment of the topsoil and re-vegetation using indigenous plant species.

3.6 Waste Management Programme

The proposed project is bio-organic in nature. Most of the waste that will be generated from the farm operations are non-hazardous and biodegradable and will be re-applied as manure in the farm. A comprehensive Waste Management Plan has been modelled using the standard principles of minimize/reduce (waste generation), reuse (components), or recycle (before disposal). All wastes will be segregated and managed to best practice standards. The detailed concepts of waste management to be followed will be to avoid, minimize, recover (recycle & re-use) treat/ process, responsible disposal, dumping in the order of desirability and re-apply as manure (only in the case of organic waste). A specific fit for purpose of Waste Management Plan (WMP) has been designed for the proposed cassava farming and processing facility. The waste management approach is carried out in line with Plateau State's Waste Management Procedure. Detailed strategies are

evaluated on intended waste identification, characterization methods, storage, tracking, monitoring, and audit of the waste disposal sites.

3.6.1 Solid Waste Management (ISWM)

Plateau State will adopt an integrated solid waste management to ensure a holistic management of all wastes to be generated at the Farm (both hazardous and non-hazardous wastes). The wastes life cycle analysis (LCA) which emphasizes waste re-use or resource recovery will be used. The LCA involves re-use in its wholeness, by the State and or another end user, of the material primarily classified as waste at the hub. Therefore, the waste hierarchy of waste reduction, reuse and recycling which classify waste management strategies according to their desirability in terms of waste minimization will be adopted. At the hub, waste prevention will be a preferred option to waste disposal.

Waste Tracking All non-degradable and hazardous wastes such as waste chemicals, used batteries, etc. will be disposed of site using accredited waste handlers. To ensure that all waste collected from the location is disposed of appropriately, a Waste Consignment Note (WCN) shall accompany all waste transfers. The content of the WCN includes the quantity of waste, as well as the Disposal Facility. The Materials Handler shall set up a WCN for each transport and will include the Materials Safety Data Sheet (MSDS) for hazardous waste.

Waste Segregation An important aspect of waste management process is waste segregation which involves the separation of hazardous and non-hazardous wastes, which could be further separated depending on the specific nature of wastes. The re-use of recyclable waste is also put into practice. The key advantage of this phase is that wastes of different kinds are treated more efficiently, before being disposed of separately.

3.6.2 Waste Management Plan

A comprehensive waste management plan has been designed to ensure that all waste streams from the hub conform to regulatory requirements, Plateau State‘s policies and FMEnv Waste Management Guidelines. Through effective management of waste streams, the possibility of wastes entering the environment will be minimal.

3.7 Project Schedule

In all, project execution (Feasibility studies and permitting including ESIA) spans about 12 months as shown on figure 3.9. The lifespan of the proposed project is 50 years.

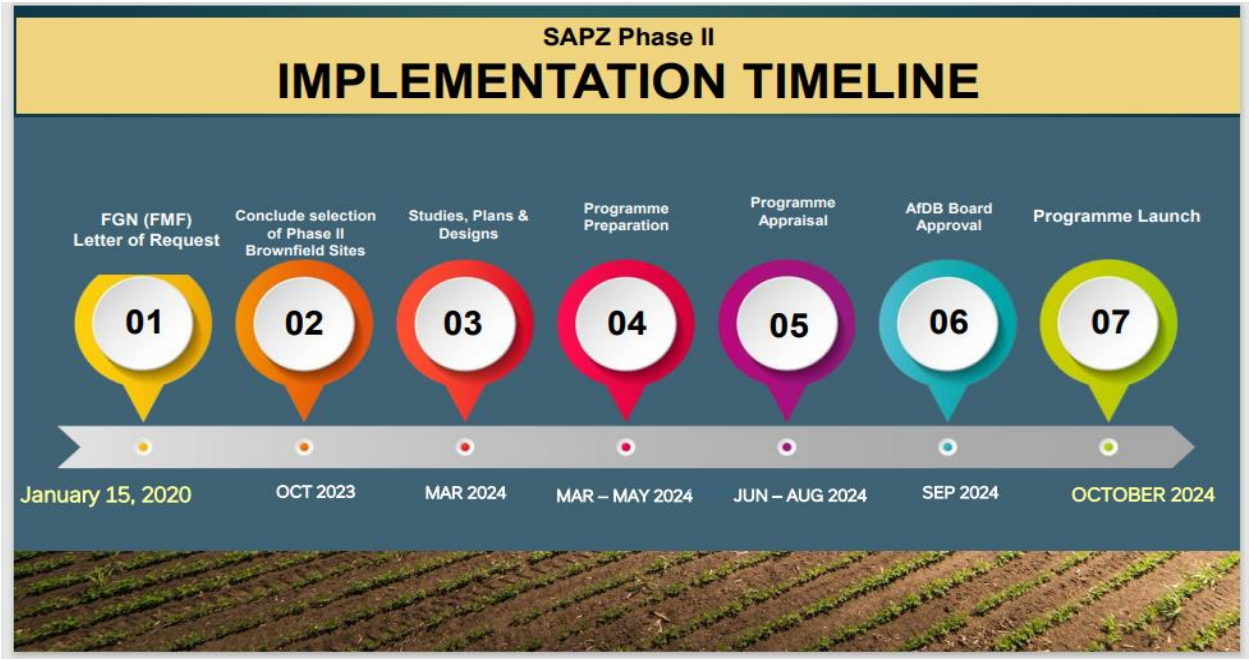

Figure 3.9: Project Implementation Schedule

CHAPTER FOUR
ENVIRONMENTAL BASELINE DESCRIPTION

4.1 Introduction

The environmental baseline (physical, chemical, biological, socio-economic and health) characteristics of the proposed project area are presented in this chapter. The baseline characteristics are required to establish the existing environmental status of the proposed project area and to serve as a reference data for future studies and environmental monitoring. It will also be used as a basis for which the anticipated impacts of the proposed project would be determined for appropriate mitigation measures to be put in place.

4.2 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 from field studies. The environmental data acquisition involved a multidisciplinary approach and was conducted in line with regulatory requirements and international best 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.

4.3 Daily Toolbox Meeting

A daily toolbox meeting was held prior to work to ensure that team members understood the work plan of the day and the security and safety tips. These are geared toward achieving a successful data-gathering exercise and zero incident.

4.4 Baseline Data Collection

The baseline data gathering for the project was conducted between 16th to 17th May 2024, while the socio-economic studies was conducted on 22nd of May, 2024. The data obtained include information on receptors and resources that were identified as having the potential to be significantly affected by the construction and operation of the Agricultural Industrial Hub (AIH). The ESIA report provided a description of the existing environmental and socio-economic conditions as a basis against which the impacts were assessed.

4.5 Field Sampling Equipment and Methods

4.5.1 Meteorology/Air Quality and Noise Measurements

Meteorological elements, namely wind, speed, wind direction, humidity, and temperature were measured during the fieldwork from 6 predetermined locations with a control point inclusive along the road. Each sampling location was adequately geo-referenced 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.

4.5.2 Soil Sampling

Topsoil (0-15cm) and bottom soil (15-30cm) samples were collected from 2 points using a hand auger (**Plate 4.**). Sample for microbiology were taken in 25 ml sterilized vials. Samples for physico-chemical parameters were collected in pre-cleaned 250ml amber bottle. The samples were properly labeled, and preserved in ice chests at 4°C.

4.5.3 Ground /Surface Water Sampling

Groundwater samples were collected from 2 existing boreholes while surface water and sediments samples were collected from a stream around the project site (see Plate 4.2 & 4.3). 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, prior to 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.
- 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.

Plate 4.1: Groundwater Sampling

Plate 4.2: Surface Water Sampling

4.5.4 Socio Economics

Two distinct methods of socio-economic data collections were adopted. The first method involved survey of the communities using specially designed questionnaires. The document contained enquiries on the nature and type of dwelling (units), tenure status, environmental conditions and services, personal characteristics, state of origin, economic environment, social environment, and cultural environment, among others. Information was also sought on their views on the expected potential positive and negative impacts of the road rehabilitation project, the likely environmental impact of the road rehabilitation project and suggestion on mitigation measures. An average of fifty copies of questionnaires was administered to respondents in each of the communities.

Each group meeting focused first on political/administrative structure of the communities/population characteristics, ethnic composition, and existing infrastructural facilities, predominant occupation as well as cultural practices and treasures. The open discussions provided opportunities to as many people as possible to air their views or contribute their ideas on the issues raised and their expectations for the future. Photographs of the participants were taken with a digital camera except where objections were raised.

4.5.5 Health Assessment

Health status assessment for the area involved the use of primary and secondary data. Primary data was generated during field visits by carrying out some physical examination in a randomly selected population size in each of the communities visited. This was carried out by a public Health Specialist who is part of the study team. As much as possible, sample population included a fair representation of the different age groups and sexes (male and female). The results of these examinations were documented and further analysed statistically to enable us to obtain the required data base of the health status of the communities., Secondary health data was generated from

medical records of some clinics within the area including traditional healing/ herbal homes e.g. maternity and dispensaries. All the data were carefully integrated to yield meaningful information which was used to assess the health status of the project area.

4.5.6 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.

4.5.7 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 are summarized in Table 4.1.

Table 4.1: Sample Handling and Preservation Methods used during the Field Work

S/N	Parameters	Sample Vol.	Container	Preservative	Holding Time	Container pretreatment
1	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
2.	Physico-Chemical, TSS, COD, O/G, Chloride	2L	Plastic	Cool 4 °C ± 2◦C	28 Days	Rinsed with Distilled water
3.	Hydrocarbons, phenols	1L	Glass (wide mouth, calibrated)	H_2SO_4 to 2ml & cool 4 °C ± 2◦C	28 Days	Rinsed with Solvent
4.	Microbiology, THB, HUB, Coliform, THF & HUF	200ml	Wide mouth plastic bottles	Cool 4 °C ± 2◦C	As soon as possible	Sterilized

4.6 Description of The Biophysical Environment

4.6.1 Climate and Meteorology of the Study Area

Plateau State falls within the tropical wet and dry (Aw) climatic belt of Nigeria as obtained in the Koppen-Geiger (1928) world climates classification system. Like any other part of the Aw climatic area, the entire state is marked by distinct wet and dry seasons. However, owing to high relief nature of the Jos plateau landscape, places situated on it exhibit considerable variations in climatic characteristics compared to other places down the plateau. The Heipang area of Barkin Ladi LGA is among the list of places with such relief influenced climatic characteristics. In Heipang area, the wet season is warm, humid, and overcast, while the dry season is hot and partly cloudy. Through the year, the temperature typically varies from 12°C to 32°C and seldom falls below 9°C or above 35°C (Weather Spark, 2024). The *hot season* lasts for about *3 months* (from late *January through April),* with an average daily high temperature above *30°C*. The hottest month of the year in in the area is *March,* with an average maximum temperature of *32°C* and an average minimum of *17°C.* The *cool season* also lasts for *3 months* from early *July* to early *October,* with average daily maximum temperature falling below *25°C.* The coldest month of the year is *August,* with average minimum temperature of *16°C* and maximum of *23°C* (Weather Spark, 2024). The trends of Average maximum and minimum Temperatures at Heipang (Barkin Ladi) are presented in figure 4.1.

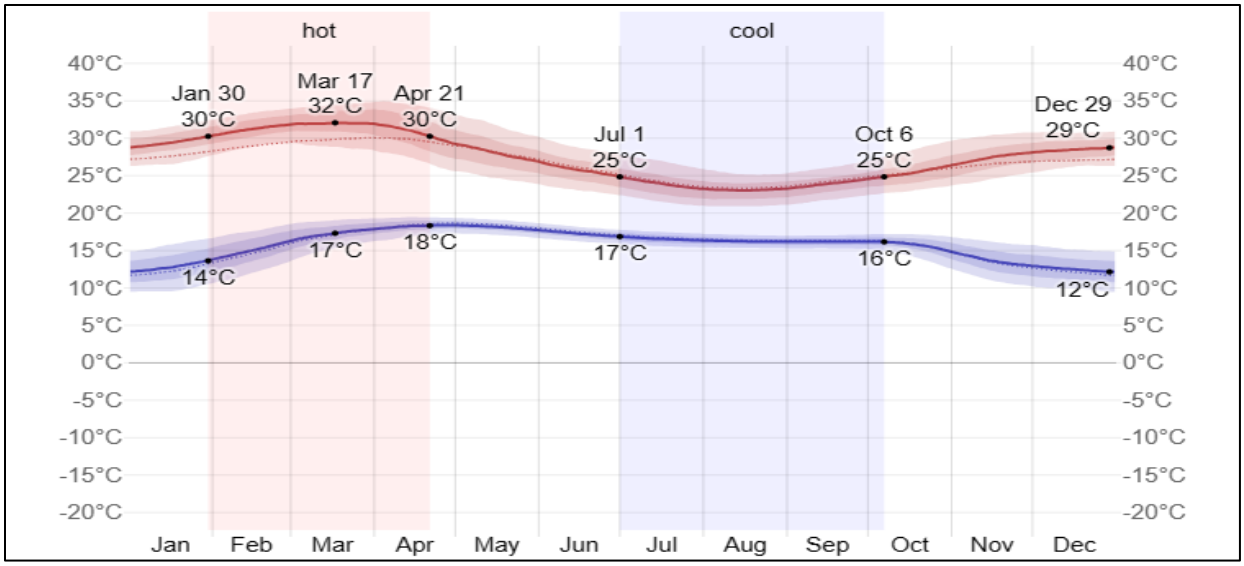

Figure 4.1: Trends of Average maximum and minimum Temperatures at Heipang

The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures. **Source: Weather Spark, 2024.

Generally, humidity defines the moisture content of an area's the atmosphere. High Relative Humidity percentages signify abundant moisture conditions that could result to precipitations of various forms. Humidity also defines the muggy condition of an area. The term *Muggy* simply refers to the combined heat and moisture conditions of the atmosphere that often create damp uncomfortable environment to humans.

Heipang (Barkin Ladi) often experiences *extreme* seasonal variations in humidity (Weather Spark, 2024). Relative Humidity percentages at Heipang could be as low as less than 10% in the months of February (Dry season) and gradually rise to very high percentages (above 80%) in September (wet season) (Figure 4.2). Besides, the *muggier period* of the year lasts for about *7 months* (from late *March* to late *October). At this period, the area's atmosphere is less humid (Relative Humidity below 60%) and the comfort level is muggy.* The month with the muggiest *days* in the area is *May*, with *19 days* that are *muggy* or worse.

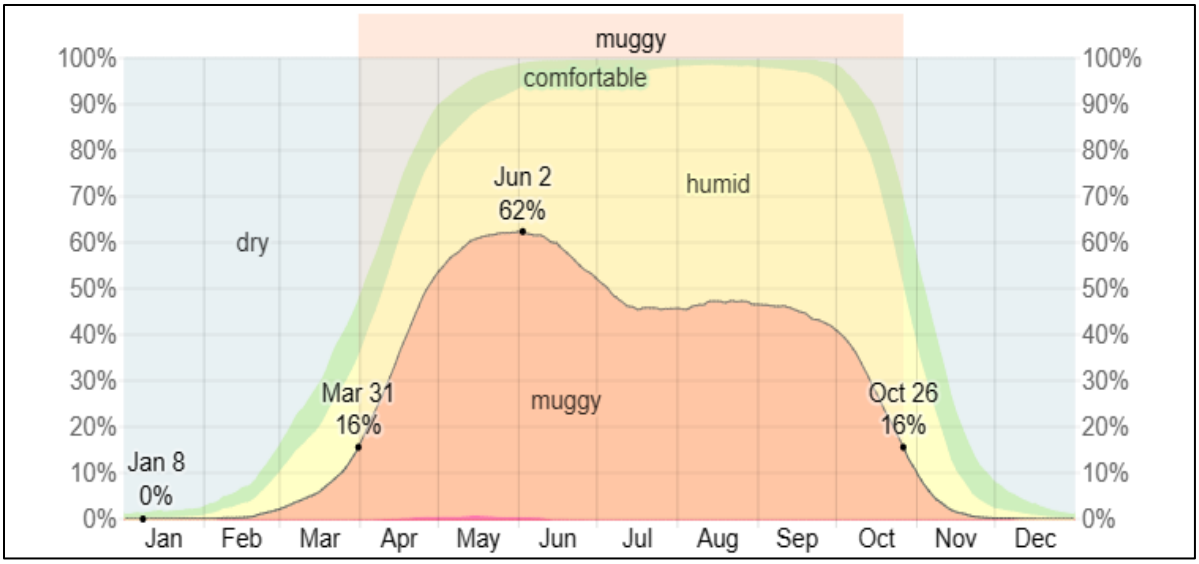

Figure 4.2: Annual Humidity Characteristics of Heipang Area

Source: Weather Spark, 2024

The climatic regime of the Heipang area provides favorable atmospheric conditions for both rain-fed irrigation agriculture as well as livestock farming as observed in the pond area and the surrounding open lands of the proposed site.

Barkin Ladi LGA experiences *distinct* seasonal variation in monthly rainfall. The *wet* season lasts for about *7 months* (from *March 21* to *November),* with a sliding 31-day rainfall of at least *13 millimeters (Weather Spark, 2024).* The wettest month of the year is *August*, with a monthly average rainfall of *196 millimeters*. The *dry season* lasts for *5 months (*from *November* to *March).* The driest month is *December*, with a monthly average rainfall of *0 millimeters (Figure 4.3).*

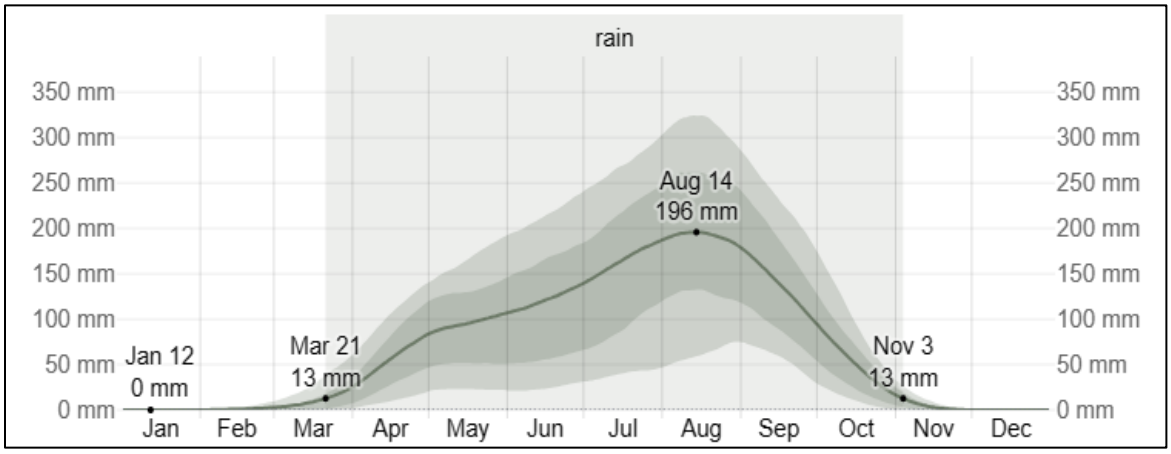

Figure 4.3: Monthly Average Rainfall Characteristics of Heipang Area

**The average rainfall (solid line) accumulated over the course of a sliding 31-day period centered on the day in question, with 25th to 75th and 10th to 90th percentile bands

Source: Weather Spark, 2024

Considering the above, climatic trends of Heipang area should be put into consideration in the execution of the proposed project at the site.

Rainfall

As presented in Table 4.4, Generally, monthly rainfall in the area presents a unimodal distribution with a peak in August (360mm), though the amount of rainfall in September was equally high. It is noteworthy that peak monthly rainfall between August and September was preceded and followed by a more-or-less exponential increase and drop in amounts of rainfall, respectively. The months of January and February (i.e., peak dry season), were completely devoid of rain. Amounts of rainfall during March and November – December, had extremely low amounts of rainfall (i.e., range = 1.43 mm in December to 4.12mm in November), However, the dry-rainy transition period (i.e., April) recorded much higher amounts of rainfall (59.88mm) than the counterpart rainy-dry transition month of November.

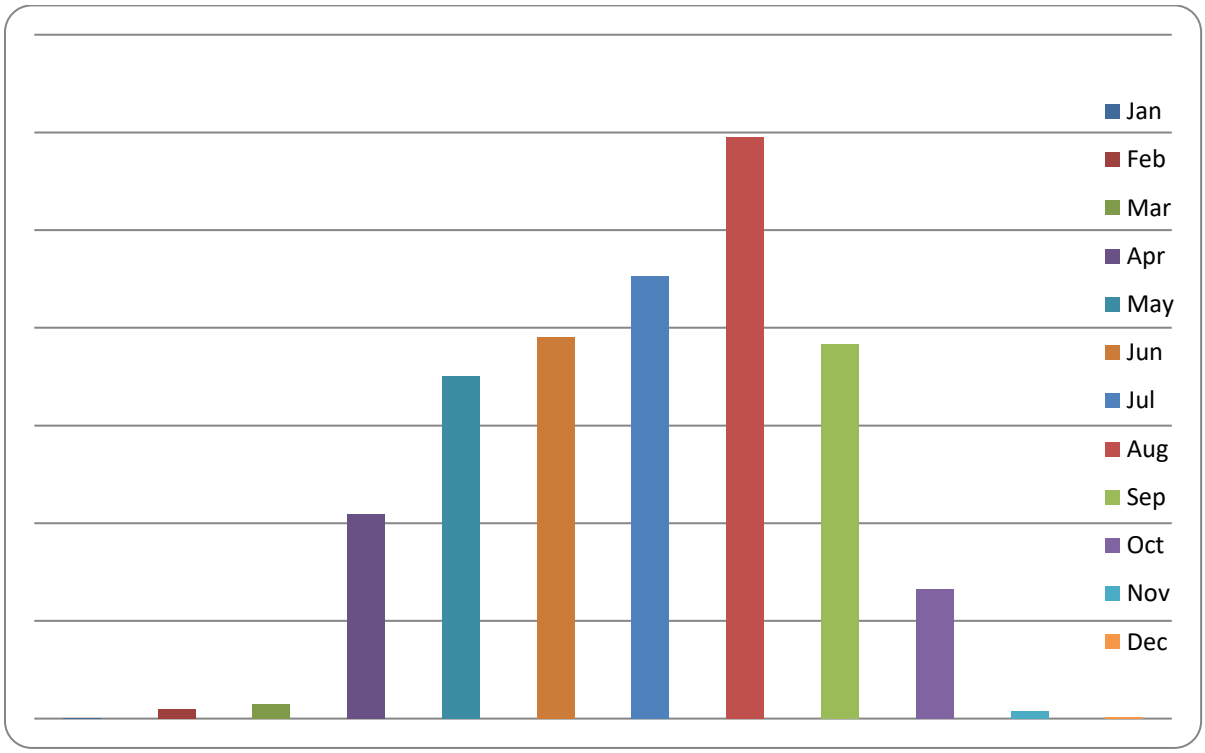

Figure 4.4: Average Rainfall Pattern in Plateau State (1997-2017)

Source: NiMet

Temperature

The regional maximum and minimum temperature data obtained from NiMet are given in Figure 3.6 to Figure 3.10, A wet season from April to October, with lower monthly temperatures and the wettest month being June. Also, a dry season from November to March, with midday temperatures that rise above 38° Celsius but relatively cool nights, dropping as low as 12° Celsius (54° Fahrenheit).

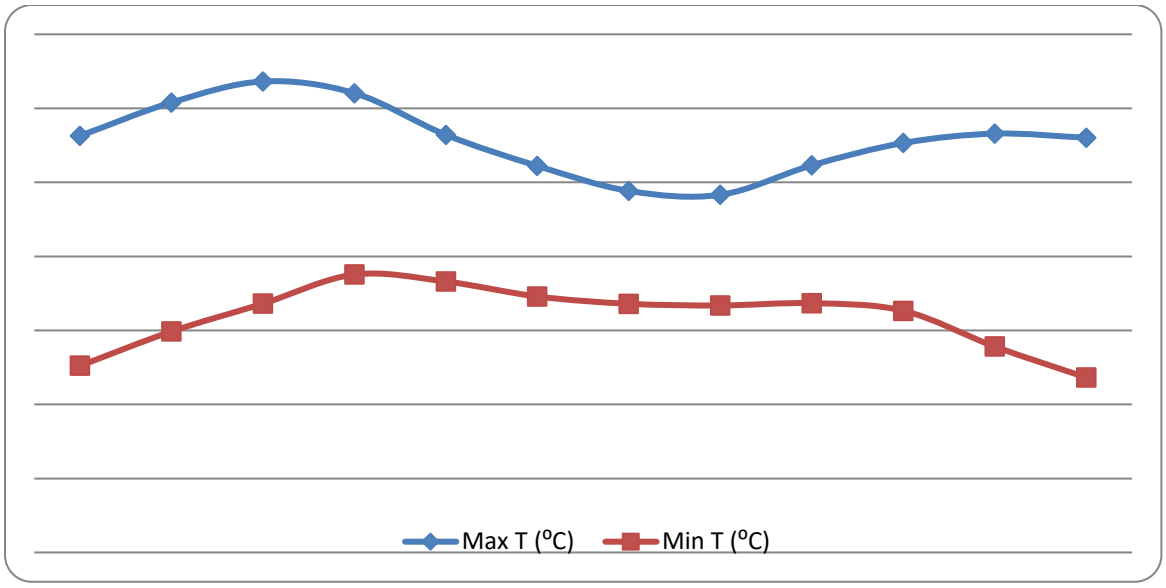

Figure 4.5: Maximum and Minimum Temperature of Plateau State (1997-2017)
Source: NiMet

Wind Speed and Direction

The annual mean wind speeds in the North Central of Nigeria range from about 2 to 9.5 m/s. The wind pattern follows the migratory Inter-Tropical Discontinuity (ITD) or Inter-Tropical Front (ITF) caused by the separation of the North Easterly CT and the South Westerly MT. Also playing a part in the observed wind speed is the influence of sea breezes from the adjourning maritime environment. The wetter winds prevail for more than 65% of the time. The proposed project would not affect the wind direction. However, wind could aid the distribution of pollutants in the areas.

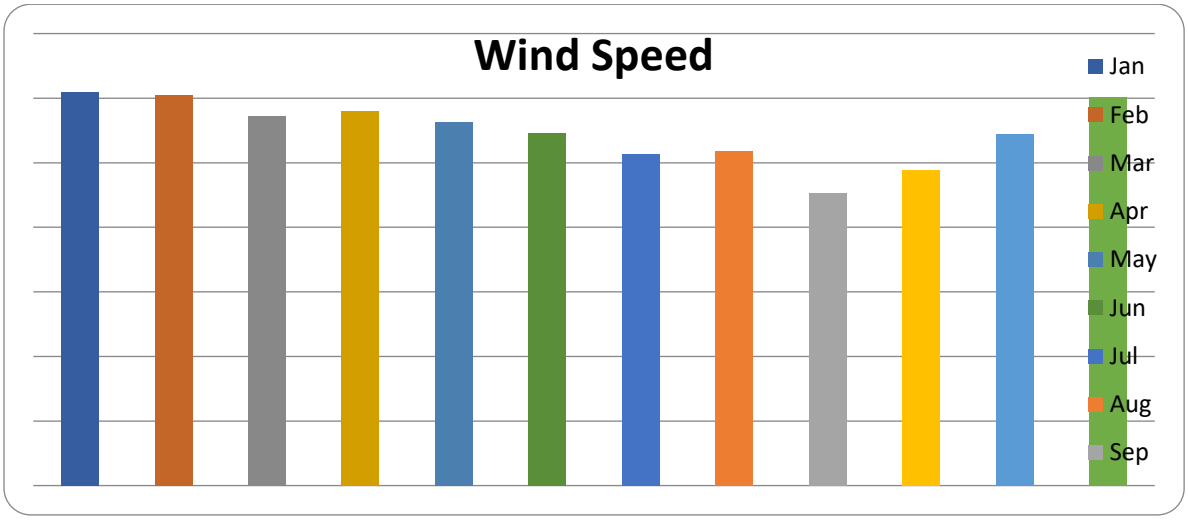

Figure 4.6: Monthly Wind Speed of Plateau State (1997-2017)

Relative Humidity

Relative humidity is the amount of water vapour (vapour pressure) present in the air. Relative humidity is a combination of the actual moisture content of the air, the temperature, and the atmospheric pressure. The amount of vapour that can be contained in the air increases as the temperature does. The higher the percentage of relative humidity, the more humid (moist) the air, while a lower percentage is usually drier. Saturation occurs when air is holding the maximum amount of water vapour possible at the existing pressure and temperature. The relative humidity is highest at the peak of the rainy season and lowest at peak of the dry season. It could be as high as 80% between night and morning during the wet season and as low as 18% at mid-day during the dry season. Generally, the drier months between December and February have lower values. A moist atmosphere supports the washout of the emitted gaseous pollutants, notably NO_2 and SO_2.

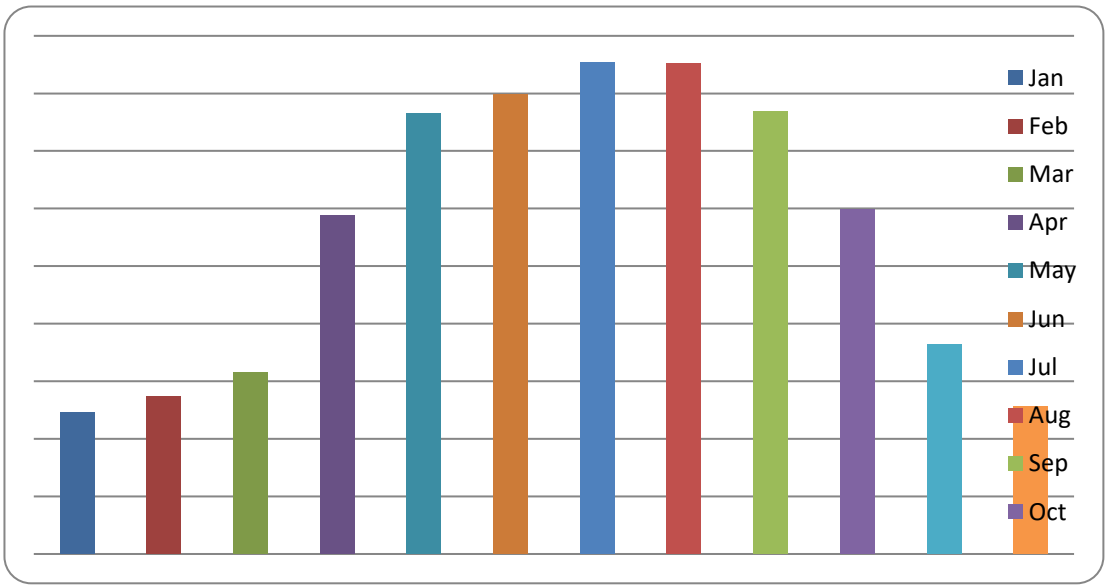

Figure 4.7: Average Monthly Relative Humidity of the Plateau State (1997-2017)
(Source: NiMet)

4.6.2 Ambient Air Quality and Noise

Air Quality is the measurement of deviation of the ambient air from its natural state due to air pollution (the presence of undesirable material in air, in quantities large enough to produce harmful effects). The undesirable materials may damage human health, vegetation, human property, or the global environment as well as create a disrupt in the aesthetic in the form of brown or hazy air or unpleasant smells.

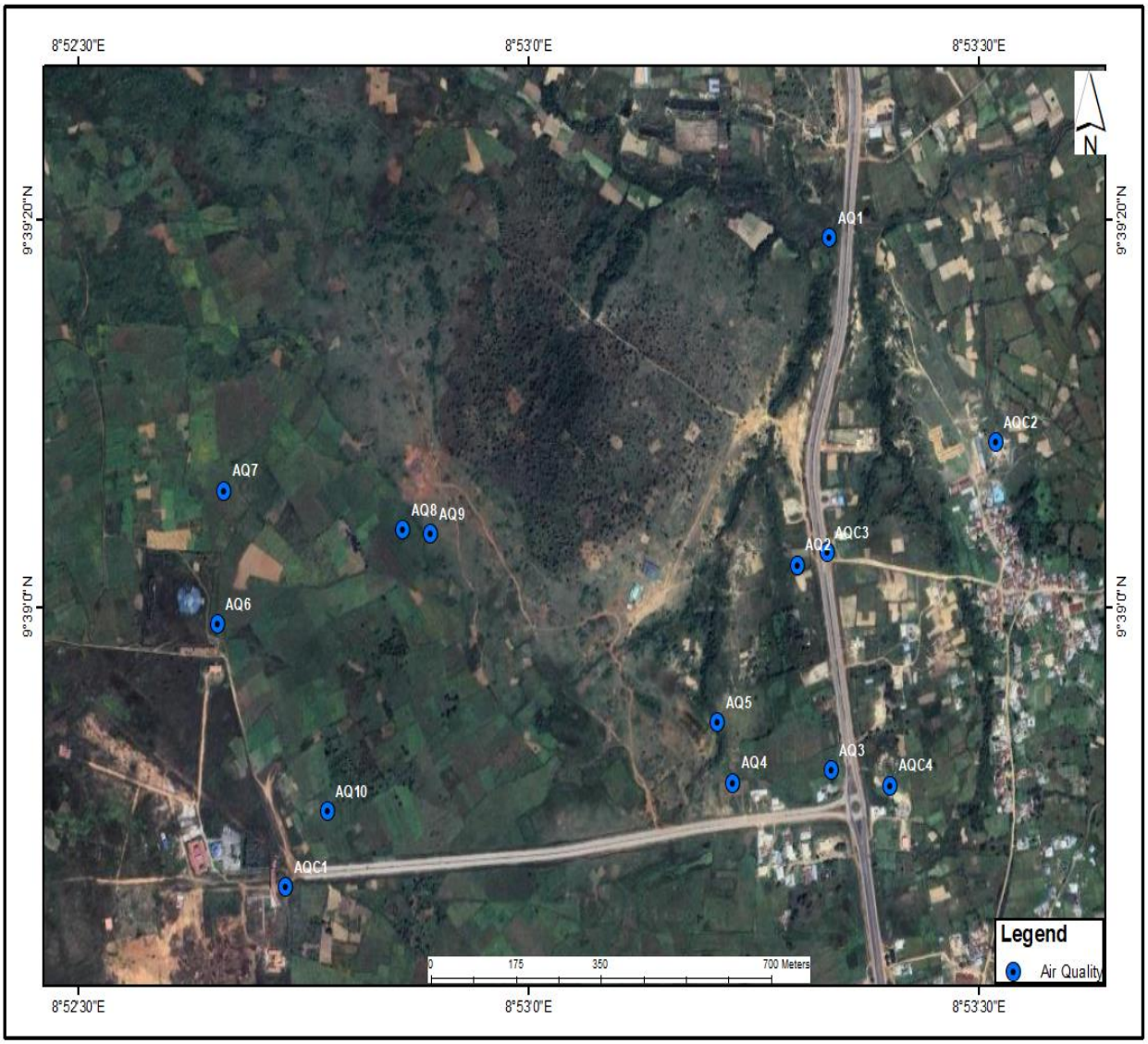

Figure 4.8: Air Quality and Noise Level Sampling Map

The assessment of the air quality of the study area was necessary to determine the air quality status of the area and investigate the possible contribution of the study environment activities to ambient air quality. The air quality parameters determined were mainly those of public and health concern. The relative concentrations of ambient air pollutants (suspended particulate matter - SPM), Nitrogen oxides (NOx), sulphur oxides (SOx), carbon monoxide (CO), etc, are within tolerable limits in the atmosphere.

Plate 4.3: Field Sampling Equipment's

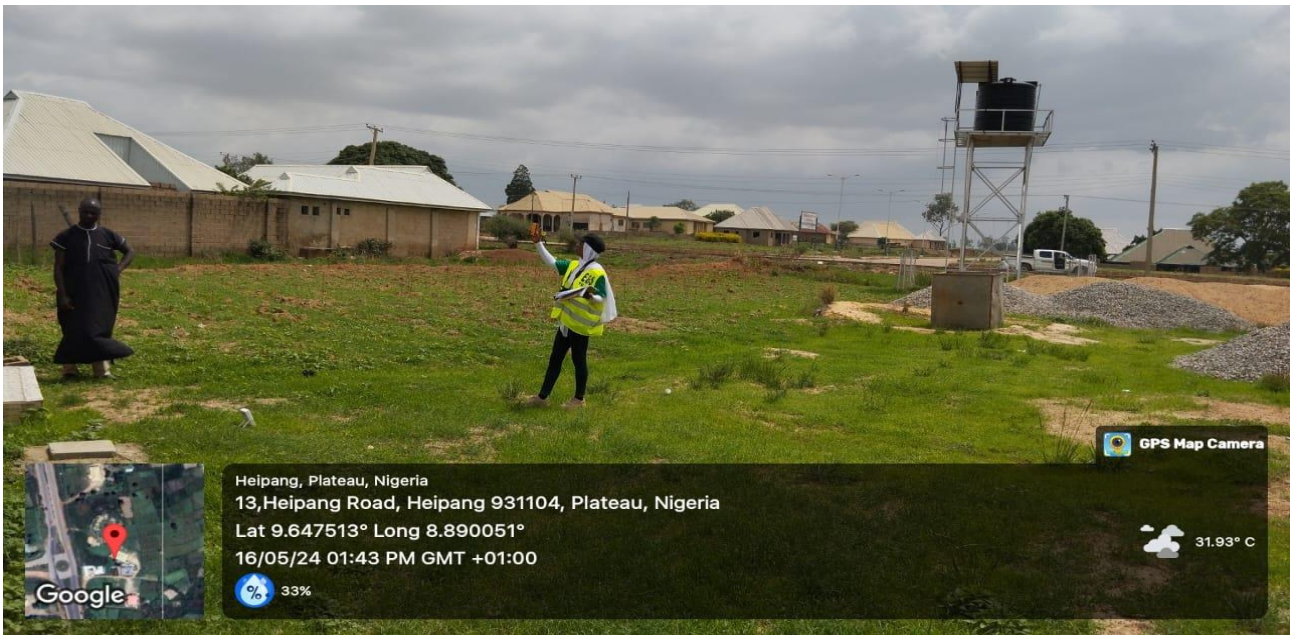

Plate 4.4: Air Quality and Noise Sampling

Table 4.2: Ambient Air Quality and Noise Level Result of Heipang Community, Barkin Ladi LGA

Point Code	Description	Latitude (°N)	Longitude (°E)	Temp. (°C)	Humidity (%)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	CO (ppm)	CO_2 (ppm)	TVOC (mg/m³)	HCHO (mg/m³)	Noise db(A) Minimum	Noise db(A) Maximum
AQ1	Point A (50m away from the stream)	9.655312	8.888891	34	61	53	75	02	411	0.008	0.003	44.7	57.8
AQ2	On-Site	9.650624	8.888299	32	67	55	72	02	431	0.011	0.006	49.3	66.4
AQ3	On-Site	9.64768	8.888926	30	67	70	91	02	410	0.020	0.009	41.7	65.9
AQ4	On-site	9.647504	8.887108	31	67	57	74	02	411	0.014	0.006	35.9	69.7
AQ5	Point B (On-site)	9.64837	8.88682	33	76	44	57	01	433	0.011	0.005	36.0	69.1
AQ6	50m away from the potato market	9.649776	8.877564	28	78	57	74	01	410	0.007	0.003	43.7	67.6
AQ7	On-Site	9.651688	8.87769	36	75	56	72	01	550	0.015	0.007	34.3	64.6
AQ8	On-Site 50m away from the Champion stone crushing company	9.651124	8.881007	37	55	46	60	01	405	0.016	0.009	35.6	64.0
AQ9	On-Site	9.651127	8.881023	32	77	75	101	01	424	0.011	0.006	32.7	68.2
AQ10	On-Site	9.647091	8.879614	31	67	88	115	01	410	0.021	0.010	35.8	64.2
AQC1	The Inland Dry Port	9.646008	8.878836	29	73	87	114	02	415	0.020	0.009	32.0	67.1
AQC2	LEA Primary School	9.652379	8.891983	30	68	81	106	01	410	0.008	0.002	41.4	66.6
AQC3	Waves of Glory Apostolic Church	9.650806	8.888854	32	75	90	115	02	537	0.075	0.015	57.6	87.1
AQC4	Gwol Borehole Opposite Inland Port Road	9.647462	8.890026	31	77	79	102	02	525	0.063	0.010	59.7	67.4
FMEnv /WHO/ USEPA Standard*						250	250	10	-	-	-	90	
NESREA Limit						40	150	10	-	-	-		

4.6.2.1 Results of Gaseous Air Quality Monitoring

The Special Agro-Processing Zone (SAPZ) in Heipang Community, Barkin Ladi LGA, Plateau State, was assessed for its ambient air quality and noise levels. The study encompasses various parameters, including temperature, humidity, particulate matter (PM2.5 and PM10), carbon monoxide (CO), carbon dioxide (CO2), total volatile organic compounds (TVOC), formaldehyde (HCHO), and noise levels. These findings are compared against standards set by the Federal Ministry of Environment (FMEnv), World Health Organization (WHO), United States Environmental Protection Agency (USEPA), and National Environmental Standards and Regulations Enforcement Agency (NESREA). The implications for human health, agricultural usability, aquatic life, and livestock health are also discussed.

4.6.2.2 Ambient Air Quality Parameters

Temperature and Humidity

Temperature across the sampling points in Heipang Community ranges from 28°C to 37°C, while humidity levels vary between 55% and 78%. These environmental conditions are typical for the region and can influence the dispersion and concentration of air pollutants.

Particulate Matter (PM2.5 and PM10)

PM2.5 levels range from 44 to 90 µg/m³, and PM10 levels range from 57 to 115 µg/m³. Both parameters are well within the FMEnv/WHO/USEPA standards of 250 µg/m³, indicating relatively safe levels of particulate matter. However, PM2.5 and PM10 levels exceed the NESREA limits of 40 µg/m³ and 150 µg/m³ respectively, at certain points, highlighting potential health risks, especially for sensitive individuals.

Carbon Monoxide (CO)

CO levels range from 01 to 02 ppm, well within the FMEnv/WHO/USEPA standard of 10 ppm, indicating minimal risk of CO poisoning.

Carbon Dioxide (CO2)

CO2 levels across the sampling points range from 405 to 550 ppm. Although specific FMEnv/WHO/USEPA standards for CO2 in ambient air are not provided, these levels are typical for outdoor environments and pose no immediate health risks.

Total Volatile Organic Compounds (TVOC)

TVOC levels range from 0.007 to 0.075 mg/m³. While specific standards for TVOCs are not provided by FMEnv/WHO/USEPA, these levels are relatively low, indicating minimal risk of air quality issues related to volatile organic compounds.

Formaldehyde (HCHO)

HCHO levels range from 0.002 to 0.015 mg/m³. There are no specific ambient air quality standards for formaldehyde from FMEnv/WHO/USEPA; however, these values are low and suggest minimal risk of formaldehyde exposure.

4.6.2.3 Noise Levels

The noise levels recorded range from 32.0 dB(A) to 63.6 dB(A) during the minimum periods and from 57.8 dB(A) to 87.1 dB(A) during the maximum periods. These values are below the FMEnv/WHO/USEPA standard of 90 dB(A) for maximum noise levels, indicating that noise pollution is within acceptable limits for the region.

4.6.2.4 Comparisons and Implications

Agricultural Usability

The ambient air quality in Heipang Community generally falls within acceptable limits for agricultural use. However, the elevated levels of PM2.5 and PM10 at certain points could affect crop health by hindering photosynthesis and causing deposition on plant surfaces. Measures should be taken to mitigate these particulate levels to ensure optimal agricultural productivity.

Impact on Aquatic Life

Although this report primarily focuses on air quality, good ambient air quality indirectly benefits aquatic life. Low levels of pollutants such as CO and TVOCs reduce the likelihood of contaminating water bodies through atmospheric deposition, thereby protecting aquatic ecosystems.

Safety for Livestock Health

The recorded air quality parameters indicate a safe environment for livestock health. Livestock exposed to high levels of particulate matter and toxic gases can suffer respiratory issues, but the current levels in Heipang Community pose minimal threats. Nonetheless, the elevated PM2.5 and PM10 levels necessitate monitoring and mitigation to prevent potential long-term health impacts on livestock.

Human Health

For human health, the ambient air quality and noise levels in Heipang Community are crucial. The PM2.5 and PM10 levels, while within international standards, exceed NESREA limits, indicating potential respiratory risks for sensitive groups such as children, the elderly, and individuals with pre-existing respiratory conditions. CO levels are within safe limits, reducing the risk of carbon monoxide poisoning. The low levels of TVOCs and formaldehyde suggest minimal risk of exposure to harmful volatile organic compounds and carcinogens, respectively. Noise levels are also within acceptable limits, reducing the risk of noise-induced hearing loss and stress-related health issues.

The ambient air quality and noise levels in Heipang Community, Barkin Ladi LGA, Plateau State, are generally within the standards set by FMEnv, WHO, USEPA, and NESREA. However, the elevated levels of PM2.5 and PM10 at certain points pose potential health risks, particularly for sensitive individuals and livestock. Continuous monitoring and adherence to environmental

regulations are essential to ensure the sustainability of this agro-processing zone and safeguard the health of all living organisms in the area.

4.6.3 Soil Quality

The soils of the study area have been placed in Soil taxonomy (Soil Survey Staff, 1998) order Inceptisols and Ultisols (Holland et al., 1989). The soil is derived from acid crystalline rocks which consist of granites and gneisses. The surface texture may range from loamy sand to sandy loam. Being leached mineral soils, they are acidic in reaction, low-in contents of exchangeable bases, organic carbon, total and available phosphorous. They are moderate infertility status (Abua and Edet, 2007). The low inherent fertility of the soil showed up in the low total organic carbon, low clay, and low essential plant nutrients concentration in the soil.

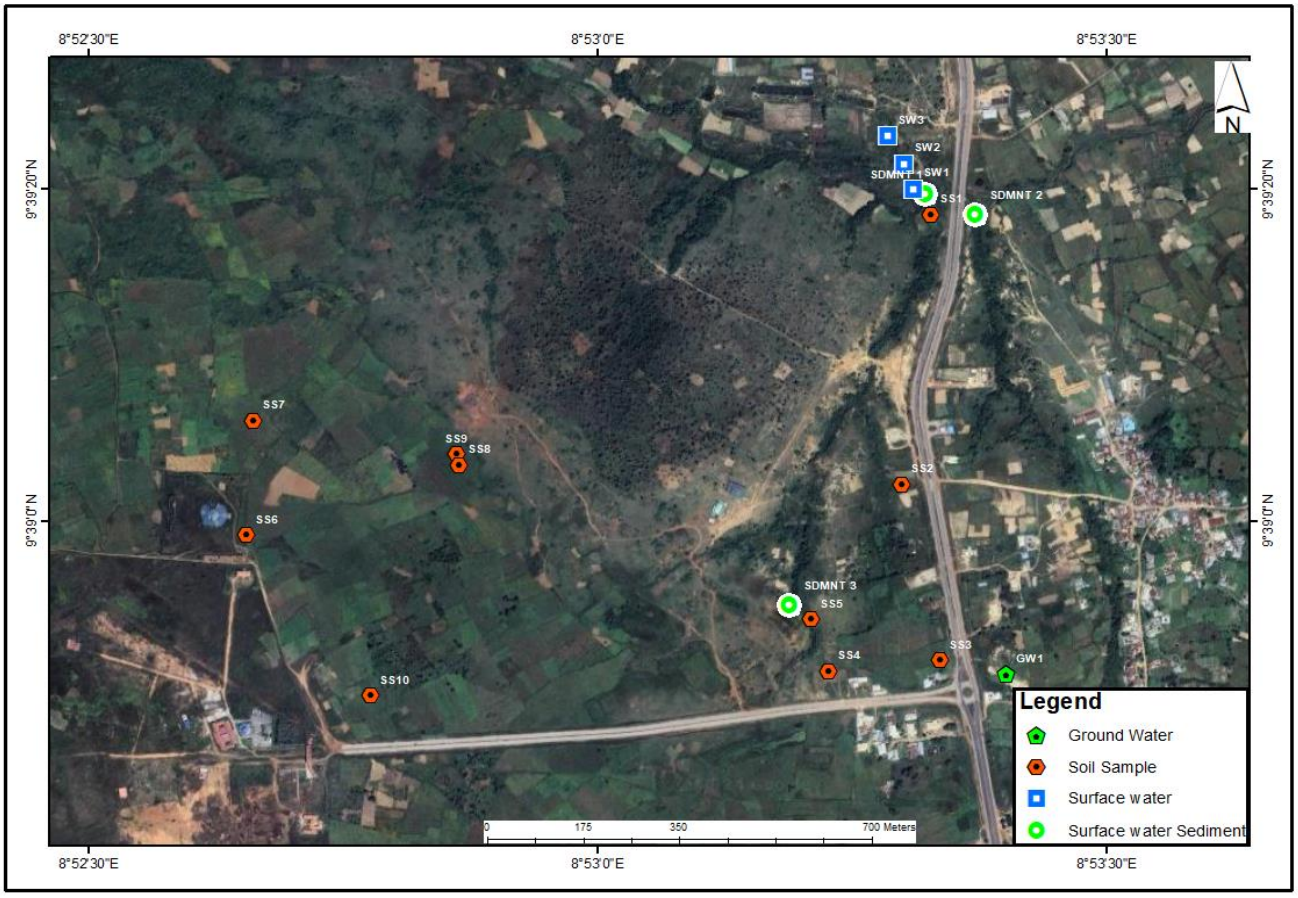

Figure 4.9: Map of Soil Sampling Location within the Project Site

Soil quality Sampling/ instrumentation

Soil samples were collected using stainless auger at a depth of 0-10cm), this was aided with a hand trowel due to the hardening of the ground. Soil samples collected were immediately taken to the laboratory, air-dried for 48 hours (2 days) at temperature of about 38-42^{0}C, crushed with mortar and pestle and sieved with 2 mm sieve. The sieved samples were placed in a container and labeled appropriately ready for digestion. Unwanted materials such as stones, leaves and debris were removed from the soil samples by handpicking.

Physicochemical parameters were determined using multiparameter equipment while heavy metals were analyzed using AAS. Soil samples for microbiology analysis were separated from the pool. Soil microorganisms were estimated by soil dilution plate method in which serial dilution of all the soil samples in sterile normal saline were plated on a surface agar medium.10g of the soil samples were aseptically added to 90ml of sterile normal saline and shaken vigorously to give a 10-fold diluton.10-fold serial dilutions were made by transferring 1ml of the soil suspension to 9ml of the diluents.0.1ml of the of the appropriate dilutions were then plated in duplicate on nutrients agar. The plates with soil extract were incubated at a temperature of 37 ^{0}C for 24hrs. Incubation was done at 37^{0}C for 96hrs for fungi/yeast determination while for hydrocarbon degrading bacteria; media was autoclave at 121^{0}C for 15 minutes.

Table 4.3: Soil Sampling Results

S/N	PARAMETER		UNIT	*SS1*		*SS2*		*SS3*	
				0-15cm	**15-30cm**	**0-15cm**	**15-30cm**	**0-15cm**	**15-30cm**
1.	Color		-	Dark reddish-brown 3/4	Dark-reddish brown 3/4	Yellowish red 4/6	Yellowish red 4/6	Red 5/6	Red 5/6
2.	PH		-	5.86	5.87	5.98	5.95	5.64	5.63
3.	Redox Potential		-	395.00	415.00	409.00	420.00	390.40	400.30
4.	Electrical Conductivity		uS/cm	123.00	120.00	137.00	141.20	152.00	155.00
5.	Temperature		^oC	33.20	35.00	35.70	37.50	34.20	34.40
6.	Texture	Sand	%	25.93	35.19	35.90	44.23	37.92	53.20
		Silt		45.20	42.92	40.63	32.60	41.29	31.60
		Clay		28.87	21.89	23.47	23.17	20.79	15.20
7.	Grain Size		Mm	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00
8.	Moisture Content		%	2.03	2.78	2.08	2.74	2.67	2.13
9.	Total Organic Matter		mg/kg	5.33	5.39	5.00	4.54	6.45	6.22
10.	Total Organic Carbon		mg/kg	2.30	3.00	4.70	4.87	5.55	5.55
11.	Total Nitrogen		mg/kg	25.40	26.50	27.90	28.59	26.30	27.70
12.	Total Phosphorus		mg/kg	5.34	5.42	5.30	5.19	5.32	5.05
13.	Ammonium		mg/kg	0.76	0.77	0.79	0.65	0.45	1.11
14.	Oil and Grease		mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
15.	THC		mg/kg	3.74	3.23	2.25	2.22	2.05	2.06
Exchangeable Cations									
16.	Calcium (Ca^{2+})		Cmol/Kg	2.50	0.64	0.61	0.89	0.79	0.70
17.	Potassium (K^+)		Cmol/Kg	0.04	0.23	0.02	0.35	0.03	0.05
18.	Sodium (Na^+)		Cmol/Kg	0.05	0.08	0.18	0.67	0.17	0.15

19.	Magnesium (Mg^{2+})	Cmol/Kg	0.65	0.45	0.08	0.93	0.49	0.50
Metals/Heavy Metal Parameter								
20.	Barium (Ba)	mg/kg	1.34	1.00	<0.001	<0.001	1.47	1.32
21	Aluminium(Al)	mg/kg	0.75	0.54	2.49	0.19	<0.001	<0.001
22.	Mercury(Hg)	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23.	Lead (Pb)	mg/kg	0.01	<0.001	<0.001	<0.001	<0.001	<0.001
24.	Zinc(Zn)	mg/kg	5.89	5.15	1.41	1.30	1.76	1.21
Microbial Parameter								
25.	HBC	Cfu/g	2.6×10^5	1.1×10^5	7.1×10^5	7.0×10^5	3.7×10^5	3.9×10^5
26.	HFC	Cfu/g	2.7×10^3	2.7×10^3	5.0×10^3	2.4×10^3	2.8×10^3	2.9×10^4
27.	HUBC	Cfu/g	1.0×10^3	1.0×10^3	7.0×10^3	4.0×10^3	3.0×10^3	2.0×10^3
28.	HUFC	Cfu/g	3.2×10^2	3.0×10^2	4.1×10^2	1.0×10^2	4.7×10^2	3.1×10^2

THC: Total Hydrocarbon Content***, CFU***=Colony forming unit, ***HBC*****=** Heterotropic Bacteria Count, ***HFC*****=** Heterotropic Fungi Count, ***HUBC***=Hydrocarbon Utilizing Bacteria Count, ***HUFC***=Hydrocarbon Utilizing Fungi Count, ***FMEnv***: Federal Ministry of Environment
Source: Mozuk Scientific and Analytics Laboratories; May, 2024.

Soil Sampling Result: Continuation

S/N	PARAMETER		UNIT	*SS4*		*SS5*		*SS6*	
				0-15cm	**15-30cm**	**0-15cm**	**15-30cm**	**0-15cm**	**15-30cm**
1.	Color		-	Dark reddish-brown 3/3	Dark reddish-brown 3/3	Dark reddish-brown 3/4	Yellowish red 5/8	Reddish yellow 6/6	Reddish yellow 6/8
2.	PH		-	5.73	5.76	6.25	5.99	5.80	5.99
3.	Redox Potential		-	195.00	368.00	387.00	390.00	368.20	399.00
4.	Electrical Conductivity		uS/cm	152.00	150.60	139.20	139.00	144.70	150.00
5.	Temperature		^oC	35.60	37.30	35.60	36.60	37.80	37.90
6.	Texture	Sand	%	39.44	32.75	44.50	42.60	39.50	39.87
		Silt		40.51	40.35	27.23	30.60	42.50	29.45
		Clay		20.05	26.90	28.27	26.80	18.00	30.68
7.	Grain Size		Mm	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00
8.	Moisture Content		%	2.00	1.34	1.60	1.90	2.21	2.60
9.	Total Organic Matter		mg/kg	7.03	6.60	8.72	6.35	9.30	7.77
10.	Total Organic Carbon		mg/kg	1.44	1.30	1.41	0.94	0.58	0.08
11.	Total Nitrogen		mg/kg	18.90	17.50	20.60	18.90	22.34	18.60
12.	Total Phosphorus		mg/kg	5.00	5.60	4.49	5.23	4.51	3.45
13.	Ammonium		mg/kg	1.20	1.00	0.80	1.59	1.11	2.27
14.	Oil and Grease		mg/kg	0.01	<0.001	<0.001	<0.001	<0.001	<0.001
15.	THC		mg/kg	2.30	2.37	2.11	2.08	1.62	1.70
Exchangeable Cations									
16.	Calcium (Ca^{2+})		Cmol/Kg	0.95	0.46	1.04	0.70	1.42	0.87
17.	Potassium (K^+)		Cmol/Kg	0.04	0.13	0.09	0.10	0.08	0.09

18.	Sodium (Na^{+})	Cmol/Kg	0.05	0.10	0.32	0.03	0.15	0.18
19.	Magnesium (Mg^{2+})	Cmol/Kg	0.23	0.40	1.00	1.40	0.59	0.66
Metals/Heavy Metal Parameter								
20.	Barium (Ba)	mg/kg	2.81	1.77	21.00	15.20	5.00	3.20
21	Aluminium(Al)	mg/kg	0.57	<0.001	<0.001	<0.001	3.00	1.22
22.	Mercury(Hg)	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23.	Lead (Pb)	mg/kg	0.01	0.04	<0.001	<0.001	<0.001	<0.001
24.	Zinc(Zn)	mg/kg	5.33	5.65	3.70	3.88	4.53	5.59
Microbial Parameter								
25.	HBC	Cfu/g	6.4×10^5	6.0×10^5	7.7×10^5	5.1×10^5	8.8×10^5	5.0×10^5
26.	HFC	Cfu/g	5.0×10^3	3.0×10^3	4.4×10^3	3.0×10^3	4.5×10^3	4.2×10^3
27.	HUBC	Cfu/g	6.9×10^3	5.0×10^3	7.0×10^2	5.8×10^2	7.9×10^3	9.0×10^2
28.	HUFC	Cfu/g	4.2×10^2	4.1×10^2	8.8×10^1	7.0×10^1	2.0×10^2	1.7×10^1

THC: Total Hydrocarbon Content***, CFU***=Colony forming unit, ***HBC=*** Heterotropic Bacteria Count, ***HFC=*** Heterotropic Fungi Count, ***HUBC***=Hydrocarbon Utilizing Bacteria Count, ***HUFC***=Hydrocarbon Utilizing Fungi Count, ***FMEnv***: Federal Ministry of Environment ***Source:*** Mozuk Scientific and Analytics Laboratories; May, 2024.

Soil Sampling Result: Continuation

S/N	PARAMETER		UNIT	*SS7*		*SS8*		*SS9*		SS 10 Control	
				0-15cm	**15-30cm**	**0-15cm**	**15-30cm**	**0-15cm**	**15-30cm**	**0-15cm**	**15-30cm**
1.	Color		-	Red 4/6	Red 4/8	Dark red 3/6	Dark red 3/6	Strong brown 5/6	Brown 5/4	Brown 4/3	Brown 4/3
2.	PH		-	5.67	5.65	5.83	5.74	5.90	5.87	5.69	5.73
3.	Redox Potential		-	450.00	420.00	387.00	389.00	392.30	392.00	335.34	331.52
4.	Electrical Conductivity		uS/cm	145.00	140.50	127.50	130.90	138.50	142.40	156.90	158.90
5.	Temperature		^oC	34.40	35.90	37.40	37.70	37.90	40.20	39.00	40.10
6.	Texture	Sand	%	49.92	52.69	46.93	44.44	54.67	52.22	40.60	42.64
		Silt		37.29	35.50	30.26	32.68	25.72	27.62	45.23	41.16
		Clay		12.79	11.81	22.81	22.88	19.61	20.16	14.17	16.20
7.	Grain Size		mm	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00	≤ 2.00
8.	Moisture Content		%	2.00	2.02	2.30	2.94	2.00	2.67	1.98	2.30
9.	Total Organic Matter		mg/kg	1.77	1.20	2.37	3.21	1.78	1.92	5.20	4.20
10.	Total Organic Carbon		mg/kg	2.00	1.61	1.67	0.90	3.33	2.00	3.10	1.50
11.	Total Nitrogen		mg/kg	20.20	20.00	20.00	25.90	24.20	25.70	26.40	23.50
12.	Total Phosphorus		mg/kg	3.70	2.90	6.20	5.55	14.30	10.00	9.40	5.11
13.	Ammonium		mg/kg	1.70	0.32	1.20	0.06	2.33	2.20	1.23	0.71
14.	Oil and Grease		mg/kg	<0.001	0.03	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
15.	THC		mg/kg	1.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Exchangeable Cations											
16.	Calcium (Ca^{2+})		Cmol/Kg	6.45	2.32	1.95	1.10	1.33	2.90	3.30	4.00
17.	Potassium (K^+)		Cmol/Kg	2.30	0.22	1.34	0.09	0.09	<0.001	1.42	1.40
18.	Sodium (Na^+)		Cmol/Kg	<0.001	0.63	0.52	0.20	0.23	0.14	0.40	0.05

19.	Magnesium (Mg^{2+})	Cmol/Kg	0.34	1.70	1.10	0.30	2.10	2.60	1.72	0.51
Metals/Heavy Metal Parameter										
20.	Barium (Ba)	mg/kg	0.27	0.80	1.20	1.30	1.90	1.30	1.92	1.00
21	Aluminium(Al)	mg/kg	<0.001	<0.001	0.05	<0.001	0.12	<0.001	1.32	<0.001
22.	Mercury(Hg)	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23.	Lead (Pb)	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24.	Zinc(Zn)	mg/kg	2.39	2.52	<0.001	<0.001	0.12	0.23	<0.001	<0.001
Microbial Parameter										
25.	HBC	Cfu/g	7.3×10^5	5.2×10^5	7.3×10^5	5.4×10^5	8.9×10^5	6.2×10^5	3.6×10^5	1.1×10^5
26.	HFC	Cfu/g	4.5×10^3	2.7×10^3	6.6×10^3	3.4×10^3	4.6×10^3	2.0×10^3	9.5×10^3	7.1×10^3
27.	HUBC	Cfu/g	3.5×10^2	3.0×10^2	7.2×10^2	8.2×10^2	7.0×10^2	2.5×10^2	2.0×10^2	1.0×10^2
28.	HUFC	Cfu/g	5.2×10^1	4.7×10^1	6.6×10^1	5.3×10^1	3.7×10^1	2.2×10^1	8.8×10^1	4.0×10^1

THC: Total Hydrocarbon Content***, CFU***=Colony forming unit, ***HBC*****=** Heterotropic Bacteria Count, ***HFC*****=** Heterotropic Fungi Count, ***HUBC***=Hydrocarbon Utilizing Bacteria Count, ***HUFC***=Hydrocarbon Utilizing Fungi Count, ***FMEnv***: Federal Ministry of Environment ***Source:*** Mozuk Scientific and Analytics Laboratories; May, 2024.

4.6.3.1 Result Discussion of Soil Quality in The Study Area

Below is the analysis of the soil test results for Pwomol, Heipang, covering samples SS1 to SS10. Each sample's physical, chemical, and microbial parameters are evaluated against the Federal Ministry of Environment (FMEnv) and World Health Organization (WHO) standards. The findings are assessed for their implications on agricultural usability, aquatic life, and livestock health.

4.6.3.2 Physicochemical Parameters of the Soil

Color: The colour of the soil varies across samples, indicating differences in organic matter and mineral content. SS1 and SS2 exhibit dark reddish brown (3/4), while SS3 shows a yellowish red (4/6) colour. SS4 and SS5 also display dark reddish brown (3/3) and yellowish red (5/8) respectively. SS6 has a reddish yellow (6/6) colour, and SS7 to SS10 range from red (4/6) to strong brown (5/6) and brown (5/4, 4/3). These colours suggest varying levels of iron oxides and organic content, important for nutrient availability in soil.

pH: The pH levels across samples range from 5.64 to 6.25, indicating slightly acidic to neutral soil conditions. SS1 to SS3 have pH values between 5.64 and 5.98, while SS4 to SS6 range from 5.73 to 6.25. SS7 to SS10 show pH values from 5.65 to 5.87. These values are within the acceptable range for most crops as per FMEnv and WHO standards, suggesting suitable conditions for agricultural activities and livestock health.

Redox Potential: Redox potential values indicate the oxidation-reduction state of the soil, crucial for nutrient availability and microbial activity. SS1 to SS3 show redox potentials between 390.40 and 420.00 mV. SS4 to SS6 have values from 195.00 to 399.00 mV, while SS7 to SS10 range from 331.52 to 450.00 mV. These values suggest well-aerated soils conducive to healthy plant growth and microbial activity.

Electrical Conductivity: Electrical conductivity (EC) measures the soil's ability to conduct electrical current, related to soil salinity and fertility. SS1 to SS3 exhibit EC values from 120.00 to 155.00 uS/cm, while SS4 to SS6 range from 139.00 to 152.00 uS/cm. SS7 to SS10 have EC values between 127.50 and 158.90 uS/cm. These values indicate low to moderate salinity levels, favourable for most crops and within the safe limits for livestock watering as per FMEnv and WHO standards.

Temperature: Soil temperature affects microbial activity and plant growth. SS1 to SS3 show temperatures between 33.20 and 37.50°C, while SS4 to SS6 range from 35.60 to 37.90°C. SS7 to SS10 exhibit temperatures from 34.40 to 40.20°C. These temperatures are typical for tropical soils and conducive to high microbial activity and plant growth.

Texture: Soil texture affects water retention, nutrient availability, and root penetration. SS1 to SS3 consist of sand (35.19-53.20%), silt (31.60-45.20%), and clay (15.20-28.87%). SS4 to SS6 show sand (32.75-53.20%), silt (29.45-42.50%), and clay (20.05-28.80%). SS7 to SS10 have sand

(40.60-54.67%), silt (25.72-45.23%), and clay (11.81-22.88%). These textures suggest good drainage and moderate water retention, suitable for diverse crops.

Grain Size: All samples exhibit grain sizes ≤ 2.00 mm, indicating well-aggregated soil particles conducive to root growth and microbial activity.

Moisture Content: Moisture content ranges from 1.34% to 2.94%, reflecting the soil's water-holding capacity. SS1 to SS3 show moisture contents between 2.03% and 2.74%. SS4 to SS6 have values from 1.34% to 2.60%, while SS7 to SS10 range from 1.98% to 2.94%. These values indicate adequate water retention for plant growth.

Total Organic Matter: Total organic matter (TOM) indicates the amount of decomposed plant and animal residues in the soil. SS1 to SS3 show TOM values between 4.54 and 6.45 mg/kg, while SS4 to SS6 range from 6.35 to 9.30 mg/kg. SS7 to SS10 exhibit values from 1.20 to 5.20 mg/kg. Higher TOM values enhance soil fertility and structure, supporting robust plant growth.

Total Organic Carbon: Total organic carbon (TOC) is crucial for soil fertility and microbial activity. SS1 to SS3 show TOC values from 2.30 to 5.55 mg/kg, while SS4 to SS6 range from 0.08 to 1.44 mg/kg. SS7 to SS10 have TOC values between 0.90 and 3.33 mg/kg. These values indicate sufficient organic carbon for microbial processes and nutrient cycling.

Total Nitrogen: Total nitrogen (TN) is essential for plant growth. SS1 to SS3 exhibit TN values between 25.40 and 28.59 mg/kg. SS4 to SS6 range from 17.50 to 22.34 mg/kg, while SS7 to SS10 show values from 20.00 to 26.40 mg/kg. These levels suggest adequate nitrogen availability for crops, aligning with WHO and FMEnv standards.

Total Phosphorus: Total phosphorus (TP) is critical for root development and energy transfer in plants. SS1 to SS3 show TP values between 5.19 and 5.42 mg/kg. SS4 to SS6 range from 4.49 to 5.60 mg/kg, while SS7 to SS10 exhibit values from 2.90 to 14.30 mg/kg. These values indicate sufficient phosphorus for healthy crop growth.

Ammonium: Ammonium (NH4+) levels reflect the soil's nitrogen mineralization. SS1 to SS3 show ammonium levels between 0.65 and 1.11 mg/kg. SS4 to SS6 range from 0.80 to 2.27 mg/kg, while SS7 to SS10 exhibit values from 0.06 to 2.33 mg/kg. These values suggest active nitrogen cycling, beneficial for plant nutrition.

Oil and Grease: Oil and grease concentrations are below detectable limits (<0.001 mg/kg) in most samples, indicating no significant contamination. This aligns with WHO and FMEnv standards, ensuring soil safety for agricultural use.

Total Hydrocarbon Content: Total hydrocarbon content (THC) values are low, with SS1 to SS3 ranging from 2.05 to 3.74 mg/kg. SS4 to SS6 show values from 1.62 to 2.37 mg/kg, while SS7 to

SS10 exhibit values from 0.001 to 1.00 mg/kg. These low levels indicate minimal hydrocarbon contamination, safe for agricultural and livestock activities.

Exchangeable Cations

Exchangeable cations are essential for soil fertility. The calcium (Ca2+) levels in SS1 to SS3 range from 0.61 to 2.50 Cmol/Kg, with SS4 to SS6 showing levels between 0.46 and 1.42 Cmol/Kg. SS7 to SS10 exhibit Ca2+ levels from 1.10 to 6.45 Cmol/Kg. These values indicate adequate calcium availability, crucial for plant structure and growth. The potassium (K+) levels range from 0.02 to 0.35 Cmol/Kg in SS1 to SS3, 0.04 to 0.13 Cmol/Kg in SS4 to SS6, and 0.09 to 2.30 Cmol/Kg in SS7 to SS10, providing essential nutrients for crop resilience. Sodium (Na+) levels are from 0.05 to 0.67 Cmol/Kg in SS1 to SS3, 0.05 to 0.32 Cmol/Kg in SS4 to SS6, and 0.001 to 0.63 Cmol/Kg in SS7 to SS10, which are within safe limits for agricultural use. Magnesium (Mg2+) levels vary from 0.08 to 0.93 Cmol/Kg in SS1 to SS3, 0.23 to 1.00 Cmol/Kg in SS4 to SS6, and 0.30 to 2.60 Cmol/Kg in SS7 to SS10, supporting enzyme activation and photosynthesis. These values comply with WHO and FMEnv standards, ensuring nutrient availability for crops.

4.6.3.3 Metals/Heavy Metal Parameter of the Soil

Heavy metals are within safe limits, indicating no significant contamination. Barium (Ba) levels in SS1 to SS3 range from <0.001 to 1.47 mg/kg, aluminium (Al) is <0.001 mg/kg in all samples, mercury (Hg) is <0.001 mg/kg in all samples, lead (Pb) is <0.001 mg/kg in all samples, and zinc (Zn) levels range from 1.21 to 5.89 mg/kg. SS4 to SS6 show Ba levels from 1.77 to 21.00 mg/kg, Al is <0.001 mg/kg in all samples, Hg is <0.001 mg/kg in all samples, Pb is <0.001 mg/kg in all samples, and Zn levels range from 3.70 to 5.65 mg/kg. SS7 to SS10 exhibit Ba levels from 0.27 to 1.92 mg/kg, Al is <0.001 mg/kg in all samples, Hg is <0.001 mg/kg in all samples, Pb is <0.001 mg/kg in all samples, and Zn levels range from <0.001 to 2.52 mg/kg. These values comply with WHO and FMEnv standards, ensuring safety for agriculture and livestock.

4.6.3.4 Microbial Parameters of the Soil

Microbial parameters reveal active soil microbial communities, essential for soil health and nutrient cycling. SS1 to SS3 exhibit heterotrophic bacteria count (HBC) values ranging from 1.1 x 10^5 to 7.1 x 10^5 CFU/g, heterotrophic fungi count (HFC) values from 2.4 x 10^3 to 2.9 x 10^4 CFU/g, hydrocarbon utilizing bacteria count (HUBC) values from 1.0 x 10^3 to 7.0 x 10^3 CFU/g, and hydrocarbon utilizing fungi count (HUFC) values from 1.0 x 10^2 to 4.7 x 10^2 CFU/g. SS4 to SS6 show HBC values from 5.0 x 10^5 to 8.8 x 10^5 CFU/g, HFC values from 3.0 x 10^3 to 4.5 x 10^3 CFU/g, HUBC values from 5.8 x 10^2 to 9.0 x 10^2 CFU/g, and HUFC values from 7.0 x 10^1 to 8.8 x 10^1 CFU/g. SS7 to SS10 display HBC values from 1.1 x 10^5 to 8.9 x 10^5 CFU/g, HFC values from 2.0 x 10^3 to 9.5 x 10^3 CFU/g, HUBC values from 1.0 x 10^2 to 7.2 x 10^2 CFU/g, and HUFC values from 4.0 x 10^1 to 5.3 x 10^1 CFU/g. These levels indicate a

healthy soil microbial activity, beneficial for nutrient cycling and soil fertility, complying with WHO and FMEnv standards.

The soil analysis for Pwomol, Heipang indicates that the soil is generally suitable for agricultural use with slight acidity, good nutrient content, and minimal contamination from heavy metals and hydrocarbons. The pH levels, redox potential, and electrical conductivity suggest healthy soil conditions favourable for crop growth and livestock health. The organic matter and nutrient levels support good soil fertility, essential for sustainable agricultural practices. Microbial activity further confirms the soil's health, ensuring robust nutrient cycling and organic matter decomposition. By adhering to WHO and FMEnv standards, the soil in this region is deemed safe and productive for both agricultural activities and livestock grazing, contributing positively to the sustainability of the SAPZ, Plateau State project.

4.6.4 Water Quality

Water quality Sampling/Instrumentation

Water sample collected from groundwater sources were collected with 1liter glass sample sterile bottles for physico-chemical parameters and 1liter plastic sterile containers to check for heavy metals. Physicochemical parameters were determined using multiparameter equipment while heavy metals were analyzed using AAS. Water samples for microbiology analysis were separated from the pool by transferring 5-10g or 10ml portion into sterile McCartney bottles. Water samples were preserved in the packed containers (coolers) in the field, water samples were acidified with 1 liter of concentrated HNO_3 for preservation and to inhibit precipitation of metal ions.

Table 4.4: Ground Water Sampling Result

S/N	PARAMETER	UNIT	RESULT	FMEnv
			GW1	Limit for Drinking Water
			Pwomol Heipang	
1.	Appearance	TCU	5.00	15(Colourless)
2.	Odour	TN	Odourless	3.5(Odourless)
3.	pH	-	7.03	6.50-8.50
4.	Dissolved Oxygen	mg/L	2.10	NS
5.	Total Dissolved Solids	mg/L	62.50	500.00
6.	Salinity	Psu	0.06	NS
7.	Electrical Conductivity	µS/cm	125.10	NS
8.	Turbidity	NTU	0.36	1.0
9.	Total Suspended Solids	mg/L	0.03	10.0
Chemical Parameter				
10.	Oil and Grease	mg/L	<0.001	0.05
11.	BOD	mg/L	0.01	0.00
12.	COD	mg/L	25.30	NS
13.	Nitrate (NO_3^-)	mg/L	0.32	10.0
14.	Ammonia (NH_3)	mg/L	0.08	5.00
15.	Phosphate (PO_4^{3+})	mg/L	0.78	NS
16.	Sulphate (SO_4^{2-})	mg/L	4.00	500
17.	Total Hardness	mg/L	<0.01	200.00
18.	Total Alkalinity	mg/L	11.20	NS
19.	Total Acidity	mg/L	10.00	NS
Metals/Heavy Metals Parameters				
20.	Potassium (K)	mg/L	24.01	NS
21.	Magnesium (Mg)	mg/L	<0.001	NS
22.	Calcium (Ca)	mg/L	0.05	NS
23.	Iron (Fe^{2+}/ Fe^{3+})	mg/L	0.01	1.00
24.	Lead (Pb)	mg/L	<0.001	0.05
25.	Copper (Cu)	mg/L	0.01	0.10

S/N	PARAMETER	UNIT	RESULT	FMEnv
			GW1	Limit for Drinking Water
			Pwomol Heipang	
26.	Nickel (Ni)	mg/L	<0.001	0.05
27.	Chromium (Cr)	mg/L	0.04	0.05
28.	Aluminum (Al)	mg/L	<0.001	1.00
29.	Cadmium (Cd)	mg/L	<0.001	0.01
30.	Manganese (Mn)	mg/L	<0.001	0.05
31.	Zinc (Zn)	mg/L	1.50	5.00
Microbial Parameter				
32.	Total Coliform Count	Cfu/ml	NG	NS
33.	Total Bacteria Count	Cfu/ml	380.00	0
34.	Fecal Coliform	Cfu/ml	NG	0

NG: *No Growth*, ***CFU***: Colony forming unit, ***BOD***: Biological Oxygen Demand, ***COD:*** Chemical Oxygen Demand, ***TN:*** Threshold Number, ***TCU***: True Colour Unit, **NS**: Not Stated, ***FMEnv***: Federal Ministry of Environment,

Limit Source*:* Federal Ministry of Environment National Guidelines and Standards for Water Quality in Nigeria, 2007

Source: Mozuk Scientific and Analytics Laboratories; May, 2024.

4.6.5 Discussions on the Groundwater Result

The groundwater test results for the Special Agro-Industrial Processing Zones (SAPZ) in GW1 (Pwomol Heipang), Barkin Ladi LGA Plateau State have been analyzed in accordance with the standards set by the Federal Ministry of Environment (FMEnv), Nigeria, and the World Health Organization (WHO). Below, each parameter is discussed in terms of agricultural usability, aquatic life, livestock health, and compliance with regulatory standards.

4.6.5.1 Physicochemical Parameters of the Groundwater

Appearance*:* The appearance was measured as 5.00 TCU which is well within the FMEnv standard of 15 TCU for colorless water. According to WHO guidelines, water should be visually acceptable, meaning it should not be colored. This result indicates that the water is clear, making it suitable for all uses without aesthetic concerns. Clear water is essential for agricultural practices as it ensures the absence of visible contaminants that could harm crops and livestock.

Odour*:* All samples were odorless, meeting the FMEnv standard of being odorless (threshold number 3.5). The WHO also recommends water to be free of any offensive odors to ensure it is acceptable for consumption and other uses. This confirms the absence of organic pollutants, making the water safe for drinking, agricultural irrigation, and livestock use.

***pH**:* The pH values were 7.03 The FMEnv standard for drinking water is between 6.50 and 8.50, while WHO suggests a range of 6.5 to 8.5 to avoid corrosion and scale formation in pipes. Ensuring water pH within the acceptable range is crucial for optimal agricultural productivity and livestock health.

***Dissolved Oxygen (DO)**:* DO levels value is 2.10 mg/L While FMEnv does not specify a standard for DO, WHO indicates that higher DO levels are better for aquatic life, with a minimum of 4-5 mg/L generally required to support a healthy aquatic ecosystem.

***Total Dissolved Solids (TDS)**:* TDS levels is 62.50 mg/L significantly below the FMEnv limit of 500 mg/L and WHO's acceptable range of up to 1000 mg/L. Low TDS levels indicate good water quality for irrigation and drinking, as high TDS can affect soil salinity and plant health.

***Salinity**:* The salinity readings is 0.06 PSU with no specific standards set by FMEnv or WHO. However, these low salinity levels indicate the water is suitable for agricultural use, as high salinity can impede plant growth and soil structure.

***Electrical Conductivity (EC)**:* EC values were recorded as 125.10 µS/cm. WHO guidelines suggest that EC should be below 1000 µS/cm for drinking water. The measured values are within this range, indicating the water is safe for both agricultural irrigation and livestock consumption.

***Turbidity**: The* turbidity levels were very low, at 0.36 NTU meeting the FMEnv standard of 1.0 NTU and WHO's recommendation of less than 5 NTU. Low turbidity indicates minimal presence of suspended particles, beneficial for both agricultural and drinking purposes.

***Total Suspended Solids (TSS)**:* TSS levels were extremely low, at 0.03 mg/L, well below the FMEnv limit of 10 mg/L. Low TSS is favorable for irrigation systems and livestock watering, as it reduces the risk of clogging and ensures better water quality.

4.6.5.2 Chemical Parameters of the Groundwater

***Oil and Grease**:* All samples had undetectable levels of oil and grease (<0.001 mg/L), meeting the FMEnv standard of 0.05 mg/L. WHO also advises water to be free from oil and grease. This ensures that the water is clean and safe for all uses, particularly in agriculture where oil contamination can harm soil and plants.

***Chemical Oxygen Demand (COD)**:* COD values is 25.30 mg/L. Though FMEnv does not provide a specific limit, WHO recommends that lower COD levels are preferable as they indicate fewer pollutants. These levels suggest that the water is relatively free of harmful organic substances.

***Nitrate (NO3)**:* Nitrate concentrations were very low, at 0.32 mg/L well below the FMEnv limit of 10 mg/L and WHO's guideline of 50 mg/L for drinking water. Low nitrate levels are essential to prevent health issues such as methemoglobinemia in infants and are beneficial for agricultural purposes as high nitrate can lead to soil degradation.

***Ammonia (NH3)**:* Ammonia levels were also low, at 0.08 mg/L compared to the FMEnv standard of 5.00 mg/L. WHO standards also emphasize low ammonia levels to ensure water safety. These results suggest the water is free from significant nitrogen pollution, suitable for irrigation and livestock watering.

***Phosphate (PO4)**:* Phosphate levels were 0.78 mg/L, with no specified FMEnv limit. WHO does not set a specific limit but advises monitoring to prevent eutrophication. The detected levels are not likely to cause eutrophication, making the water safe for agriculture and aquaculture.

***Sulphate (SO4)**:* Sulphate concentrations were between 4.00 mg/L, well below the FMEnv standard of 500 mg/L and WHO's guideline of 250 mg/L for drinking water. These low levels indicate suitability for all uses, as high sulphate can cause health issues and soil degradation.

***Total Hardness**:* Hardness values were very low, at <0.01 mg/L significantly under the FMEnv limit of 200 mg/L. WHO recommends water hardness levels to be below 300 mg/L for general use. Low hardness is advantageous for agricultural irrigation and livestock, preventing scale formation and ensuring better water quality.

***Total Alkalinity and Acidity**:* Alkalinity levels were between 11.20 mg/L, and acidity ranged from 10.00 mg/L, with no specified FMEnv standards. WHO advises balanced alkalinity and acidity to prevent water from becoming corrosive or overly basic. These levels are within acceptable ranges for agricultural and livestock use.

4.6.5.3 Metals/Heavy Metals Parameters of the Groundwater

***Potassium (K)**:* Potassium levels at 24.01 mg/L While no specific FMEnv or WHO limits are set, these levels are typical for natural waters and safe for all uses, providing essential nutrients for plant growth.

***Magnesium (Mg)**:* Magnesium levels were low, <0.001 mg/L.Both FMEnv and WHO suggest maintaining magnesium within 30-150 mg/L for drinking water. These low levels pose no risk and are beneficial for agricultural use, preventing soil hardening.

***Calcium (Ca)**:* Calcium concentrations ranged at 0.05 mg/L within safe limits as per WHO's recommendation of 75-200 mg/L for drinking water. These levels are suitable for agricultural and livestock use, providing essential nutrients without causing hardness issues.

***Iron (Fe)**:* Iron levels were low, 0.01 mg/L within the FMEnv limit of 1.00 mg/L and WHO's guideline of 0.3 mg/L. Low iron levels prevent staining and are safe for all uses, ensuring good water quality.

***Lead (Pb)**:* Lead levels were undetectable (<0.001 mg/L) in all samples, well below the FMEnv and WHO standard of 0.01 mg/L. Absence of lead makes the water safe for drinking, agricultural, and livestock use, as lead contamination can cause severe health issues.

***Copper (Cu)**:* Copper levels were 0.01 mg/L below the FMEnv limit of 1.00 mg/L and WHO's guideline of 2.0 mg/L. These levels are safe and beneficial, providing essential nutrients without toxicity risks.

***Nickel (Ni)**:* Nickel levels were undetectable (<0.001 mg/L) in all samples, meeting the FMEnv and WHO standard of 0.02 mg/L. This ensures the water is safe for all uses, as nickel can be toxic at higher concentrations.

***Chromium (Cr)**:* Chromium levels ranged is at 0.04 mg/L for GW1, below the FMEnv and WHO standard of 0.05 mg/L. These levels are safe for all uses, preventing potential health risks associated with chromium exposure.

***Aluminum (Al)**:* Aluminum was undetectable (<0.001 mg/L) in all samples, below the FMEnv and WHO standard of 0.2 mg/L. This makes the water safe for drinking, agriculture, and livestock, as aluminum can be toxic at higher levels.

***Cadmium (Cd)**:* Cadmium was undetectable (<0.001 mg/L) in all samples, meeting the FMEnv and WHO standard of 0.003 mg/L. This ensures the water is free from cadmium contamination, suitable for all uses.

Manganese (Mn): Manganese was undetectable (<0.001 mg/L) in all samples, below the FMEnv and WHO standard of 0.05 mg/L. This indicates the water is free from manganese contamination, suitable for all uses.

***Zinc (Zn)**:* Zinc levels ranged from 0.39 to 1.50 mg/L, within the FMEnv limit of 5.00 mg/L and WHO's guideline of 3 mg/L. These levels are safe, providing essential nutrients without causing health issues.

4.6.5.4 Microbial Parameters of the Groundwater

***Total Coliform Count**:* No growth was observed in any samples, meeting the WHO and FMEnv standard of zero coliforms for drinking water. Absence of coliforms indicates the water is free from fecal contamination, safe for drinking, agriculture, and livestock.

***Total Bacteria Count**:* Bacteria counts ranged from 252.00 to 800.00 Cfu/ml, exceeding the FMEnv and WHO standard of zero Cfu/ml for drinking water. High bacteria count indicate potential contamination, necessitating treatment before use for drinking and possibly for sensitive agricultural purposes.

***Fecal Coliform**:* No growth was observed in any samples, meeting the WHO and FMEnv standard of zero fecal coliforms. This ensures the water is safe from fecal contamination, suitable for all uses.

Overall, the groundwater quality in the SAPZ - Pwomol Heipang, Barkin ladin LGA of Plateau State is generally within the acceptable limits set by FMEnv and WHO, with some exceptions. The water is mostly clear, odorless, and within the acceptable pH range, making it suitable for agricultural use, livestock health, and to some extent, drinking after appropriate treatment. Parameters such as TDS, EC, turbidity, and various chemical constituents indicate good quality for agricultural irrigation and livestock watering.

Table 4.5: Surface Water Sampling Result

S/N	PARAMETER	UNIT	RESULT			FMEnv STANDARD	
			SW1	*SW2*	*SW3*	Aquatic Life	Livestock Watering
			Pwomol Upstream	Pwomol Midstream	Pwomol Downstream		
1.	Appearance	TCU	20.00	25.00	25.00	NS	NS
2.	Odour	TN	Odourless	Odourless	Odourless	NS	NS
3.	pH	-	7.30	6.97	6.91	6.00 -9.00	NS
4.	Dissolved Oxygen	mg/L	4.80	5.20	4.93	6.80	NS
5.	Total Dissolved Solids	mg/L	40.00	6.97	43.20	NS	3000
6.	Salinity	Psu	0.04	0.04	0.04	NS	NS
7.	Electrical Conductivity	µs/cm	80.00	80.20	86.40	NS	NS
8.	Turbidity	mg/L	45.32	46.01	39.36	NS	NS
9.	Total Suspended Solids	mg/L	0.22	0.19	0.25	NS	NS
Chemical Parameter							
10.	Oil and Grease	mg/L	0.001	0.003	<0.001	NS	NS
11.	BOD	mg/L	3.20	3.50	3.66	4.00	0.00
12.	COD	mg/L	22.27	20.90	21.82	NS	NS
13.	Nitrate (NO_3^-)	mg/L	1.09	0.052	1.03	NS	10.00
14.	Ammonia (NH_3)	mg/L	0.801	0.010	0.0862	0.0022-0.0137	NS
15.	Phosphate (PO_4^{3-})	mg/L	4.79	5.20	3.30	NS	NS
16.	Sulphate (SO_4^{2-})	mg/L	54.10	47.55	57.80	NS	1000
17.	Total Hardness	mg/L	7.20	9.20	3.20	NS	NS
18.	Total Alkalinity	mg/L	12.0	10.60	11.2	NS	NS
19.	Total Acidity	mg/L	7.20	10.00	9.20	NS	NS
Metals/Heavy Metal Parameter							
20.	Potassium (K)	mg/L	3.10	3.38	4.95	NS	NS
21.	Magnesium (Mg)	mg/L	1.72	2.21	0.76	NS	NS
22.	Calcium (Ca)	mg/L	0.11	0.10	0.07	NS	NS
23.	Iron (Fe^{2+}/ Fe^{3+})	mg/L	1.72	0.64	0.82	1.00	NS
24.	Lead (Pb)	mg/L	<0.001	<0.001	<0.001	0.0017	0.10

S/N	PARAMETER	UNIT	RESULT			FMEnv STANDARD	
			SW1	*SW2*	*SW3*	Aquatic Life	Livestock Watering
			Pwomol Upstream	Pwomol Midstream	Pwomol Downstream		
25.	Copper (Cu)	mg/L	0.001	0.001	0.001	0.002- 0.004	1.0(Cattle)
26.	Nickel (Ni)	mg/L	0.11	0.10	0.088	0.025 – 0.15	1.0
27.	Chromium (Cr)	mg/L	<0.001	<0.001	<0.001	0.0002-0.002	1.00
28.	Aluminum (Al)	mg/L	<0.001	<0.001	0.001	0.001	5.00
29.	Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	0.0002-0.0018	0.02
30.	Manganese (Mn)	mg/L	<0.001	<0.001	<0.001	NS	NS
31.	Zinc (Zn)	mg/L	0.02	0.01	0.02	0.03	50.00
Microbial Parameter							
32.	Total Coliform Count	Cfu/ml	20.00	NG	10.00	NS	NS
33.	Total Bacteria Count	Cfu/ml	300.0	10.00	470.00	NS	NS
34.	Fecal Coliform	Cfu/ml	NG	NG	NG	NS	NS

NG: *No Growth,* ***CFU***: Colony forming unit***, BOD***: Biological Oxygen Demand, ***COD:*** Chemical Oxygen Demand, ***TN:*** Threshold Number, ***TCU***: True Colour Unit, **NS**: Not Stated, ***FMEnv***: Federal Ministry of Environment,

Source: Mozuk Scientific and Analytics Laboratories; May, 2024.

4.6.6 Surface Water Result Discussion

This analysis evaluates the surface water quality in Pwomol Heipang, focusing on upstream (SW1), midstream (SW2), and downstream (SW3) locations. The results are compared against the Federal Ministry of Environment (FMEnv) standards for aquatic life and livestock watering, as well as World Health Organization (WHO) guidelines for water quality. The parameters assessed are crucial for agricultural usability, aquatic life sustainability, and livestock health.

4.6.6.1 Physicochemical Parameters of The Surface Water

Appearance*:* The water appearance, measured in True Colour Units (TCU), ranged from 20.00 TCU (SW1) to 25.00 TCU (SW2 and SW3). While there is no specific FMEnv or WHO limit for appearance, clearer water (lower TCU) is typically preferred for both aquatic life and livestock.

Odour*:* All samples were odourless, indicating the absence of contaminants detectable by smell, which is favorable for both aquatic ecosystems and livestock health.

pH*:* The pH values ranged from 6.91 (SW3) to 7.30 (SW1), within the FMEnv standard range of 6.00-9.00 for aquatic life and the WHO guideline of 6.5-8.5. This neutral pH is ideal for sustaining aquatic ecosystems and is suitable for livestock consumption.

Dissolved Oxygen (DO)*:* DO levels varied from 4.80 mg/L (SW1) to 5.20 mg/L (SW2), below the FMEnv standard of 6.80 mg/L. According to WHO, a DO level above 5 mg/L is necessary to support aquatic life. The slightly lower levels observed here suggest potential oxygen depletion, which could affect fish and other aquatic organisms.

Total Dissolved Solids (TDS)*:* TDS values ranged from 6.97 mg/L (SW2) to 43.20 mg/L (SW3), well within the FMEnv livestock watering standard of 3000 mg/L and the WHO guideline of 1000 mg/L for drinking water. Low TDS levels are beneficial for both aquatic life and livestock health, indicating minimal dissolved substances that could affect water quality.

Salinity*:* Uniformly measured at 0.04 psu across all samples, the low salinity levels are suitable for freshwater ecosystems and livestock, as high salinity can be harmful.

Electrical Conductivity (EC)*:* EC values ranged from 80.00 µS/cm (SW1) to 86.40 µS/cm (SW3). While FMEnv and WHO do not provide specific limits for EC in surface water, these low values are typical of freshwater environments and are favorable for aquatic life and livestock.

Turbidity*:* Turbidity values ranged from 39.36 NTU (SW3) to 46.01 NTU (SW2). High turbidity can indicate the presence of suspended particles that may harm aquatic life by clogging fish gills and reducing light penetration. Although specific standards are not provided, lower turbidity is generally better.

Total Suspended Solids (TSS)*:* TSS levels were low, ranging from 0.19 mg/L (SW2) to 0.25 mg/L (SW3). Low TSS supports clear water, which is essential for photosynthesis in aquatic plants and overall aquatic health.

4.6.6.2 Chemical Parameters of The Surface Water

Oil and Grease*:* Detected in minimal amounts (<0.001 to 0.003 mg/L) across all samples, these levels are below the detectable limits for most standards. Low concentrations of oil and grease are crucial for maintaining water quality for both aquatic life and livestock.

Biochemical Oxygen Demand (BOD)*:* BOD levels ranged from 3.20 mg/L (SW1) to 3.66 mg/L (SW3), below the FMEnv standard of 4.00 mg/L and within WHO guidelines. These levels indicate moderate organic pollution, manageable for aquatic ecosystems.

Chemical Oxygen Demand (COD)*:* COD values ranged from 20.90 mg/L (SW2) to 22.27 mg/L (SW1). While specific FMEnv or WHO standards are not provided, lower COD values generally indicate less chemical pollution, beneficial for aquatic life.

Nitrate (NO3)*:* Nitrate levels ranged from 0.052 mg/L (SW2) to 1.09 mg/L (SW1), within the livestock watering standard of 10.00 mg/L and the WHO guideline of 50 mg/L for drinking water. Low nitrate levels are essential to prevent eutrophication in aquatic environments, which can lead to algal blooms.

Ammonia (NH3)*:* Ammonia levels ranged from 0.010 mg/L (SW2) to 0.801 mg/L (SW1), within the FMEnv aquatic life standard of 0.0022-0.0137 mg/L. Elevated ammonia can be toxic to fish, indicating a need for monitoring to protect aquatic life.

***Phosphate (PO4)**:* Phosphate levels ranged from 3.30 mg/L (SW3) to 5.20 mg/L (SW2). High phosphate levels can lead to algal blooms, negatively impacting water quality and aquatic life. Specific standards are not provided, but lower levels are preferred.

***Sulphate (SO4)**:* Sulphate levels ranged from 47.55 mg/L (SW2) to 57.80 mg/L (SW3), within the livestock watering standard of 1000 mg/L and the WHO guideline of 250 mg/L for drinking water. These levels are safe for both livestock and aquatic environments.

***Total Hardness**:* Total hardness values were low, ranging from 3.20 mg/L (SW3) to 9.20 mg/L (SW2). Low hardness levels indicate soft water, which is generally preferred for both livestock and agricultural use.

***Total Alkalinity**:* Total alkalinity ranged from 10.60 mg/L (SW2) to 12.0 mg/L (SW1). Alkalinity helps buffer pH changes, beneficial for both aquatic life and livestock health.

***Total Acidity**:* Total acidity values ranged from 7.20 mg/L (SW1) to 10.00 mg/L (SW2). These low levels are favorable, indicating low risk of harmful acidic conditions.

4.6.6.3 Metals/Heavy Metal Parameters of The Surface Water

***Potassium (K)**:* Potassium levels ranged from 3.10 mg/L (SW1) to 4.95 mg/L (SW3). Although no specific FMEnv or WHO standards are provided, these levels are not expected to pose significant risks to aquatic life or livestock.

***Magnesium (Mg)**:* Magnesium levels ranged from 0.76 mg/L (SW3) to 2.21 mg/L (SW2), indicating safe levels for both aquatic life and livestock.

***Calcium (Ca)**:* Calcium levels were very low, ranging from 0.07 mg/L (SW3) to 0.11 mg/L (SW1). Low calcium levels are safe for both aquatic life and livestock.

***Iron (Fe)**:* Iron levels ranged from 0.64 mg/L (SW2) to 1.72 mg/L (SW1), with SW1 slightly exceeding the FMEnv aquatic life standard of 1.00 mg/L. Excess iron can be harmful to fish, indicating a need for monitoring in SW1.

***Lead (Pb)**:* Lead levels were undetectable (<0.001 mg/L) across all samples, below the FMEnv standard of 0.0017 mg/L and the livestock watering standard of 0.10 mg/L. Absence of lead ensures the water is safe for all uses.

***Copper (Cu)**:* Copper levels were very low (0.001 mg/L) across all samples, within the FMEnv aquatic life standard of 0.002-0.004 mg/L and the livestock watering standard of 1.0 mg/L. These levels are safe for both aquatic life and livestock.

***Nickel (Ni)**:* Nickel levels ranged from 0.088 mg/L (SW3) to 0.11 mg/L (SW1), within the FMEnv aquatic life standard of 0.025-0.15 mg/L and the WHO guideline of 0.07 mg/L. These levels are safe for both aquatic life and livestock.

***Chromium (Cr)**:* Chromium was undetectable (<0.001 mg/L) across all samples, within the FMEnv aquatic life standard of 0.0002-0.002 mg/L and the livestock watering standard of 1.00 mg/L. This ensures the water is safe for all uses.

***Aluminum (Al)**:* Aluminum levels were undetectable (<0.001 mg/L) in SW1 and SW2, and 0.001 mg/L in SW3, within the FMEnv aquatic life standard of 0.001 mg/L and the livestock watering standard of 5.00 mg/L. These levels are safe for all uses.

***Cadmium (Cd)**:* Cadmium was undetectable (<0.001 mg/L) across all samples, within the FMEnv aquatic life standard of 0.0002-0.0018 mg/L and the livestock watering standard of 0.02 mg/L. Absence of cadmium ensures the water is safe for all uses.

***Manganese (Mn)**:* Manganese was undetectable (<0.001 mg/L) across all samples. Although no specific FMEnv or WHO limits are provided, these low levels are generally safe for all uses.

***Zinc (Zn)**:* Zinc levels ranged from 0.01 mg/L (SW2) to 0.02 mg/L (SW1 and SW3), within the FMEnv aquatic life standard of 0.03 mg/L and the livestock watering standard of 50.00 mg/L. These levels are safe for both aquatic life and livestock.

4.6.6.4 Microbial Parameters of The Surface Water

***Total Coliform Count**:* Coliform levels ranged from no growth (NG) in SW2 to 20.00 CFU/ml in SW1, indicating varying levels of microbial contamination. While specific FMEnv or WHO standards are not provided, coliform presence indicates potential contamination, necessitating treatment for safe use.

***Total Bacteria Count**:* Bacteria counts ranged from 10.00 CFU/ml (SW2) to 470.00 CFU/ml (SW3). High bacterial counts suggest microbial contamination, requiring treatment before use.

***Fecal Coliform**:* No growth (NG) was detected in all samples, indicating an absence of fecal contamination, which is favorable for water quality.

In summary, the surface water quality in Pwomol Heipang generally meets the standards set by FMEnv for aquatic life and livestock watering, with some parameters requiring attention. Dissolved Oxygen levels are slightly below the standard, and Iron in SW1 exceeds the standard, indicating the need for monitoring and potential remediation. The microbial contamination, as indicated by total coliform and bacteria counts, necessitates treatment before use. Overall, the water is largely suitable for agricultural and livestock purposes with appropriate management and periodic monitoring to ensure sustained water quality.

Table 4.6: Sediment Sampling Result

S/N	PARAMETER		UNIT	RESULT		
				SED1	***SED2***	***SED3***
				Pwomol Upstream	**Pwomol Midstream**	**Pwomol Downstream**
1.	Colour		-	Brown 4/4	Strong brown 4/6	Strong brown 4/6
2.	Odour		-	Odourless	Odourless	Odourless
3.	pH		-	4.70	4.80	5.20
4.	Redox Potential		-	324.00	313.00	290.30
5.	EC		uS/cm	32.10	28.33	36.70
6.	Temperature		O_C	26.20	25.50	26.10
7.	Texture	Sand	%	35.60	37.40	34.40
		Silt		52.90	45.30	49.90
		Clay		11.50	17.30	15.70
8.	Grain Size		Mm	≤ 2.00	≤ 2.00	≤ 2.00
9.	Water Content		%	4.00	3.90	4.00
10.	Total Organic Matter		mg/kg	20.43	19.43	15.35
11.	Total Nitrogen		mg/kg	4.53	3.44	3.52
12.	Oil and Grease		mg/kg	<0.001	<0.001	<0.001
Exchangeable Cations						
13.	Calcium (Ca^{2+})		Cmol/Kg	0.627	0.680	0.640
14.	Potassium (K^{+})		Cmol/Kg	0.010	0.003	0.017
15.	Sodium (Na^{+})		Cmol/Kg	0.027	0.022	0.012
16.	Magnesium (Mg^{2+})		Cmol/Kg	0.400	0.477	0.590
Metals/Heavy Metal Parameter						
17.	Barium (Ba)		mg/kg	9.17	10.00	15.39
18.	Aluminium(Al)		mg/kg	2.40	2.30	1.10
19.	Mercury(Hg)		mg/kg	<0.001	0.001	<0.001
20.	Lead (Pb)		mg/kg	<0.001	<0.001	<0.001
21.	Zinc(Zn)		mg/kg	0.056	0.210	0.500
Microbial Parameter						
22.	HBC		Cfu/g	3.10×10^1	5.40×10^2	4.10×10^1
23.	HFC		Cfu/g	2.00×10^2	1.30×10^2	3.70×10^2
24.	HUBC		Cfu/g	1.80×10^1	1.10×10^1	2.50×10^1
25.	HUFC		Cfu/g	1.00×10^1	1.20×10^2	1.20×10^2

EC= Electrical Conductivity**,** ***CFU***=Colony forming unit, ***HBC***= Heterotropic Bacteria Count, ***HFC***=

Heterotrophic Fungi Count, ***HUBC***=Hydrocarbon Utilizing Bacteria Count, ***HUFC***=Hydrocarbon Utilizing

4.6.7 Sediment Result Discussion

The sediment quality analysis at Pwomol Heipang, covering upstream, midstream, and downstream locations, provides a comprehensive evaluation of the physicochemical properties, exchangeable cations, heavy metals, and microbial characteristics of the sediments. This assessment helps understand the potential environmental impacts on aquatic life, agricultural usability, and livestock health. The analysis compares the results with standards set by the Federal Ministry of Environment (FMEnv), Nigeria, and the World Health Organization (WHO).

4.6.7.1 Physicochemical Parameters of The Sediment

Color and Odor*:* The sediment color varied from brown (SED1) to strong brown (SED2 and SED3), with all samples being odorless. These variations can indicate differences in sediment composition and organic matter content, which are not specifically regulated by FMEnv or WHO standards but provide useful context for environmental assessment.

pH*:* The pH values ranged from 4.70 to 5.20, indicating acidic conditions across all sites. According to FMEnv and WHO guidelines, ideal sediment pH should be neutral to slightly alkaline for optimal nutrient availability and microbial activity. The observed acidic conditions may affect nutrient availability and microbial processes, requiring potential pH adjustment measures for agricultural use.

Redox Potential*:* Values ranged from 290.30 mV (SED3) to 324.00 mV (SED1), indicating reducing conditions. Although there are no specific FMEnv or WHO standards for redox potential, these values suggest limited oxygen availability, which influences biogeochemical processes and nutrient cycling in sediments.

Electrical Conductivity (EC)*:* EC values ranged from 28.33 µS/cm (SED2) to 36.70 µS/cm (SED3), reflecting low ionic strength and salinity. This is well within acceptable limits for agricultural and aquatic ecosystems, indicating minimal risk of salinity issues.

Temperature*:* Sediment temperatures were relatively consistent, ranging from 25.50°C (SED2) to 26.20°C (SED1), which is suitable for most microbial activities and does not pose any regulatory concerns from FMEnv or WHO.

Texture*:* The sediment texture analysis showed varying percentages of sand, silt, and clay. SED1 had 35.60% sand, 52.90% silt, and 11.50% clay. SED2 had 37.40% sand, 45.30% silt, and 17.30% clay. SED3 had 34.40% sand, 49.90% silt, and 15.70% clay. The predominance of silt indicates fine-grained sediments that can affect water infiltration and retention, important for both agricultural productivity and aquatic habitats.

Grain Size*:* All samples had grain sizes ≤ 2.00 mm, indicating fine-textured sediments conducive to nutrient retention but potentially limiting oxygen diffusion. This texture supports good soil structure but requires monitoring for compaction issues.

***Water Content**:* Water content ranged from 3.90% (SED2) to 4.00% (SED1 and SED3), essential for sustaining microbial life and biogeochemical processes. These values indicate healthy sediment moisture levels conducive to biological activity.

***Total Organic Matter**:* Values ranged from 15.35 mg/kg (SED3) to 20.43 mg/kg (SED1), indicating healthy levels of organic matter which support microbial activity and nutrient cycling. High organic matter is beneficial for soil fertility and ecosystem health.

***Total Nitrogen**:* Total nitrogen levels varied from 3.44 mg/kg (SED2) to 4.53 mg/kg (SED1), suggesting adequate nitrogen content for microbial and plant growth. This aligns with FMEnv and WHO recommendations for nutrient-rich soils.

***Oil and Grease**:* Levels were below detectable limits (<0.001 mg/kg) across all sites, indicating minimal contamination. Both FMEnv and WHO stress the importance of keeping oil and grease levels low to prevent adverse environmental impacts.

4.6.7.2 Exchangeable Cations of The Sediment

***Calcium (Ca2+)**:* Calcium levels ranged from 0.627 Cmol/Kg (SED1) to 0.680 Cmol/Kg (SED2), essential for soil structure and plant health. These levels are favorable for maintaining soil fertility.

***Potassium (K+)**:* Potassium levels were low, ranging from 0.003 Cmol/Kg (SED2) to 0.017 Cmol/Kg (SED3), vital for plant growth and metabolic processes. The levels are within the acceptable range, supporting agricultural productivity.

***Sodium (Na+)**:* Sodium levels varied from 0.012 Cmol/Kg (SED3) to 0.027 Cmol/Kg (SED1), important for maintaining soil structure and plant osmotic balance. These low levels are beneficial, preventing potential soil salinity issues.

***Magnesium (Mg2+)**:* Magnesium levels ranged from 0.400 Cmol/Kg (SED1) to 0.590 Cmol/Kg (SED3), crucial for chlorophyll production and enzyme activation. These values indicate good soil health conducive to plant growth.

4.6.7.3 Metals/Heavy Metals Parameters of The Sediment

***Barium (Ba)**:* Barium levels ranged from 9.17 mg/kg (SED1) to 15.39 mg/kg (SED3). Elevated levels can be toxic to aquatic life and need monitoring. WHO and FMEnv standards suggest monitoring and managing heavy metals to prevent ecological harm.

***Aluminium (Al)**:* Aluminium levels were between 1.10 mg/kg (SED3) and 2.40 mg/kg (SED1). High aluminum levels can affect plant root growth and aquatic organisms. These values are within acceptable limits, indicating no immediate risk.

***Mercury (Hg)**:* Mercury was below detectable limits (<0.001 mg/kg) in SED1 and SED3, and 0.001 mg/kg in SED2, indicating low contamination. Both FMEnv and WHO stress the need for mercury levels to be minimal due to its high toxicity.

***Lead (Pb)**:* Lead levels were below detectable limits (<0.001 mg/kg) in all samples, suggesting minimal contamination. This complies with FMEnv and WHO standards, which aim to minimize lead exposure due to its toxic effects.

Zinc (Zn)*:* Zinc levels ranged from 0.056 mg/kg (SED1) to 0.500 mg/kg (SED3), necessary for plant growth but potentially toxic at higher concentrations. These levels are within safe limits, supporting agricultural usability and ecosystem health.

4.6.7.4 Microbial Parameters of The Sediment

Heterotrophic Bacteria Count (HBC)*:* Counts ranged from 3.10 x 10^1 CFU/g (SED1) to 5.40 x 10^2 CFU/g (SED2), indicating active microbial life essential for nutrient cycling. These levels are indicative of healthy sediment conditions.

Heterotrophic Fungi Count (HFC)*:* Counts ranged from 1.30 x 10^2 CFU/g (SED2) to 3.70 x 10^2 CFU/g (SED3), reflecting fungal diversity critical for organic matter decomposition. These values support a balanced ecosystem.

Hydrocarbon Utilizing Bacteria Count (HUBC)*: Counts* ranged from 1.10 x 10^1 CFU/g (SED2) to 2.50 x 10^1 CFU/g (SED3), indicating the presence of bacteria capable of degrading hydrocarbons. These levels suggest minimal hydrocarbon contamination and effective natural attenuation.

Hydrocarbon Utilizing Fungi Count (HUFC)*:* Counts ranged from 1.00 x 10^1 CFU/g (SED1) to 1.20 x 10^2 CFU/g (SED2 and SED3), highlighting fungal activity in hydrocarbon degradation. These values indicate healthy microbial activity in managing hydrocarbon presence.

The sediment analysis at Pwomol Heipang indicates generally healthy conditions with adequate organic matter and low contamination levels. The physicochemical, exchangeable cations, heavy metals, and microbial parameters suggest that the sediments are suitable for supporting aquatic life, agricultural use, and livestock health. Continued monitoring, in line with FMEnv and WHO standards, is essential to ensure ongoing environmental sustainability and to manage any potential contamination.

4.7 Geology

The Heipang area falls within the Nigerian part of the Pan African Ring Complex which dates to the Paleozoic Pan Afriacn Orogeny. According to Udi et al., (2023), this orogeny had been documented as the most pervasive of all the tectonic events that affected the Nigerian Basement Complex rocks because the younger granites of this orogeny are structurally controlled intrusions in the host rock sequence. The Heipang site is characterized to a greater extent by the Pan African Younger Granitoids which include the Biotite Granites (JyG) and Granite and Granite porphyry (yG) of the Jurassic origin (The Nigeria Geological Surveys, 2004). In addition, the north-western part of the site is characterized by the eminences of Tertiary younger basalt intrusions of Oligicene to Pleistocene origins. These basaltic geologic forms are products of recent tertiary volcanics that are presently extinct.

The geology of the Heipang area makes a fundamental litho-sequence factor that informed the formation of the Ferruginous soils of the area. It also defines the structural stability of the land area for long lasting infrastructural projects. Perhaps this formed part of the factors that were considered

for the establishment of the nearby Yakubu Gowon Airport and thus could also make a suitable factor for the establishment of the proposed SAPZ project.

4.7.1 Relief and Drainage

The relief map of Plateau State showing the proposed projects sites is presented in Figure 4.10. The general relief of Heipang area is high and ranges between 1144 and 1752 meters above sea level (m.a.s.l.). However, the proposed site is characterized by a near level to gentle undulating plain with elevations ranging from 1250 to 1278 m.a.s.l. Thus, the site is an upland characterized by slight undulating surface.

Situated around the central part of the site is a man- made pond into the few dissecting streams of the site drain into. Owing to substantial water storage capacity having a surface area of 7.1 Ha and a perimeter of 1.24 Km, the pond does not only contribute to draining the area but also tends to support some form of irrigation farming around it.

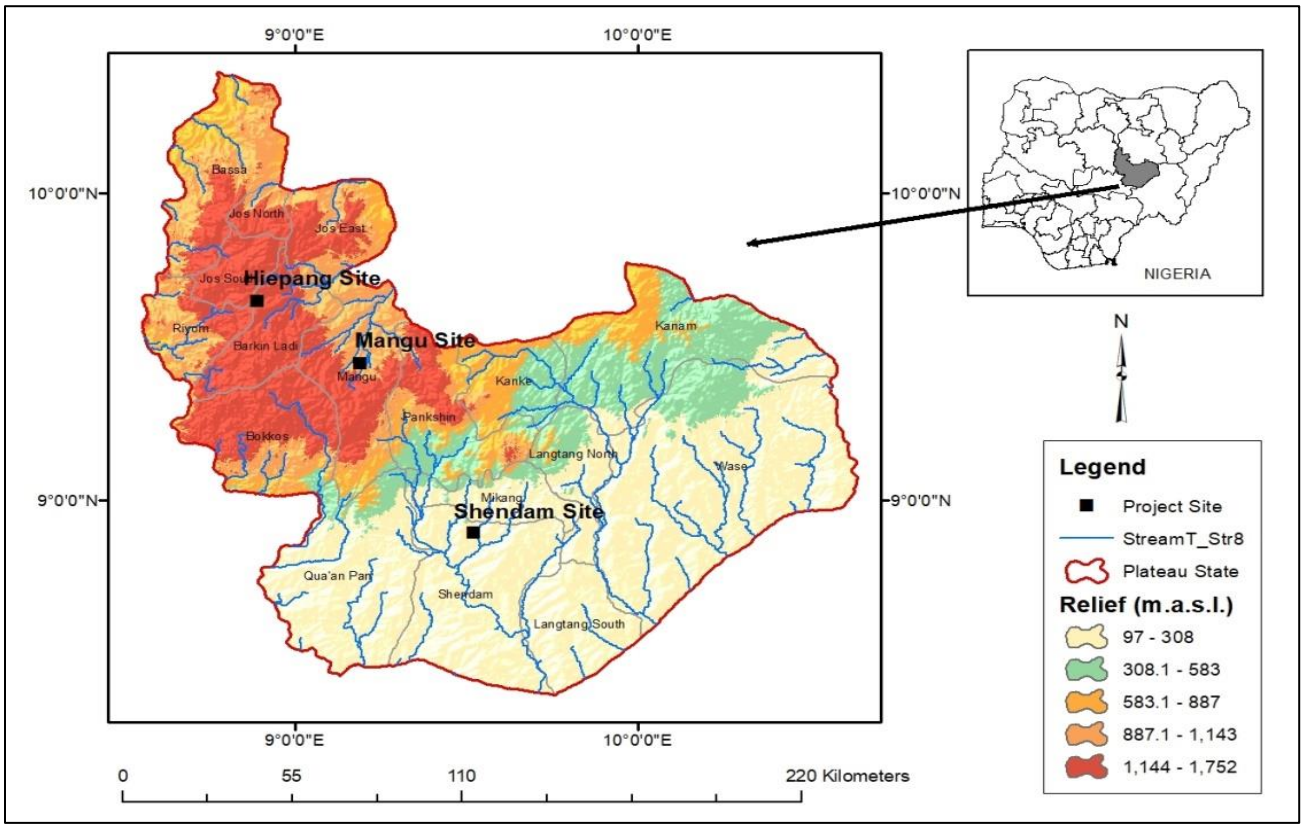

Figure 4.10: The Relief of Plateau State and The Proposed SAPZ Sites

4.7.2 Soil

Soils of the Heipang proposed site are derived from undifferentiated Basement Complex, and younger granitoids and younger basaltic rock material (saprolite) of the area. They commonly are referred to as Ferruginous Soils on Crystalline Acid Rocks as described the Land and Water Development Division, FAO (1964) or Ustisols according to the USDA Soil Classification. They also described as very deep, zonal soils of tropical savanna and bushlands, morphologically characterized by dark red-brown A horizons with weak crumbling structures and B horizons stained by red ferruginous gravel. The soils are chemically acidic with appreciable amounts of silicate clays minerals (mainly kaolinite) and abundant content of the sesquioxides of iron and aluminum which give rise to their lateritic status and hard pan concretions (Duricrustal surfaces) in some parts of the site. Crops cultivated on the soils include maize, ground nut, fornio, rice, yam, potatoes, and vegetables (mostly around the dam site).

4.8 Vegetation

The vegetation of the entire Jos Plateau is typically that of the Guinea Savanna which is characterized by largely grasses and sparsely distributed shrub and tree plant forms. The vegetation characteristic reflects the plants interactions with climate, soil, and the activities of man (Benette 1978). Although the original vegetation cover of the area has been depleted by prolonged anthropogenic activities such prolonged cultivation, fuel wood exploitation and settlement development, little of it remains to this day. The complex Heipang project site is predominantly of grass/herb plan forms which cover a larger proportion of the land area. A gallery forest of shrub/tree forms dominates the stream valley that makes up part of the northern boundary.

On a general note, the Heipang site falls within the Plateau Vegetation Complex as presented by Benette et al., (1978). Common plant species that dominate the site are presented on Table 4.7. Besides, the site is characterized by a sparse distribution of exotic tree plant forms mostly eucalyptus.

The dominance of the site by grass/herb plant forms makes the area suitable for the proposed hub infrastructure construction. However, the establishment of well-designed tree form shelter belts will be required to serve the purposes of wind break and landscaping.

Table 4.7: Dominant Vegetation Forms of the Heipang site

S/No	Scientific Name	Plant form	Family	Common Name
1	*Andropogon pseudapricus*	Grass	*Poaceae*	Beard Grass
2	*Imperata cylindrica*	Grass	*Poaceae*	Spear grass; Cogon Grass
3	*Loudetia simplex*	Grass	*Poaceae*	Russet Grass
4	*Ctenium elegans*	Grass	*Poaceae*	Bata
5	*Microchloa*	Grass	*Poaceae*	Small Grass
6	*Sporobolus fimbriatus*	Grass	*Poaceae*	Dropseed grass
7	*Flyparrhenia rufa*	Grass	*Poaceae*	Giant thatching grass
8	*Paspalum conjugatum*	Grass	*Poaceae*	Buffalo grass
9	*Brachiaria mutica*	Grass	*Poaceae*	Para grass
10	*Syzygium cumini*,	Shrub/tree	*Myrtaceae*	African Olive; Java Plum
11	*Ficus religiosa*	Shrub/tree	*Moraceae*	Sacred fig
12	*Ficus benghalensis*	Shrub/tree	*Moraceae*	Banyan fig
14	*Agave sissalina L.*	Shrub	*Annonaceae*	Century Plant
15	*Bixa orellana L.*	Shrub	*Bixaceae*	Achiote
16	*Carissa edulis Vahl*	Shrub	*Apocynaceae*	Carandas plum
17	*Clerodendrum trichotomum L.*	Shrub	*Lamiaceae*	harlequin glorybower
18	*Annona senegalensis Pers.*	Shrub	*Annonaceae*	African custard
19	*Euphorbia kamerunica Pax*	Shrub	*Eupborbiaceae*	Suru

While the vegetation cover of the upland area of the site has been seriously tempered with and replaced by farmlands, the stream valley areas that form the northern boundary of the site still retain significant gallery forest vegetation cover.

Plate 4.5: Portions of Shrub/Tree Gallery Forest in the Heipang Proposed Site

Source: Field Survey, 2024

4.9 Socio-economic and Health Profile of Host Community

4.9.1 Objectives of the Socio-Economic and Health Impact Assessment Study

The Socio-economic and Health study had the following objectives;

- To obtain relevant secondary socio-economic and health data through conducting literature reviews on the study area and the health sector.
- To undertake field assessment visits to the proposed project area.
- To conduct interviews and discussions with stakeholders in the proposed project area, and obtain primary data, perceptions, concerns and suggestions on potential impact enhancement and mitigation measures.
- To administer questionnaire in the proposed project area and obtain primary data from stakeholders.
- To analyze and interpret data obtained from primary and secondary sources.
- To determine livelihoods and dependence on the natural environment for sustenance in the proposed project area.
- To determine the potential impacts of the proposed project on the socio-economic and health environment in the proposed project area.
- To outline enhancement and mitigation measures for the potential impacts.

4.9.2 Scope of the Study

The socio-economic and health study is focused on Pwomol Heipang and Chit communities in Barkin Ladi LGA, Plateau State.

The socio-economic and health assessment covered demographic characteristics of the LGA, socio-cultural and historical resources, cultural heritage and archaeological resources, political and traditional administrative institutions, and conflict resolution in the Pwomol Heipang and Chit communities, social vices, and security situation in project area. The study included analysis of the quality of life as indicated by quality of housing, availability of facilities and utilities, and the infrastructural framework. Others were land ownership and tenure, employment situation in households, livelihood activities especially exploitation of natural resources for sustenance, income levels and expenditure pattern. Health conditions including available facilities and service, morbidity, nutrition, water and sanitation and disease vectors were studied. It also covered perceptions, concerns and expectations of residents and stakeholders, potential impacts of the proposed project and impact enhancement and mitigation measures.

4.9.3 Methodology

Study Design and Strategy

The study was designed to enable collection of all relevant socio-economic and health data from Pwomol Heipang and Chit communities, Barkin Ladi LGA and Plateau State in general. The strategy adopted had the following activities:

- Conducting literature searches and reviews.
- Design and pretesting of structured questionnaire.
- Determination of the target population and sample size for administering questionnaire.
- Conducting field visits, holding interviews and discussions, and administering questionnaire.
- Authentication, collation, and analysis of data obtained from all the sources.
- Report preparation.

4.9.4 Sampling Process

Purposeful sampling strategies were used to select the study communities base on nearest proximity within five kilometers from the proposed project site, where Pwomol-heipang and Chit villages were selected. A Quota sampling that allows for classifying study population based on the community they live, and subgroups of people within further classified based on neighbourhood in the communities were identified; within which members of social groups and association in the neighbourhood were identified and noted. Each of the groups had their members later clustered into male and female. The number of males and females in the subgroups were proportionally selected according to the determined sample size and were interviewed.

The quota sampling ensures that the sampled population represents key people that characterised the entire population across different socio-economic attributes.

Table 4.8: Selected Study Communities Estimate Population, and Sample Size

Study Communities	Selected Study Communities	* Population (≥18 years)	Sample size	%
Kassa	Pwomol Primary school	1140	59	5.2
Pwomol Primary school				
Tatu village				
Chit Village II	Chit Village II	135	51	4.7
Chit village I	Chit village I	963		
Tapo				
Total		2,238	110	4.9

Source: Population based on Electoral Polling Unit Registered Voters, INEC, 2023

Data from primary and secondary sources including structured questionnaire, discussions, interviews, and observations, published and unpublished documents were used in the study. A structured questionnaire was used to collect information relevant to achieving the study objectives. The questions on the instrument used for data collection were both open-ended and closed-ended questions. The questions are in three main sections. The first asked about the background information of the respondents that include name of locality, gender, age group, educational status, and major occupational. Others include major occupation, monthly income, duration lived at the community, and types of language spoken at the community. The second assesses the existing socio-economic conditions of the study communities such as crops cultivated, available economic

trees, traditional economic activities, social groups and association, and values placed on traditional laws and sacred places. The third section explores the potential socio-economic impact of the proposed new project on the study communities that focuses on knowledge, attitude, perception on the benefits, beneficiaries, and problems and solutions.

4.9.5 Socio-Economics Background Characteristics

The study examines the background information about the study participants and is classified as their demographic and socio-economic attributes as follows:

Demographic Characteristics

This entails basic attributes that describe human populations and their identities that relate to biological or locational status**.** These are the names of their locality, gender, age groups, main languages spoken, social, groups, and duration of stay in the community.

Study Community: Figure 4.11 shows that Pwomol Heipang had a frequency of 59, representing 53.6% study participants and Chit village, 51 (46.4%) of the total respondents.

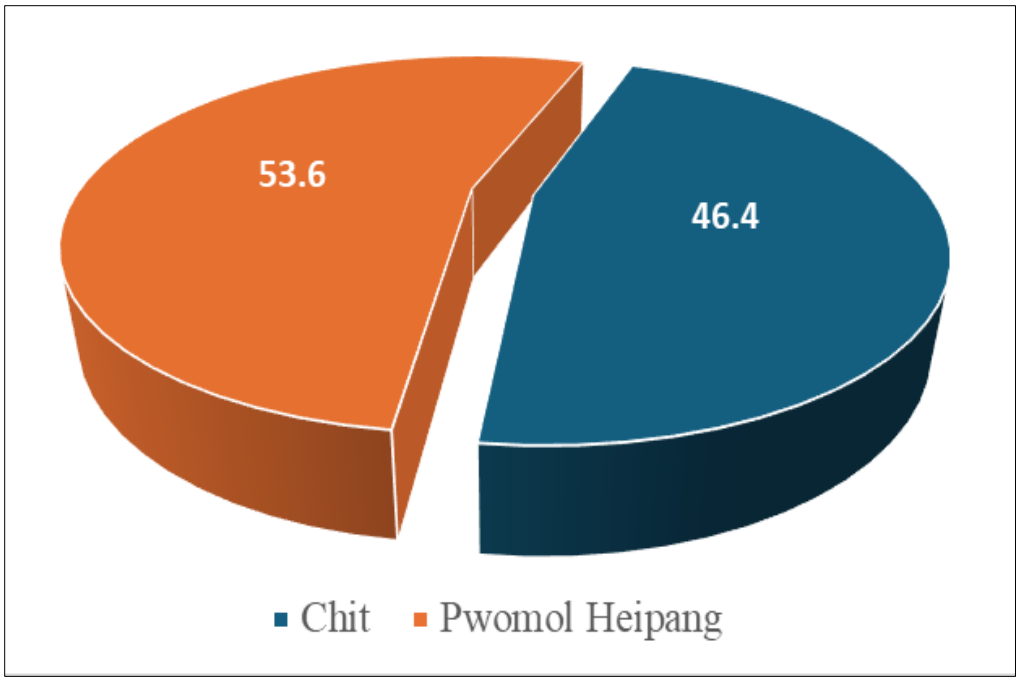

Figure 4.11: Study Participants per Community

Gender

There were 62 females, accounting for 42.7% and 47 males, representing 56.4% of the total respondents as shown in Figure 4.12.

Figure 4.12: Distribution of Gender within the Communities

Age Group

On age distribution, Figure 4.13 shows that there were 42 respondents (38.2%) aged 18-30 years, 27 (24.5%) aged 31-43 years, 25 respondents (22.7%) aged 44-55 years, and 15 respondents (13.6%) were aged 56 years and above.

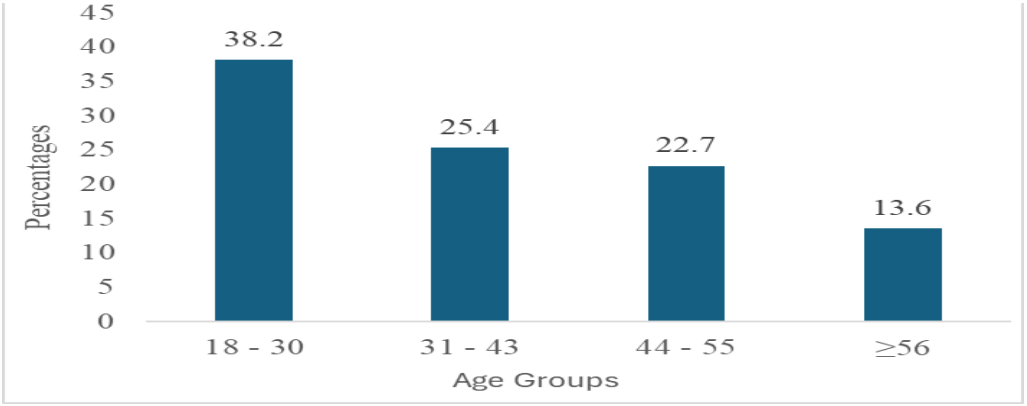

Figure 4.13: Age Distribution of Participant

Languages Spoken

Figure 4.14 shows that the most spoken language in the community is Berom, with all respondents (100%) reporting proficiency in it. Over half (53.6%) can speak English while Hausa is spoken by a 21.8% of the respondents and Mwaghavl is spoken by a small percentage (3.6%) and the less commonly spoken language in the communities. Results imply that the community has diverse

language usage, with some languages being more dominant than others. This diversity in language indicates cultural diversity within the community and the need for language support services or translation resources to facilitate communication in the project sensitisation and mobilisation.

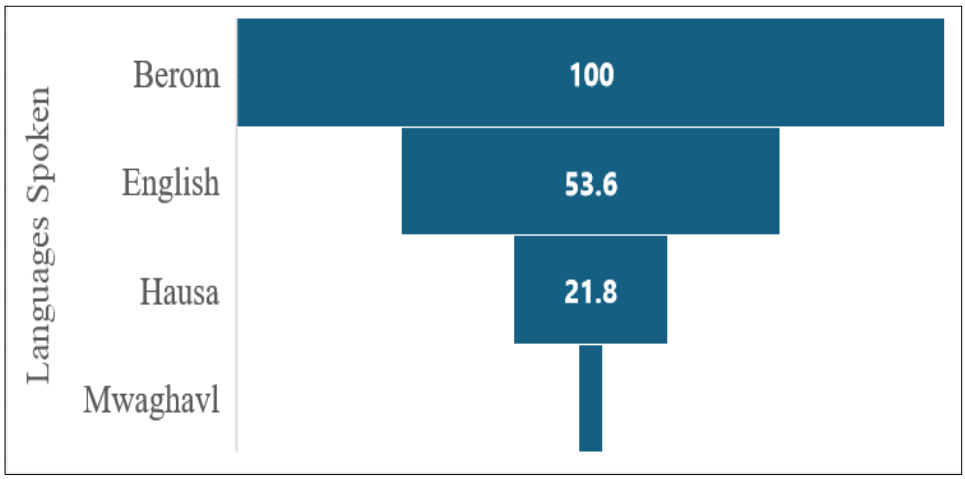

Figure: 4.14: Language Distribution in the communities

Years lived in the community

The majority (80%) of the respondents have lived in the community for 16 years or more. Those who lived in the community for 11-19 years. A smaller proportion (5.5%) of respondents have lived in the community for 6-10 years representing 10.0%. Only a few (4.5%) respondents have lived in the community for 1-5 years. The result implies that a large portion of the community has long-term familiarity and experience with the community, which indicates a stronger sense of belonging and community cohesion (Figure 4.15).

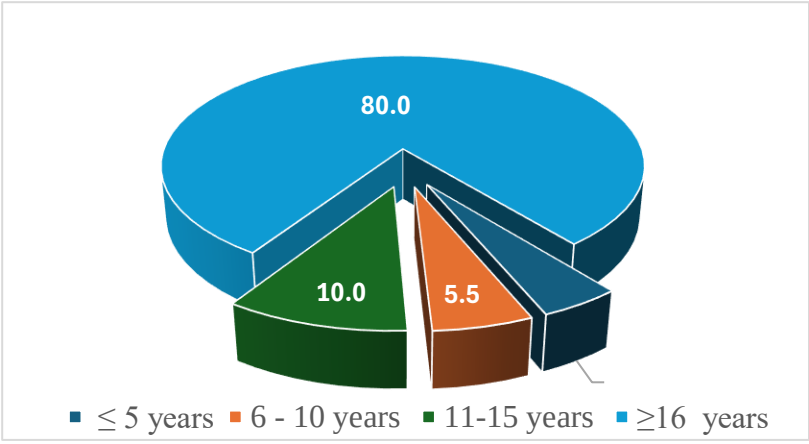

Figure: 4.15: Number of Years respondents Lived in the Communities

Social groups/associations

Figure 4.16 shows the social groups and associations in the study community were dominantly made up of tribal cultural dancers (90.9%), farmers, (86.4%), Youth (82.7%), and women (80.9%). Other groups such as the elderly, traders, hunters, men, and vigilantes were available in the community. The groups suggest the communities relate with one another for support. A supportive attitude is needed for coherence, peaceful coexistence, and social capital for the proposed project.

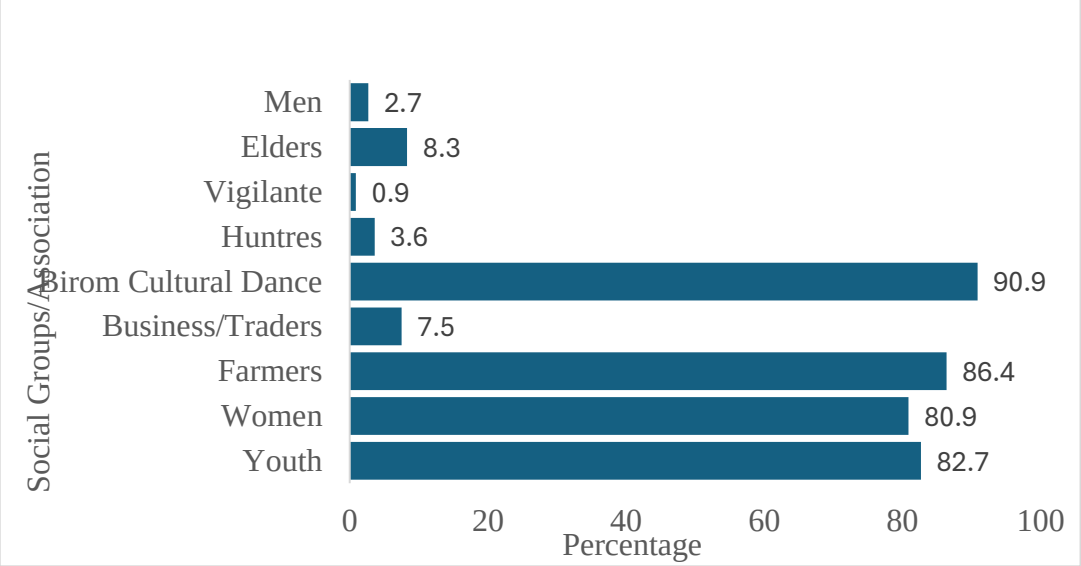

Figure: 4.16: Social Groups and Associations in the Study Communities

4.9.6 Socio-Economic Attributes

The socio-economic characteristics is presented in Table 4.9 which reflects the status of the local people in the community in terms of level of education attended, major occupation engaged, and amount of money earned.

Occupation

The table further shows that in the localities, farming is the most common occupation with 73 (66.3%) people said they engaged in. This implies that a significant portion of the population surveyed are involved in farming. Business was the second common occupation with 26 (23.6%). Those in Civil Service had a small representation of 5 (4.5%).

Monthly Income

The most common income range was between ₦5,000-₦10,000 accounting for 34.5%. This implies the respondents earned low-income range. Furthermore, those earning ₦11,000 - ₦20,000 represent 30.0 %, while 18.22% and 12,7% earned ₦11,000 - ₦ 20,000 and ₦31,000 and above (Table 4.xx).

Educational status

The result on the education of the respondents shows that 41 (32.7%) had secondary school education, 30 (27.3%) primary school education and 24.6% had tertiary education, with the least 11 (10.0%) experienced an informal schooling (see Table 4.9).

Table 4.9: Socio-economic Characteristics of the Study population

Socio-economic Attributes	Frequency (No=100	Percentage
Educational Status		
Informal School	11	10.0
Primary	30	28.2
Secondary	41	37.2
NCE/ND	17	15.5
HND/Degree	10	9.1
Major Occupation		
Farming	73	66.3
Business	26	23.6
Civil Service	5	4.5
Artisans	6	5.5
Monthly Income (in Naira)		
₦ ≤10,000	39	34.5
₦11,000 - ₦20,000	35	30.0
N21,000 - N30,000	21	18.2
N ≥31,000	15	12.7

4.9.7 Socio-Cultural Resources

Historical Background

Barkin Ladi is one of the 17 Local Government Areas (LGA) and situated in the northern Senatorial zone of Plateau State, Nigeria. The LGA has its headquarters in Barkin Ladi town located at 9°32′00″N 8°54′00″E with a land area of 1,032 km². The population of the LGA is estimated at 175,267 in the 2006 census. Barkin Ladi LGA is a subtropical highland climate with an average annual temperature ranging between 18°C (64°F) to 26°C (79°F) and receives an average of 1,200mm of rainfall annually. The rich volcanic soil of the Jos Plateau makes the land fertile and suitable for agriculture. Major crops cultivated include maize, beans, cassava, Irish potatoes, and various fruits such as mango and pear. Farming is the primary occupation for about

66.3% of the population, providing the main source of income and sustenance for many households. In addition to agriculture, the people in the area engages in crafts, hunting, and tapping resource for additional sources of income.

The people in Barkin Ladi value their cultural traditions. Predominantly Berom people, they have a rich cultural heritage characterized by traditional dances, festivals, and a deep respect for spiritual and sacred places. The community strictly observes traditional laws and maintains a strong connection to their ancestral roots. These cultural practices are not only vital for the community's identity but also play a role in social cohesion and stability. Sacred places exist and the adherence to traditional beliefs underscores the importance of cultural sensitivity in any developmental initiative. Any projects or interventions in the area must respect and integrate these cultural aspects to ensure community acceptance and support.

Despite its richness in agricultural and cultural heritage, it faces several challenges involving ethnic and religious conflicts that disrupt social harmony and economic activities. These conflicts often stem from competition over land and resources, exacerbated by ethnic and religious differences. The LGA has inadequate infrastructural facilities such as roads, healthcare facilities, though has Polytechnic, and several secondary and primary schools and other social amenities, yet the overall quality of life need socio-economic interventions due to the subsistence farming and recurring economic shocks, which requires diversification to improved access to markets to enhance the economic resilience of the community.

4.9.7.1 Language and Communication

English is the official language in the state; Hausa is also a common medium of communication and commerce as is the case in most parts of the North and Middle Belt of Nigeria. Plateau state has over forty ethno-linguistic groups. Some of the indigenous ethnic groups in the state are: Berom, Afizere, Amo, Anaguta, Aten, Bijim, Bogghom, Buji, Jipal, Mhiship, Gashish, Jarawa, Jukun, Kadung, Kofyar (comprising Doemak, Kwalla and Mernyang), Montol, Mushere, Ngas, Piapung and Youm.

These ethnic groups are predominantly farmers and have similar cultural and traditional ways of life. People from other parts of country have come to settle in the state; these include the Idoma, Igbo, Yoruba, Ibibio, Annang, Efik, Ijaw, and Bini.

4.9.7.2 Social Structure and Organization

A basic social unit is the family, and everyone is a member of both a nuclear family and an extended family. Individuals are identified by their family names, making the family an important identity in the lives of residents. The nuclear family is a single unit commonly headed by a father or mother with the children as members. Widows and single parents who do not have grown up adult male children head their nuclear families. The extended family incorporates several nuclear families. Members are believed to descend from a common ancestry, which may go back to various generations. The extended family is headed by a male member, usually the oldest male member.

Traditionally, each indigenous member of the community belongs to an age grade. The age grade system recognizes children born within a three-year period as mates. It is managed in such a way that nobody falls into two grades. The age grade system provides cohesion, and it is a vehicle for mobilization especially towards community development. However, the effectiveness of the age grade system has been weakened by increasing urbanization and consequent in-migration of people of different ethnic groups. Among community-based organizations (CBOs) are the Council of Chiefs, the CDC, Women's and Youth groups and the pressure groups.

Socio-cultural groups further social interactions among residents beyond filial relationships. They constitute a very important aspect of the social capital in the community as they are avenues for community development and welfare provisions for their members and the elderly.

4.9.7.3 Institutional Arrangements for Development of the Community

The Local Government Council (LGC) has responsibility for development of infrastructure, and management of public primary schools and primary healthcare, markets and cemeteries in communities in the LGA.

4.9.7.4 Roles of Women and Youth in Community Development

Women and the youth play very important traditional roles in the communities. These roles are advisory, intervention in dispute resolution, welfare, advocacy, and mobilization among others. However, in the case of roles of the women, they are generally subsumed under the men. For instance, their contribution to communal decision making is subordinate to those of the other organs of traditional administration which are all dominated by the men. Women are not traditional rulers, and they are not entrusted with management of family lands. This cultural inhibition is an indication of gender inequality in the community. Despite the inhibition, the Women Group in the community is recognized and respected, and it is expected that every woman, born or married into the community, will join the group.

4.9.7.5 Child Labour

Child labour is one of two most common forms of child abuse in Nigeria. The other is domestic violence, where the child is subjected to physical violence and deprivation at home. While the latter was not investigated during the study, it was noted that children hawk different items on the roads, especially sachet water during normal school hours. Some stand around road junctions. Many of those who hawk represent truancy from school while those who clean car screens are children are out of school. These children may turn out to be permanently deprived of schooling and attaining any appreciable level of training.

4.9.7.6 Natural Resources and Their Exploitation for Sustenance

The land is the major natural resource in the communities. They provided farmlands which residents cultivated to support their farming livelihood in the past and they also provided space and materials for housing, infrastructural and industrial development. Housing, infrastructural and industrial development have taken up the land and replaced other natural resources like forests and wetlands which were traditionally exploited for livelihood in these communities. Traditional farmlands, natural forests and even wetlands have been used for housing, infrastructural and industrial development. The land is still a much-exploited resource for livelihood and other developments.

4.9.7.7 Environmental Problems

The community experiences erosion from rainfall as topsoil is washed away from the lands during rainfall. Erosion affects some of the roads and streets. Erosion worsens annually during the wet season when rainfall is heavy and in areas where there is very little vegetation to reduce the speed of the runoff. There is also occasional flooding along some of the roads during heavy downpour. Generally, the problems of erosion and flooding have led to considerable loss of land and residents have not been able to muster the resources needed to tackle them.

4.9.7.8 Natural Resource Conservation Practices

With the use of lands, forests and wetlands for housing, infrastructural and industrial development there are no clear resource conservation practices in the community. Shifting cultivation and its attendant bush fallow system used to be a major traditional natural resource conservation practice in the community when farming was the major livelihood. The practice of leaving farmlands fallow for several years allowed them to regenerate naturally. Conservation practices serve to protect valuable natural resources from extensive exploitation and allow for the occurrence of natural regeneration processes.

4.9.7.9 Land Ownership and Tenure

The Land Use Act of 1978 gave ownership of all lands to the government, and it provides the framework for payment of compensation for land acquisition for development purposes in Nigeria. The provision that gives land ownership to government has been challenged across communities in Nigeria. The rejection stems mostly from the socio-cultural significance of lands. Therefore, despite the law, traditional land ownership practices still prevail. Land in the communities are owned by families. Families allocate, lease, and sell parts of their lands to individuals. Such lands can be put to any use including housing, infrastructural and industrial development. Family lands are managed by males in the family.

The major land uses in the community include farming, housing, and infrastructural development. These account for more than 90% of land use. They include houses used for residence, commercial and other business purposes. Infrastructural use is represented by lands used for roads, public schools, and other public infrastructural amenities.

4.9.7.10 Employment Situation in Households

Employment and unemployment are usually considered among the population aged 15-64years. Among this group of residents several were employed in various income generating activities in the public sector, organized private sector and informal sector. The employments are predominantly in micro and small-scale primary production activities and commerce in the informal sector. Unemployed residents are those among the 15-64years age group that have actively been looking for work but have not been able to secure any in the last six months preceding the EIA study. About 45.0% of households had unemployed members. Unemployment has been on the increase in Nigeria in the last decade. In a study, the National Bureau of Statistics (NBS, 2011), indicated that the highest rate of unemployment in urban communities was 33.5%, occurring among females aged between 15 and 24, whose only education is primary level.

In 2014, the International Labour Organization (ILO) estimated an unemployment rate of 10.0% in Nigeria, This Day Newspaper 23 July 2014. At that time ILO noted that Nigeria's problem was more of underemployment than unemployment. In the third quarter of 2017, the NBS (2018) indicated an unemployment rate of 18.8% and underemployment of 21.2% making the combined unemployment and underemployment rate 40.0%. Employment in the study area is present in the form of residents doing jobs that are less than their qualifications for instance university graduates working as daily paid labour at a construction site. It is hoped that the proposed project will provide direct and indirect employment and livelihood opportunities for some residents.

4.9.7.11 Crops Cultivated

Figure 4.17 shows Maize was the most cultivated crop reported by 93 (84.5%) respondents, followed by Beans reported by 89.1%, Cassava by 8.6.4%. Those who mentioned Guinea corn, Soya Beans, Irish Potatoes, and sweet potatoes were also higher in proportion reported to be cultivated crops. This suggests that maize, Beans, Cassava, are among staple crops in the area and play a significant role in the local agriculture sector, food security and raw material for the proposed agricultural transformation industry.

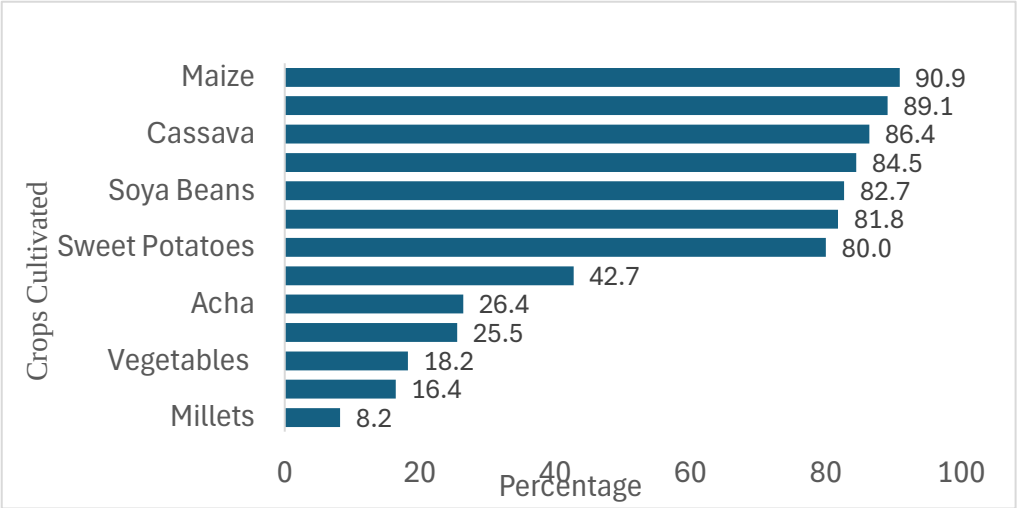

Figure 4.17: Crops Cultivated in the Communities

4.9.7.12 Economic Trees

Figure 4.18 reveal Mango was reported by 84.5% respondents. Mango trees provide both nutritional and economic benefits to the local population. Pear was the next plant tree mentioned by two quarts of the study participant (66.4%), then Guava, Pawpaw, and orange followed as top reported economic trees. Though Eucalyptus tree was the least mentioned, field observation reveals the plant appears to be on extinct, as only few houses has it and used for fencing the house.

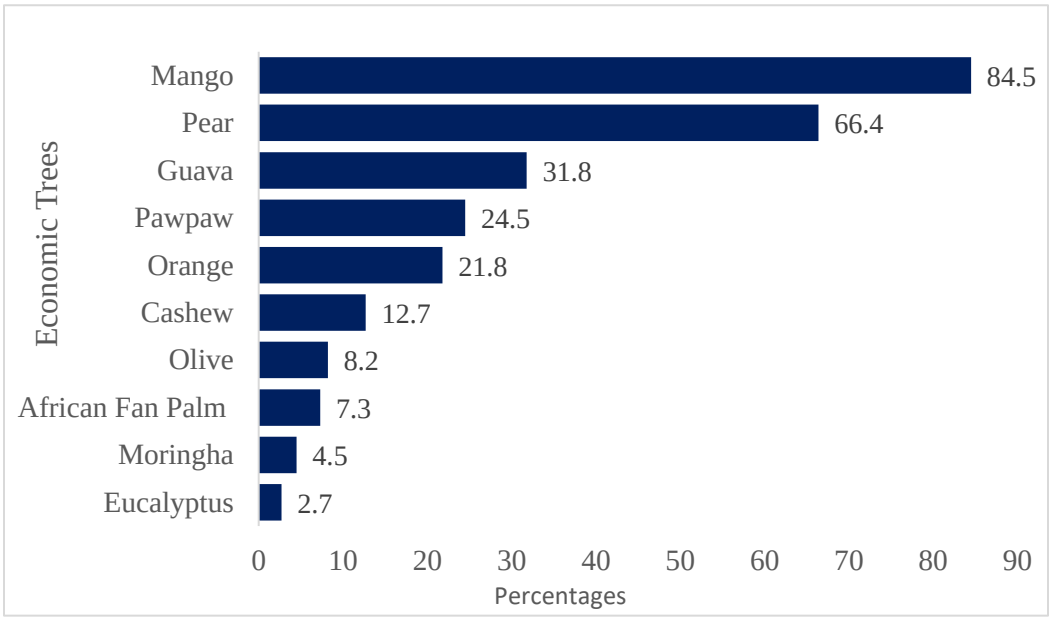

Figure 4.18: Economic Trees in the Communities

4.9.7.13 Traditional Economic Activity

Natural resource tapping was reported by 63.8% respondents indicating the importance of utilizing natural resources for economic purposes such as tapping trees for sap or resin in the area, then Traditional Craft and wild fruits gathering were reported by 61.8% respondents simultaneously which could have implications for biodiversity conservation and sustainable resource management. The traditional economic affectivities could supplement sources of income and food for the local population.

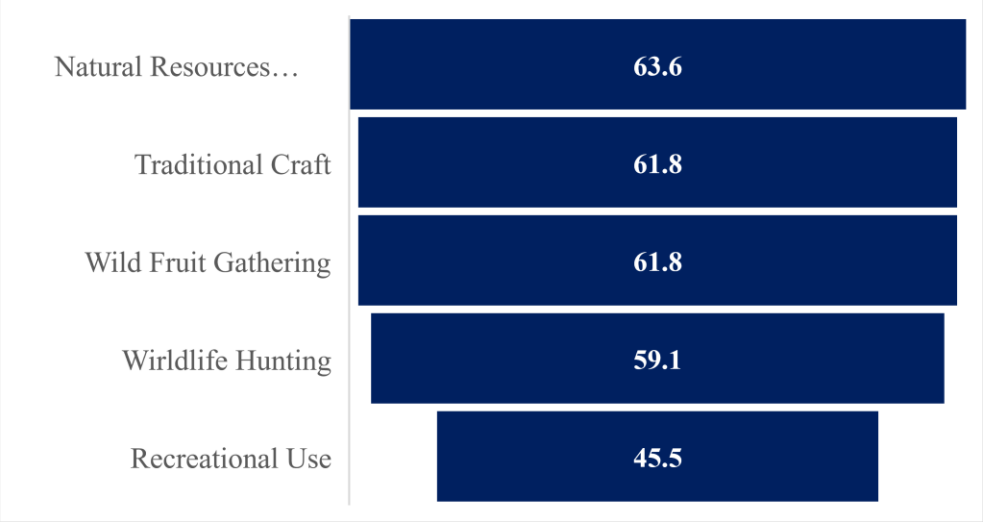

Figure 4.19: Traditional Economic Activities in the Communities

4.9.7.14 Social Amenities

The results show the different social amenities observed in the study area. Based on the data, the most common (92.7%) reported social amenity in the area is school that caters to the educational needs of the community. The next are health care centre (88.2%) and Borehole (80.9%). Boreholes provide a source of clean and safe drinking water and are important for the community's water supply. The low response on the police station, airport, and railways may be because the local communities do not have access to using them.

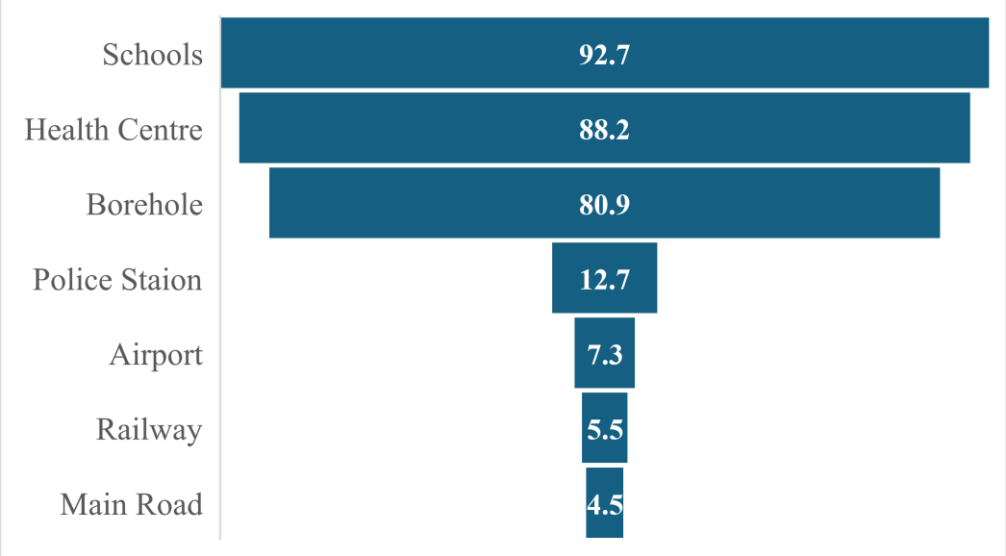

Figure 4.20: Social Amenities in the Communities

Housing Patterns and Conditions

The study communities near the Agricultural Transformation Centre to serve as an Agri-industrial Hub in Heipang had their housing pattern and conditions assessed to understand their implications on the proposed project. Pwomol and Chit were the study communities. Pwomol is clustered and planned. a small village with wide streets and minor roads through the community. It is located opposite the ATC Hub proposed site with inhabitants predominantly farming. the housing materials consist of mud and cement blocks for buildings and roofing materials are largely zinc (Plate 4). Chit village is two kilometres away and located close to the Jos - Barkin Ladi road.

Plate 4.6: Housing Pattern in the Study Area

4.9.8 Health Characteristics

This section reviews the relevant baseline information concerning health issues in the project area. It evaluates the demographic, social, biological, economic, and environmental determinants of health with reference to the project area. Although, it relied more on pieces of information collected on health and other relevant issues during the baseline survey, it nevertheless took cognizance of other relevant pertinent pieces of information from literature and other sources to provide a comprehensive picture.

The results of research and interviews indicate that majority of residents enjoy 'good' health status. The most common health problem in the communities is malaria. Other health problems include diarrhea and typhoid.

4.9.10 Perceived Views on the Proposed Project

Large proportion of the respondents (93.6%) reported to observing traditional laws strictly, and 74.5% still have spiritual/sacred places in their communities. The positions of the community on traditional beliefs should be handled with care to limit the tendency of being resistant to modernization, which industrialization brings.

On whether the local community heard about the new project coming to their community, 68.2% reported being aware. While 69.1% of them said, there is need to create more awareness through organizing stakeholder's workshops for the proposed project. As such, their excitement and curiosity about the project and want to be involved in the implementation process. This suggests that the local communities are expectant and interested in shaping their own development and ensuring their needs and perspectives are considered. Hence, about half (47.3%) of the respondents and nearly one-quarter (31.8%) said their communities are happy and thankful towards the new development project.

Table 4.10: Perceived View on the Proposed Industrial Project

Views on the Proposed Project	Frequency (No=110	Percentage
Traditional Laws Adhered to Strictly	103	93.6
Spiritual/Sacred Places Exist	82	74.5
Knows about the New Project	75	68.2
Need Awareness Workshop on the Project	76	69.1
Perceived Stakeholder on the New Project	78	70.9
Be Involved in Project Development	96	87.3
Perceived Attitudes on the New Projects		
Happiness	52	47.3
Friendly	6	5.5
Thankful	35	31.8
Good	1	0.9
Optimistic	16	14.5

4.9.11 Stakeholders Consultation and Integration in Studies

Consultation is a major feature of the socio- economic component of the EIA process and remains continuous for any project and which in this case incorporated all individuals in the communities that may be directly or indirectly affected by the project. Field consultations and discussions were held with community members and residents, women, and youth. This was part of an integration programme consisting of interactions and consultations with community residents and stakeholders, project disclosure and advocacy.

Project disclosure and advocacy serves as a tool to inform and secure permission and co-operation for the study all attempted to record the major concerns and views of all stakeholders. It shall also help to minimize the potential conflicts that could arise during project implementation while the meetings served to elicit information from residents as a major source of primary data for the study.

The overall objectives of the Consultation for the proposed project are to:

- Identify key stakeholders, provide information to them, and obtain input that provides an understanding of their concerns.
- Avoid conflict by addressing issues promptly - i.e. concerns to be aired and addressed before escalating into conflict (vandalism, blockage, sabotage or hostages);

- Ensure that any fear or apprehension about the nature, scale, and effects of the development have been fully addressed.
- Avoid any misunderstanding about the development.
- Learn through local knowledge and understanding.
- Reducing risks and costs by drawing upon stakeholders' knowledge and identifying partnerships.
- Creating a network for monitoring emerging issues and sensing of new and potential issues.
- Facilitating expedient granting of licenses, approvals, and avoiding litigation, which restricts our license to operate.
- Lowering costs by avoiding late changes to design or operational practices.
- Building trust and goodwill such that in the event of a major incident or crisis, external stakeholders are more understanding.

Plate 4.7a: Cross Section of Consultation with Host Communities

Plate 4.7b: Cross Section of Consultation with Host Communities

CHAPTER FIVE

POTENTIAL AND ASSOCIATED AND IMPACTS

5.1 Introduction

This chapter undertakes an evaluation of the biophysical, health, and socioeconomic implications across all project phases, including pre-construction, construction, operation, and decommissioning. It presents the findings from a comprehensive assessment of the potential environmental impacts associated with the proposed SAPZ - AIH project to be situated and operated within the Barkin Ladi Local Government Area (LGA) of Plateau State. The assessment considers both normal operational impacts and potential effects arising from abnormal occurrences.

The identified impacts are categorized as either threats or opportunities to human and environmental wellbeing. Project activities and their environmental interfaces encompass a wide array of concerns, such as air and water pollution, impacts on employment, and land use change, among others. These concerns have been thoroughly examined to determine the potential impacts of the proposed project on environmental receptors. This section outlines the overall approach to impact assessment and mitigation. The impact evaluation methodology is based on sectoral guidelines provided by FMEnv. It involves:

- Screening of potential impacts associated with each project phase using a Risk Assessment Matrix.
- Detailed evaluation of impact-producing factors within each project phase, with the significance of potential impacts quantified using consistent criteria.

The assessment approach involves aligning the proposed project's activities with the existing environmental components, identifying, and evaluating potential changes in the environment resulting from these interactions, and proposing mitigation measures to address such changes. At this stage of the Environmental Impact Assessment (EIA), both negative and positive impacts of the proposed SAPZ – AIH, Heipang project on the existing environment have been identified. Various references, including the EIA Procedural Guidelines, the ISO 14001 approach, and the Hazard and Effect Management Process (HEMP), were utilized in the identification process. The Risk Assessment Matrix (RAM) was employed to determine risks posed by identified potential impacts and to propose appropriate mitigation measures. In predicting impacts, a practical 'worst-case scenario' approach was utilized to assess extreme effects, while a 'consensus of opinions' method was employed to determine the importance of affected environmental components.

Evaluation of impacts was conducted using specific criteria such as legal/regulatory requirements, magnitude of impact, risk posed, public perception, and importance of affected environmental components. This section of the report presents the outcomes of the identification and evaluation processes.

5.2 Impact Methodology Description

Figure 5.1 below depicts the steps taken in identifying, assessing, and evaluating the potential and associated impacts of the proposed project.

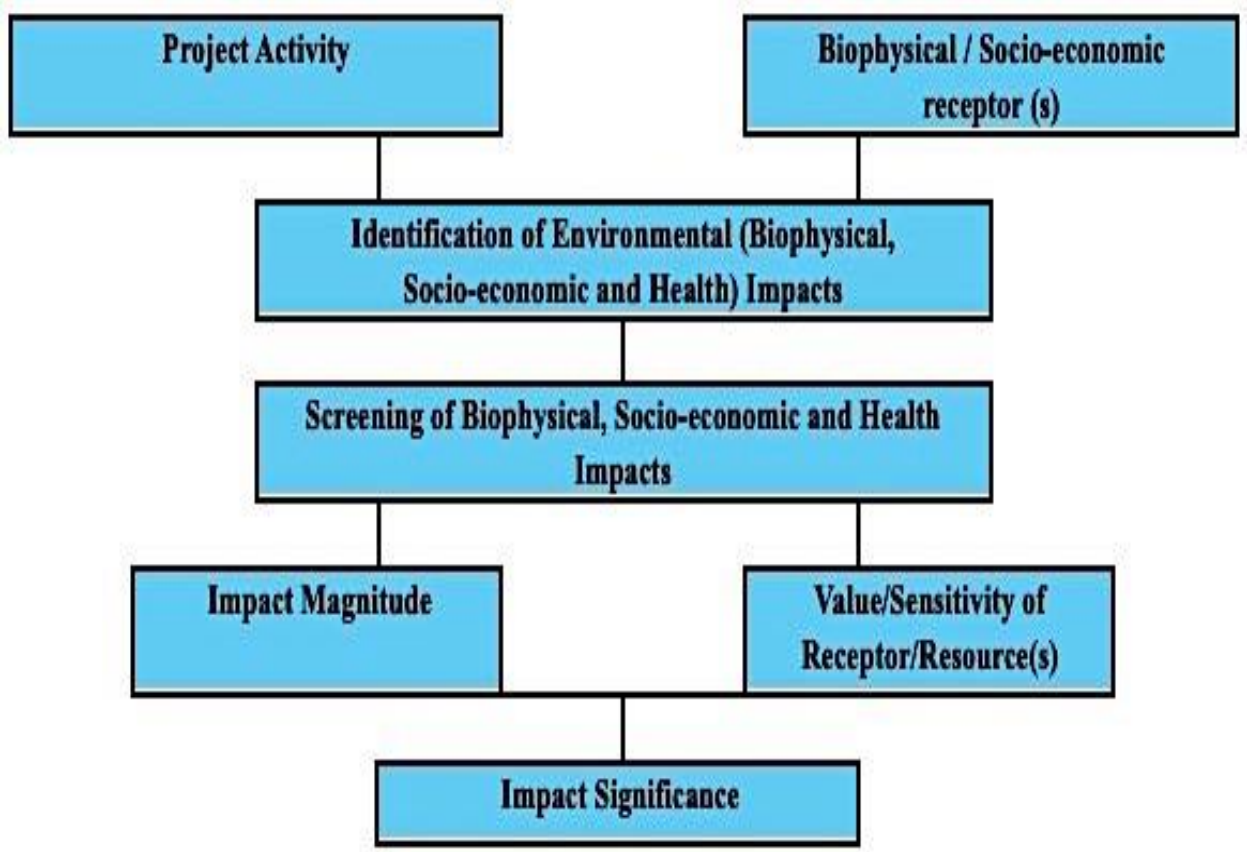

Figure 5.1: Impact Methodology Overview

5.2.1 Environmental and Social Indicators

The activities outlined in section three of this Environmental Impact Assessment (EIA) for the SAPZ – AIH, Heipang project will interact with various environmental components, with their impacts monitored through specific indicators. These indicators encompass:

a. Noise and Vibrations

- Measurement Units: Decibels (dB).
- Indicators**:**

- Baseline Noise Levels: Initial measurements to understand the pre-project noise levels.
- Construction Noise: Monitoring during construction phases to ensure compliance with noise regulations.
- Operational Noise: Assessment of noise during the operational phase of the project to gauge ongoing impact.
- Vibration Levels: Measurement of ground and structural vibrations, particularly near sensitive receptors like residential areas or wildlife habitats.

b. Ecological Impacts

Floral Abundance and Diversity:

- Species Inventory: Identification and cataloging of edible plants and weeds in the project area.
- Vegetation Cover: Measurement of changes in plant cover and health.
- Invasive Species: Monitoring the presence and spread of non-native plants.

Fauna Abundance and Diversity:

- Species Inventory: Identification of small reptiles, insects, and other fauna.
- Population Monitoring: Tracking changes in population sizes and health of species.
- Habitat Quality: Assessment of habitat conditions and suitability for local wildlife.

c. Hydrology and Water Quality

Surface Water and Groundwater:

- Dissolved and Suspended Solids: Measurement to assess water clarity and pollution levels.
- pH Levels: Monitoring to ensure water remains within safe limits for aquatic life and human use.
- Biochemical Oxygen Demand (BOD): Evaluation of organic pollution by measuring oxygen consumption.
- Chemical Oxygen Demand (COD): Measurement of total oxygen required to oxidize both organic and inorganic matter.
- Turbidity: Assessment of water clarity, indicating the presence of suspended particles.
- Toxicity: Testing for the presence of harmful substances.
- Heavy Metals: Analysis for metals like lead, mercury, and cadmium that can have severe health impacts.
- Microbial Loads: Checking for pathogens and indicator organisms such as coliform bacteria.

d. Soil

Type and Composition:

- Soil Type Classification: Identification of soil types based on texture and structure.
- Physicochemical Properties: Analysis of soil pH, nutrient content, organic matter, and moisture levels.
- Microbial Composition: Assessment of soil microbial communities and their health.
- Particle Size Distribution: Measurement of the proportions of sand, silt, and clay to understand soil texture.

e. Socio-Economic and Health Impacts

Community Needs and Concerns:

- Stakeholder Engagement: Regular consultations with host communities and third-party stakeholders to address concerns.
- Impact Assessments: Evaluating the social impact of the project on local communities.

Population and Ethnicity:

- Demographic Surveys: Collecting data on community population and ethnic composition.
- Cultural Sensitivity: Ensuring project activities are respectful of local customs and traditions.

Community Relations:

- Conflict Resolution: Mechanisms to address and resolve disputes arising from project activities.
- Community Involvement: Involving local communities in decision-making processes.

Livelihood Activities:

- Employment Opportunities: Monitoring job creation and ensuring fair employment practices.
- Income Levels: Assessing changes in community income levels as a result of the project.

Health Facilities and Risks:

- Healthcare Access: Evaluating the availability and quality of health services.
- Health Risks: Identifying potential health risks associated with the project and mitigation measures.

Waste Streams and Sanitation:

- Waste Management Practices: Assessment of waste handling, treatment, and disposal methods.
- Sanitation Facilities: Availability and condition of sanitation infrastructure.

Land Use:

- Land Use Changes: Monitoring changes in land use patterns and their impacts.
- Zoning Compliance: Ensuring the project adheres to local land use regulations.

Access to Electricity and Infrastructure:

- Infrastructure Development: Assessment of improvements in infrastructure such as roads, transport, and electricity access.
- Household Utilities: Monitoring access to essential services like water and electricity.

Climate Change Factors:

- Carbon Footprint: Measurement of greenhouse gas emissions associated with the project.
- Climate Resilience: Assessment of the project's ability to withstand climate change impacts.

These indicators are essential for ensuring that the SAPZ – AIH, Heipang project is conducted responsibly, with minimal adverse impacts on the environment and local communities. Monitoring these indicators will help in making informed decisions and implementing necessary mitigation measures.

5.2.2 Impact Identification and Characterization Technique

Impact identification is a crucial process that ensures the comprehensive identification and consideration of all potentially significant impacts during project design and implementation. These impacts are categorized into two types: positive and negative. Assessment of these impacts occurs at different stages of the project's life cycle, encompassing mobilization/construction, operation, and decommissioning phases. To assess the overall significance of the impacts, the adopted techniques consider factors such as the nature, type, and reversibility of the impact, the magnitude of the change, and the current status and sensitivity of the resource/receptor. This process is illustrated in Figure 5.2.

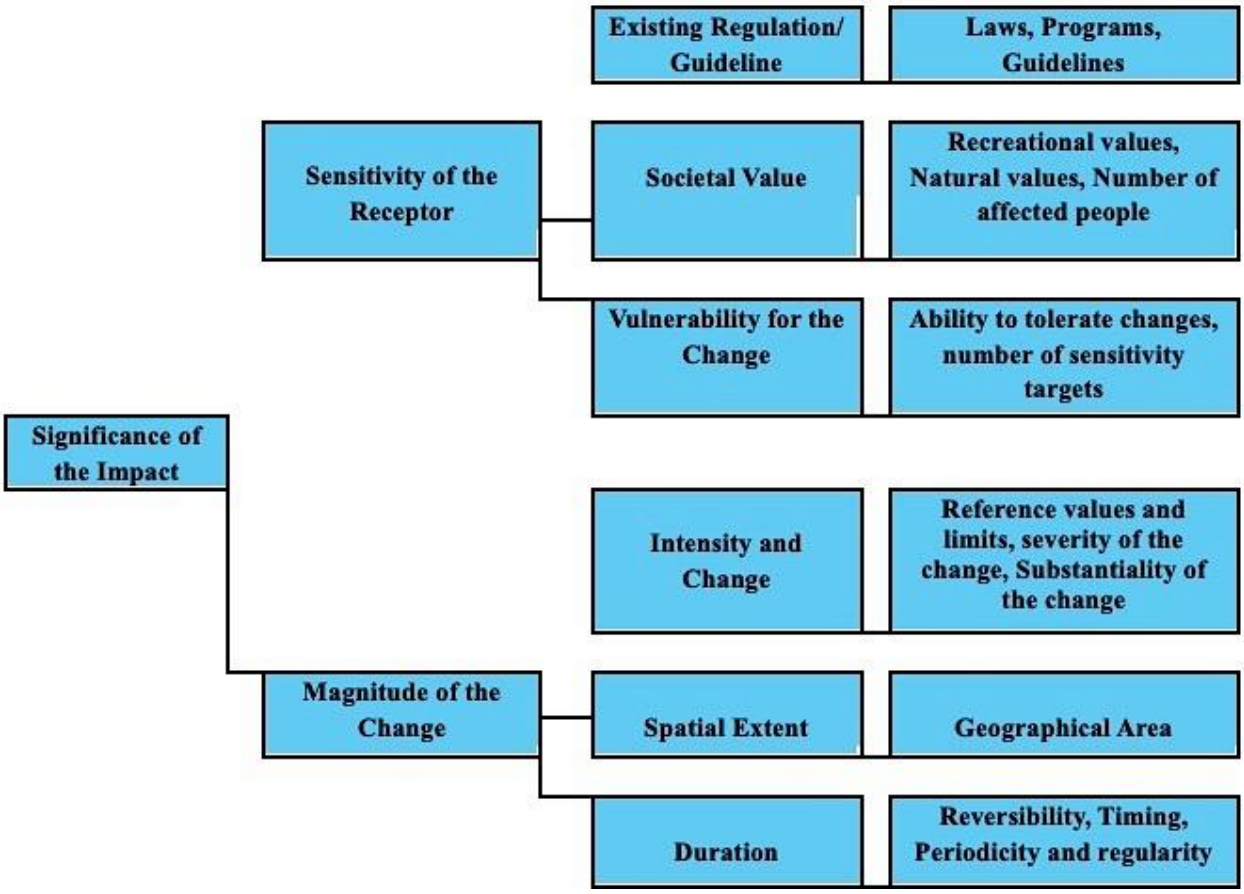

Figure 5.2: Impact Characterization

This involves the identification of the current baseline environmental, social, and project subcomponents that are expected to be affected by the proposed project. The identified impacts are categorized based on their reversibility, directness, temporality (short or long term), permanence, temporariness, and cumulative nature, among other factors.

Table 5.1: Impact Descriptions

NATURE OF IMPACTS	
Positive Impacts	These are significant benefits that result from an improvement to the baseline or the inclusion of new, desirable factor.
Negative Impacts	These are negative consequences caused by an antagonistic change from the baseline or introduction of a new, undesirable factor.
Direct Impacts	These are inevitable consequences that are directly related to the project's proposed activities.
Indirect Impacts	These are the changes that are less obvious, or impacts are further away from the impact source.
Cumulative Impacts	Impacts resulting from the interaction of project components or activities with other activities in past, concurrently, or in the future.
Residual Impacts	These are the effects that persist even after mitigation measures have been implemented.
REVERSIBILITY / IRREVERSIBILITY	
Reversible Impacts	These are impacts that do not cause permanent change to the components of the environment.
Irreversible Impacts	These impacts cause permanent impairment to the environmental component of the area.
DURATION OF IMPACTS	
Long Term	Impacts that will continue for the life of the Project, but cease when the project stops operating
Short term	Short term impacts are predicted to last only for a limited period or because of mitigation measures and natural recovery
On-site	These are limited to the project site

5.2.3 Determination of Impact Significance

Determination of impact significance is based on two key criteria namely;

- Impact Significance Criteria
- Impact likelihood Criteria

Table 5.2: Impact Significance Criteria

CONSEQUENCE LEVEL	SIGNIFICANCE CRITERIA
Major (3)	**Workers Health and Safety:** one or more fatalities or life-threatening injuries/illness. **Environmental and Social**: widespread modification or extraordinary severity in physical environment or economic resources or social structure lasting more than one year, with an area extent of impact > 1 percent of study area.
Moderate (2)	**Workers Health and Safety:** injury requiring medical attention, or illness requiring long-term medical care or > 2 lost tie instances for same or recurring incident/illness during phase of work. **Environmental and Social:** local modification of measurable severity in physical environment or economic resources, lasting form a few months up to one year before recovery, with an area extent of impact extending from 01 to 1 percent of study area; or more widespread modification of lesser severity.
Minor (1)	**Workers Health and Safety:** 1-2 lost time instances for same or recurring illness/injury. **Environmental and Safety**: localized, relatively isolated change in physical environment or economic resources, lasting only a few days to a few months before recovery, with no observable residual effects; and with an area extending from 0.01 to 0.1 percent of study area; impacts less significant than exerted by nature.
Negligible (0)	**Workers Health and Safety**: Negligible first-aid case (no lost time) or near miss. **Environmental and Social**: Little or no change in physical environment, even temporarily, conditions consistent with background conditions.

Table 5.3: Impact likelihood Criteria

CONSEQUENCE LEVEL	SIGNIFICANCE CRITERIA
Probable (3)	Impact or event can reasonably be expected to result from project, occur routinely for similar operations.
Occasional (2)	The Impact or event has occurred in similar operations in this country or conditions could allow the impact/event to reoccur.
Seldom (1)	The impact or event has occurred once or twice in the company/industry, but conditions in this program are unlikely to allow the impact/event to occur.
Improbable (0)	The impact or event has never occurred.

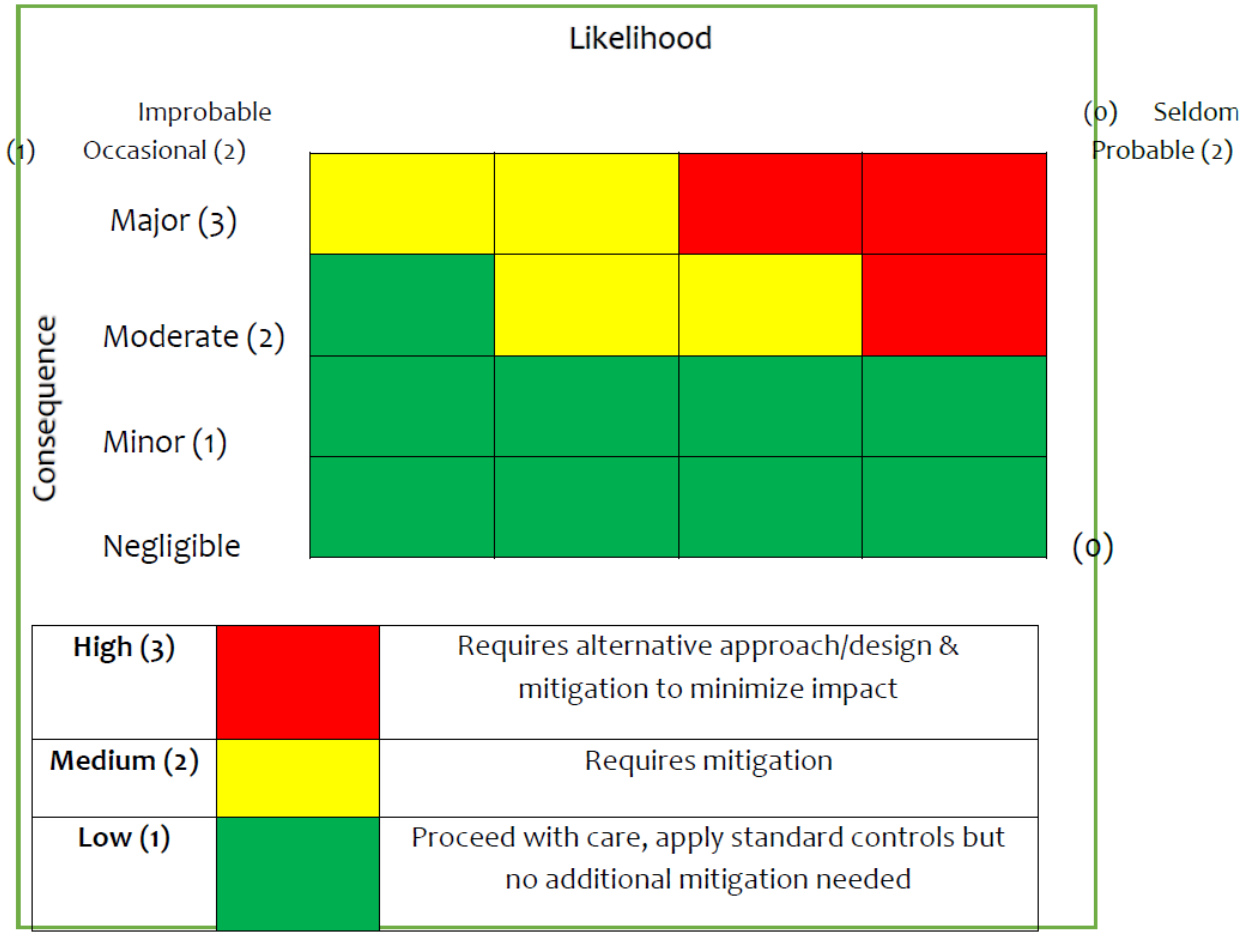

Figure 5.3: Impact Evaluation Matrix

5.3 Impact Methodology Description

The Impact Methodology Description provides a structured framework for assessing and evaluating the potential environmental and social impacts of proposed projects. This document outlines the methodologies, criteria, and tools utilized in conducting the Environmental and Social Impact Assessment (ESIA). The primary goal is to identify, predict, and mitigate adverse impacts while maximizing positive outcomes. The methodology overview includes:

Baseline Data Collection:

The assessment begins with comprehensive data collection to establish baseline conditions of the project area. This includes gathering information on environmental, social, economic, and cultural aspects through field surveys, interviews, and literature reviews.

Impact Identification:
Utilizing the collected baseline data, potential impacts associated with the project are identified. These impacts are categorized into environmental (e.g., air quality, water quality, biodiversity), social (e.g., community displacement, cultural heritage), and economic (e.g., employment opportunities, income generation).

Impact Prediction:
Various tools and models are employed to predict the magnitude, extent, and significance of identified impacts. Techniques such as Geographic Information Systems (GIS), environmental modeling, and stakeholder consultations are utilized to forecast potential impacts under different scenarios.

Impact Assessment:
Impacts are assessed based on predetermined criteria including severity, duration, reversibility, and spatial extent. Qualitative and quantitative methods are employed to evaluate both positive and negative impacts, considering their significance on the affected environment and communities.

Risk Assessment:
Risks associated with project activities are identified and analyzed, considering the likelihood and potential consequences of adverse events. This includes assessing risks related to natural hazards, project operations, and socio-economic factors.

Mitigation and Management Measures:
Based on the identified impacts and risks, appropriate mitigation and management measures will be developed to avoid, minimize, or compensate for adverse effects. These measures aim to enhance the AIH project sustainability and promote environmental and social responsibility.

Monitoring and Evaluation:
A monitoring and evaluation plan will be established to track the implementation of mitigation measures and assess the effectiveness of impact management strategies. Regular monitoring ensures compliance with regulatory requirements and enables adaptive management based on real-time data and feedback.

5.4 Impact Severity and Profiling

Table 5.4 illustrates the potential impacts and receptors throughout all stages/phases of project execution. It outlines the sources of impacts/risk, affected resources, intensity, scope, duration, consequence level and score, likelihood level and scope, as well as significance and residual impacts. These parameters facilitate the assessment of impact severity and the profiling of project activities.

Table 5.4: Summary of Key Impacts and Receptors for all Development Phases

Pre-Construction Phase				
Project Activity	**Affected Resource / Outcome**	**Identified Impact**	**Scope**	**Impact Significance**
Land-take and acquisition	Land Loss	Alteration of population characteristics if previous owners of acquired lands relocate to get farmlands elsewhere, leading to alteration of population structure.	Localized	Moderate
	Livelihood Loss	Livelihood that would normally result from tilling the land for agriculture would be lost, resulting in lower living standards for affected people.	Localized	High
	Conflict	Conflicts could occur if compensation for acquired land is not properly handled.	Localized	Medium
	Air Quality	Increased suspended particulate in ambient air and degradation of ambient air quality by emission from construction machinery.	Localized	High
	Surface	Due to the project site's close proximity to surface water, surface water impacts may result from site clearing and preparation activities. During site clearing, runoff from cleared areas, especially if conducted during the rainy season, could carry sand and clay/silt	Dispersed	High

Site clearing and preparation	and Groundwater	particles into the water, increasing turbidity. Additionally, if vegetal materials from clearing are transported into the surface water, it could elevate organic matter levels, leading to increased biochemical oxygen demand (BOD) and heterotrophic microbe populations. Furthermore, waste materials such as domestic and sanitary waste from on-site workers, as well as leaks or spills of lube and fuel from equipment and machinery, could also contaminate/pollute the surface water.		
	Soil	The key impacts of site clearing and preparation on soil is denudation and subsequent exposure to erosion	Localized	Medium
	Vegetation and Wildlife	Loss of vegetation and migration of wildlife from the area, leading to alteration of species composition and abundance	Dispersed	High
	Human Resources and Influx	Influx of job seekers into the area will lead to an alteration of population characteristics in the project area	Dispersed	Moderate
	Waste Generation	Potential soil and /or water contamination form mishandling of generated solid and liquid wastes, and construction waste.	Dispersed	High
	Health	Negative health effects on health of project workers and host communities by emissions and dust released from site clearing and preparation activities	Localized	High
	Conflict	Conflicts may arise during site clearing and preparation activities	Localized	Medium

		due to inadequate consultations and/or perceived inequalities in employment		
Construction Phase				
Mobilization of materials, equipment and men to site	Surface and Groundwater	Due to the project site's close proximity to surface water, potential impacts may arise from waste generated by workers on-site. This waste includes spent lube oils from vehicles and cranes. Additionally, sanitary waste from on-site workers could result in the introduction of heterotrophic microbes into the surface water. Improper disposal of food cans and tins may also lead to heavy metal contamination of the water.	Dispersed	High
	Soil	Heavy duty trucks used for mobilization could cause soil compaction, leading to structural changes. Wastes from construction camps could also cause soil contamination	Localized	Medium
	Vegetation and Wildlife Loss	Loss of vegetation during setting up of construction camp as well as scaring wildlife species away with noise from vehicles and equipment used during construction.	Dispersed	Medium
	Air Quality and Noise	Emissions and noise from vehicles, machinery, and equipment used for mobilization and site lighting generators could degrade ambient air quality and elevate noise levels.	Localized	High
	Human Resources and Influx	Influx of job-seekers could alter the population characteristics of the area.	Dispersed	Medium

		Pressure on existing infrastructure due to influx.		
	Noise Quality	Project-related traffic could lead to congestion, negatively affecting local people.	Public	Medium
	Health and Air Quality	Gaseous emissions from project equipment and machinery could cause health effects, mostly respiratory. Possible increase in communicable diseases due to influx is a possible impact.	Localized	High
	Conflict	Conflicts could arise between project workers and host communities if adequate consultations are not held	Localized	Medium
Civil/Structural works and facility installations	Air Quality	Emissions from vehicles and machinery, as well as dust and suspendable particulates generated from trenching activities and machinery such as concrete mixers and piling machines, could lead to degradation of air quality and elevation of ambient noise levels.	Localized	High
	Surface and Groundwater	Piles may be driven down to the upper water table level, potentially causing inadvertent infiltration of groundwater by cement and concrete. Abstraction of water from the aquifer could result in the depletion of groundwater resources, ultimately leading to subsidence. Additionally, the erection of transmission line poles in the water may disturb sediment, resulting in increased turbidity. Furthermore, cement and other hazardous	Dispersed	High

		materials from civil/structural works could be transported into surface water, causing contamination.		
	Soil	Potential infiltration and contamination of soil with hazardous materials may occur, potentially altering soil fertility status and inducing nutrient toxicity in plants.	Localized	High
	Vegetation and Wildlife	The productivity of plants may decrease due to a reduction in the photosynthetic area on leaves, blockage of stomatal pores, interference with transpiration and respiration, and mechanical damage to leaf surfaces. This could predispose plants to secondary infections. Additionally, noise generated by machinery may frighten wildlife species away from the site, resulting in their migration and potentially altering the composition and abundance of species in the area.	Dispersed	Medium
	Health	Potential health impacts on workers and host communities due to emissions from equipment and machinery. Injuries (and deaths) of site workers should be included as possible impact.	Localized	High
	Conflict	Conflicts may emerge during site clearing and preparation activities due to insufficient consultations and/or perceived disparities in employment opportunities.	Localized	Medium

Operation and Maintenance Phase				
Operation of the Heipang SAPZ – AIH	Livelihood	Boom town effects and associated inflation, leading to price hikes without a corresponding increase in earning power of local communities. Impacts of excessive abstraction of underground water and storm water runoffs into surface water can affect water resources quality and availability for the local community.	Dispersed	High
	Human Resources and Influx	Possible influx of people who will provide value added services such as schools, banks, hospitals, supermarket/stores, etc. could lead to influx of populations into project area, causing alterations to population structure in the area and pressure on existing facilities.	Dispersed	Medium
	Transport And Nosie Quality	Traffic congestion may lead to physiological effects on individuals and increase the likelihood of accidents due to operational transportation.	Public	Medium
	Waste Generation	Potential soil and /or water contamination form mishandling of generated solid waste, operation waste and sewer created by the project. Potential adverse effect from unsustainable management of effluent and wastewater generated from operations.	Dispersed	High
	Conflict	Conflicts may arise if communities perceive that they are not receiving fair treatment and if promises made by proponents are left unfulfilled.	Localized	Medium

Routine maintenance of utility, plants, mills and facilities	Surface and Groundwater	During routine maintenance, the generation of hazardous materials such as spent lube oils, fuel and oil filters, and spent batteries is possible. If not managed appropriately, these wastes could be washed into nearby surface water by runoff or infiltrate into the soil and groundwater, leading to contamination and pollution. This poses a risk to local communities that rely heavily on surface and groundwater aquifers for their water supply.	Dispersed	High
	Soil	Accidental release of hazardous materials generated from routine maintenance activities could lead to contamination of the soils, thus altering soil quality status	Localized	High
	Air and Noise Quality	The project activities may result in emissions from machinery and an increase in ambient noise levels due to the operation of maintenance equipment.	Public	Medium
Decommissioning and Closure Phase				
Dismantling of	Livelihood	Employees involved in the project may face job loss when decommissioning activities begin, impacting their employment and livelihood.	Localized	High
	Surface and	The impact of this activity on surface and groundwater quality will have both positive and negative aspects. On the positive side, the removal of piles and other structures will eliminate perturbations to	Dispersed	Low

facilities, buildings, utility and ancillary facilities	Groundwater	surface and groundwater, returning conditions to pre-project levels. However, on the negative side, the dismantling of structures may disturb sediment, particularly if transmission line poles fall into surface water. Additionally, materials from dismantling could infiltrate groundwater, leading to contamination.		
	Air and Noise Quality	The use of vehicles, machinery, equipment for mobilization, and generators for lighting on site may emit gaseous emissions, particulates, and noise. These emissions and noise levels could contribute to the degradation of ambient air quality and an increase in ambient noise levels.	Localized / Public	High
	Vegetation and Wildlife	Noise generated by machinery may disturb wildlife species, causing them to flee the site and potentially leading to changes in species composition and abundance due to migration from the area.	Dispersed	Low
	Waste Generation	Potential soil and /or water contamination form mishandling of generated solid and liquid wastes, and other decommissioning and closure procedures related waste.	Dispersed	Medium
	Transportation	Traffic congestion could lead to physiological effects on individuals due to associated stress and frustration.	Localized / Public	High
	Human Resources	The influx of job seekers into the area may result in changes to the	Localized	Medium

		population characteristics of the project area.		

The primary objective of the ESIA study was to comprehensively identify and characterize all associated environmental impacts or effects resulting from the Heipang, SAPZ Agro-Industrial Hub (AIH). While various approaches exist for predicting and evaluating project environmental impacts, the EIA Procedural Guidelines, the ISO 14001 approach, and the Hazard and Effect Management Process (HEMP), were mainly referenced in the impact identification process chosen for this study. Using this method, impacts ranging from low to severe significance were identified, assessed, and quantified. Notably, among the impacts with high significance ranking are:

a) Injury and personnel entrapment resulting from heavy lifting during construction.
b) Air pollution and potential climate change effects caused by fugitive emissions.
c) Contamination of surface water due to wastewater and effluent discharges.
d) Risk of explosions and fires resulting from routine activities and accidental incidents.
e) Noise pollution generated by process equipment.
f) Pollution of land and water from potential oil spill incidents.
g) Traffic and transportation impacts resulting from the loading of finished products.

5.5 Project Phases, Associated Activities and Potential Impacts

The proposed projects will engage with the environment through different avenues referred to as "development aspects," which may lead to alterations in the existing environmental conditions. These alterations are termed as "impacts." The activities associated with the phases of the SAPZ – AIH, Heipang project and the identified environmental aspects of the proposed development that may induce impacts on the environment comprise:

A. Pre-Construction Phase

- Preliminary site surveys and investigation works.
- Land take for the proposed Special Agro-industrial Processing Zone (SAPZ) Hub.
- Mobilization of personnel and equipment for site preparation activities.
- Energy requirements (provision of energy for construction).
- Labor requirements.
- Stakeholders' engagement.
- Site preparation activities including fencing, vegetation removal, excavations, earth works.

B. Construction Phase

- Foundations work and construction.
- Concrete works and pilling.

- Site fabrication (welding) and coating.
- Construction of the Agro-industrial hub building.
- Construction and installation of various equipment, infrastructures and facilities (processing plants, treatment plants, power generation equipment, electric poles, and transformers, etc.).
- Technical finishing and fittings (civil, electrical, and plumbing works, backfilling, etc.).
- Demobilization.
- Commissioning Agro-processing hub

C. Operation Phase

- Operation of the SAPZ – AIH, Heipang Facility.
- Use of water for domestic activities and industrial activities.
- Movement of raw materials in and finished products out of the Hub.
- Power generation and servicing (installation of electric pole to obtain electricity from an already existing power plant).
- Routine maintenance of installed facilities.
- Recruitment of workers.
- Waste generation.

D. Decommissioning Phase

- Shutdown of activities.
- Removal of electrical cables and wires.
- Demolition and Removal of AIH components for relocation, sale or land retrieval.
- Demobilization of decommissioned equipment.
- Waste generation and management.
- Site Restoration activities – clean-up of site and landscaping

5.5.1 Identified Impacts for Pre-Construction Phase

D. Environmental Impacts

Positive

- Stakeholder consultation and engagement is carried towards informing identified stakeholders about project activities and providing them with an opportunity to contribute to project development.
- Sensitization and training on the ESMP implementation and monitoring.
- Job opportunities from hiring unskilled labor for vegetation clearing, security etc.

Negative

- Loss of biodiversity and vegetation through site clearing.
- Air quality pollution from site excavation and land bulldozing.
- Site workers, products suppliers and goods seller's influx causing pressure on existing social infrastructure.
- Disruption or loss of topsoil from heavy-duty vehicle operations including grading, filling, excavation, earthwork.
- Increased noise levels and vibrations from vehicle movement and equipment operations.
- Generation of solid waste (scrap metal, wood, sand, concrete, iron rods, paper)

E. Occupational Health Impacts

Positive

- Conduction of Occupational Health and Safety (OHS) awareness programs for PMU (Project Management Unit) and third-party contractors inducting them on safety guidelines and practices.

Negative

- Increased traffic during mobilization with risk of accidents leading to possible casualties.
- Trips, falls, dust inhalation and injuries from open excavations and working at heights.

F. Socio-Economic Impacts

Positive

- The project will conduct socioeconomic stakeholder consultations to educate the residents of the host communities about the project's social safeguard components.
- Generation of jobs (skilled and unskilled) during site preparation.
- Increased demand for goods and services from retail vendors and canteens as a result of job opportunities made available for host community, locals especially the youths.
- Increased revenue for suppliers as some materials will be sourced locally.

Negative

- Stock piling and dust from materials and vehicular activity may affect the facility's visual aesthetics for personnel and visitors.
- Conflicts over employment issues.
- Population impacts, as there would be a minor increase in the host communities because of the preparation efforts.

5.5.2 Identified Impacts for Construction Phase

D. Environmental Impacts

Positive

- Employment opportunities for people within the host communities for both skilled and unskilled workers.
- Installation of Effluent Treatment Plant (ETP) will avoid the disposal of wastewater generated to the nearest water body.
- Increased livelihood from employment opportunities among host communities, locals, youth, increasing demand for goods and services from retail vendors.
- Reduce the footprint on drug importation.
- Provision of electricity from the already existing power plant within the facility with a backup generator of 800KVA, which will result in less emission.

Negative

- Emissions generated from vehicle exhaust, dust and machinery engine emissions could potentially pollute air.
- Introduction of invasive species through negligence during equipment importation.
- Site runoff resulting from dust suppression sprays, cement works, oils, grease from machinery and vehicles.
- Soil / groundwater contamination resulting from accidental leakages and spills from heavy duty trucks.
- Construction activities will alter and lead to loss of the existing fauna and flora habitat and diversity around the facility.

E. Occupational Health Impacts

Positive

- Reinduction of all site staff and personnel on OHS awareness, safety guidelines and practices.

Negative

- Increased dust in the ambient air in working zones.
- Heat stress from increased exposure of construction workers to the sun.
- Work site accident and injuries, trips, falls, and burns.
- Increased risk of infections and spread of communicable diseases due to influx of people.
- Increased noise and vibration levels.

F. Socio-Economic Impacts

Positive

- Recruitment of skilled, semi-skilled and unskilled labour will be observed.
- Improved livelihood from job opportunities for locals especially the youths.

Negative

- Construction activities may also bring about noise pollution, thus, being a nuisance to neighbours near-by, and others.
- Possibility of conflict between contractor and working personnel.

5.5.3 Identified Impacts for Operations and Maintenance Phase

D. Environmental Impacts

Positive

- Creation of substantial agricultural and agro-allied infrastructure and products within the region.
- Operation of the ETP will avoid the disposal of wastewater generated to the nearest water body, the treated wastewater will be reused in-house for domestic purpose.
- Increased livelihood from employment opportunities among host communities, locals, youth, increasing demand for goods and services from retail vendors.

Negative

- Air Pollution by volatile and gaseous emission (CO, CHCO2, NOx, etc.) from diesel generators and other pollutant emissions from industrial activities in the AIH.
- The operations of the generators and power plants, and industrial operations will generate noise pollution.
- Water and Soil contamination in the event of an accidental oil spill, or contaminants from serviced generators and vehicles can seep into ground and groundwater, which may contaminate the aquifer.
- Generation and handling of waste materials (paper, domestic wastes, E-waste, etc).

E. Occupational Health Impacts

Negative

- Workplace accidents/incidents resulting from slips, trips and fall from height, cuts and bruises during operation and maintenance.
- Accidental fire outbreak with resultant smoke and soot from the facility

F. Socio-Economic Impacts

Positive

- Offers graduates employment opportunities as well as a channel for knowledge transfer to help skill up the workforce.
- Improve tertiary institution educational curriculum as partnerships will be formed with corporates and local/international academic institutions to improvement tertiary institution educational curriculum and, sensitization programs in universities to change perception and promote innovation and technology among potential graduates with the aim of increasing talent supply.
- Promote Research and development for innovation.
- Promotion of employment opportunities and poverty reduction: the project will attract employment during construction and operation. The employment will increase income to local communities as most of the casual laborers and some skilled workforce will be sourced from the project sites.
- Bridge of gender gap. Participation and mainstreaming different groups (women, boys, girls and men's) will have impact in minimizing disparity among vulnerable parts of the community (elders, women, children and youth).
- Presents promising investment opportunities in the agro-industrial sector, ensuring the availability of affordable food, and contributing to address food security concerns.
- Economic boost for Plateau State and generation of revenue for the state and the Nation.
- It will attract foreign investors to the state, there increasing revenue for the state.

Negative

- Influx of people into the host community, thereby putting pressure on the existing infrastructure and available resources.
- Increased traffic and road accidents from increased vehicle transit.

5.5.4 Identified Impacts for Decommissioning and Abandonment Phase

D. Environmental Impact

Positive

- Regrowth of new vegetation and return of species that have migrated away from the area.
- Restoration of the project land to the state close to its original state.

Negative

- Disturbance to soil profile, and potential contamination from surface runoff during abandonment.

- Ground water contamination from Site runoff resulting from dust suppression sprays, oils and grease from machinery and vehicles as well as wastewater from dismantling works.
- Pollution resulting from improper management of waste.
- Air quality pollution because of dust and heavy equipment dismantling movement.
- Increased noise levels within community during dismantling activities.

E. Socio-Economic Impacts

Negative

- Loss of business/employment/source of income and means of livelihood due to SAPZ – AIH, Heipang Project activity closure. Thus, indirectly impeding other small business activities banking on the project activities.
- Social vices like theft and vandalism because of job loss by host community youths.
- Increased traffic impact while moving demobilized equipment and personnel.

F. Occupational Health Impacts

Negative

- Air quality pollution resulting in illnesses such as swollen eye, difficulty in breathing, catarrh, and bronchitis (respiratory tract infections).
- On-site traffic congestion and risk of accident during dismantling of the AIH facilities.

5.5.5 Summary of Positive Impacts

Employment Opportunities

The project is envisaged to provide direct employment in the AIH and other industrial raw material procurement zones including direct employment in the farming sector outside the SAPZ. The AIH project will also provide indirect employment in primary, secondary and tertiary sectors including banks, logistics, insurance, manufacturing etc. of the Project Area of Influence.

Capacity Building

The project will provide increase capacity building and training in during both construction and operational phases ensuring that the locals, project affected people and their communities are prioritized. During project construction and Implementation, locals and project affected people will be taught, skills enhanced and impacted which will be utilized even after the project life cycle.

Skill Transfer

The project seeks to attract both national and foreign experts and consultants for the development, design, construction, and operation of the AIH. During these interactions and processes, the locals will have significant benefit through the transfer of relevant technical skills and tools.

Increase Public Revenue

The project will help restore confidence in foreign investors and promote good doing business climate. The project seeks to attract foreign and national investment that help strengthen and decentralize the economy, increase the national treasury through tax payments, and encourage rural and community development.

Food Security

The project will reduce poverty and hunger by restoring hopes and confidence in farmers. Rural and local farmers will be motivated and inspire to grow and produce surplus cash crops and product with the availability of the Special Agro-Industrial Processing Zone and specific AIH across designated regions of the county. This means farmers and wouldn't have to worry about the available market for purchasing and storing their products.

Economy

The proposed AIH will promote production and value-added goods and services for the local and foreign markets thus stimulating industrial and commercial growth. It will eventually Increase in revenue and profitability of the sector thereby encouraging mindset change in youth towards the agribusiness sector. Most importantly, the project promised to raise the competitiveness and efficiency of SME opportunities among youth and significantly increase earning potential and improving health and sanitation.

Infrastructure Development

The Project will stimulate the establishment of major infrastructures for both local and foreign needs considering the local government's infrastructure gaps and needs. This infrastructural development will decentralize the area and improve the physical and aesthetic outlook of the local government. The project is envisaged to accelerate the infrastructure development in the Barkin Ladi area the commercial hub in Plateau State and Nigeria.

5.5.6 Summary of Negative Impacts

Impacts on Air Quality

It is important to note that the project takes place in rural areas where air quality is usually good. The current and existing air pollution source along the project area is vehicular traffic (particulates and combustion emissions). Potential air emissions from the project in the form of fugitive dust

and emission releases will occur because of earth work activities including vegetation clearing, excavation works, and transportation of materials to and from the project sites especially were trucks travel on unpaved portions of tracks and roadways. The local ambient air quality around the project area will be temporarily impacted during construction phase as the result of air emissions generated by construction activities. In addition, pollutant emissions will occur due to the operation of diesel fuel generators, and exhaust emissions form transport vehicles such as material transport trucks and administrative vehicles. Therefore, the potential impacts of the project activities on air quality are associated with dust emissions and an increase the following combustion pollutant concentration (CO, NO_X, SO_2 and PM). This impact is localized and not significant.

Impacts on Water Resources

Increased sediments because of increased soil erosion due to earthworks can enter surface waters causing increase turbidity and hence impacting aquatic fauna and flora by altering the aquatic environment. In proper handling of lubricants, hazardous substances, and hydrocarbons (fuels, gasoline, etc.) may also cause water pollution of surface and ground water. However, the quantities required for used are small and not expected to affect surface and ground water if good management practices are applied.

Surface Water

Surface water could be affected during the construction and operation of the AIH project. Site clearance, removal of trees and shrubs and site preparatory works would cause a subsequent increase in surface runoff which may, in turn, increase the risk of flooding and soil erosion. Surface water quality could be affected by number of factors during both construction and operations of the AIH. Construction activities and operation phases may cause increased soil erosion and sediment loading of nearby streams, while accidental leaks or spills of hydrocarbons (oil, fuel or other substances) can also pollute surface water and impact on ground water. During operations, the major threats to surface water quality is likely to be pollution form pesticides, fertilizers, sewage, effluents from operations and processing plants etc. Gradually seepage of improperly stored materials, chemicals, and products from storage continent may also continue to contaminate surface.

Groundwater

The construction works at the AIH may have significant impacts on ground water hydrology and quality. Potential chemicals and improper handling of lubricating slurry, fertilizers and other toxic substances during construction and operation may cause groundwater pollution thus through gradual seepage.

Impacts on Soil Quality

The project area is located within the coastal plain and is generally flat with some undulating rises. The main impacts on soil will occur due to increases erosion potential because of vegetation clearing and earth moving activities. Additionally, the increase in potential of erosion, will be a risk of soil contamination from solid waste generated by site activities, as well as liquid waste such

as lubricants, slurry, and accidental spills, and leaks occurring from storage and work areas. Impacts associated with soil contamination may continue long after operations have ceased if mitigation measures are not carefully management.

Impacts from Waste Generation

The Project will produce many types of wastes during both construction phase and operational phase. During mobilization and construction phases, solid materials such as domestic waste, packaging from construction materials, debris, excavation remnants and others will be generated which could contaminate both soil and water resources. Vendors, construction staffers and employees must adhere to strict hygiene practices and correctly dispose waste in adherence the EPA standards. In addition to these wastes generated during construction phase, the operational phase would produce huge volume of waste from key sectors, zones, processing and value-added streams within the Special Economic Zone and the Special Agro-Industrial Processing Zone. Waste expected to be generated during this period include; raw materials from farmlands, plantations, concessions areas and their cumulative wastes generated as well as effluents and wastewater from the processing and value-added streams.

Generally, the AIH will include; Industrial Units (Yam Processing Plant, Cassava Processing Plant, Modern Market Complex, Maize processing Unit) and the Common Infrastructure (Site Development, Road Network, Storm Water Drainage, Water Supply Network, Sewerage Collection and Treatment System, Effluent Collection and treatment system, Electrical Generation and Distribution, Office and Training Centre, Common Ware House, Custom Hiring Center and Work Shop and Farm Input Sale Counter). All these activities would post environmental, social, and economic impacts and thus mitigation measures increase the project performance and acceptability.

Impacts from Noise and Vibration

The main source of noise and vibration will be as the result of drilling and other earthmoving activities. Additionally, noise will be generated from transportation activities during construction period which would be much higher than during the operational period. The increased noise level can impact employee's health and safety and reduce performances. Heavy vehicle operators, nearby communities, and resident near project area of influence are at higher risk of noise nuisance.

Impacts of Visual

Construction activities at AIH may be include construction of campsites, recruitment and mobilization of equipment and machineries transportation and other operations carried out at both day and night. Lighting at night can result in visual impact on local communities and sensitive fauna species. Unobtrusive lighting disrupts critical behaviour of biodiversity. It can stall the recovery of threatened species and interfere with their ability to undertake long-distance migrations, reduce breeding success and their chances of survival. Lighting should be kept to the minimum requirement for safety at night-time.

Impacts on Fauna and Flora

Construction activities are likely to affect the local vegetation and faunal and flora species directly or indirectly. Site clearing, excavation and initial preparatory works will potentially impact local flora and fauna of the proposed project area. These preparatory site activities will alter the natural habitat of critical species and the ecosystem services they provide. Vegetation clearing and earthwork activities will also result in increased noise and may result in loss in fauna and flora species and by extension affect their reproduction patterns.

Impacts on Health and Safety

Construction works, industrial processes and operations attracts significant numbers of people and professionals from diverse orientations including skilled labourer, unskilled labourer, technical experts, construction works, and operations technicians. Consequently, there is an increased risk of trips, falls, injuries, accidents and spread of diseases amongst these contractors, pedestrians, passengers, and staff at the project level as well as the project's community level.

In addition to the risks of accidents, there is an increased risk of accidental exposure to hazardous materials and substances during construction and operations should said materials not stored and handled in the appropriate manner and form. The risks and impacts on health and safety are increased if contractors and employees do not adhere to the administration of the Personal Protection Equipment (PPEs) relative to their respective scope of work and not equipped with relevant trainings in occupational health and safety procedures.

An internationally trained and experienced safety specialist will be responsible for the preparation, implementation, and maintenance of a comprehensive safety program, which will periodically be reviewed and evaluated. Access to a nearby first aid facility will be provided, and a driver and an ambulance will be made available should there be a need to transport patients to another location. These risk of accidents, injuries and diseases should be minimized by providing regular training and procedures for workers, equipment usage and regular health safety induction protocols to reduce and offset these impacts.

Socio-Economic Impacts

The project is expected to provide employment and social livelihood opportunities in the short and long term during both construction and operation phases. Employment opportunities will be tailed on both male and female gender basis and preference will be given workers from the local communities. As a norm, there would be high influx of people from other region to the project proposed areas for job opportunities which potentially results into social friction an altered social dynamic, and possibly increasing the risks occurrence of diseases and infections. The Project Implementation Unit will work with the Community Liaison Officer and Contractors to put in place appropriate actions that prevent reduce, minimize, or offset such impacts.

Impacts to Cultural Resources

Based on the field survey, no activities under the project are expected to take place near any cultural or archaeological resources. Avoiding cultural resources during planning stages and ensuring equal representation and participation of relevant project affected persons and communities in decision making process helps to mitigate impacts to cultural resources. Damage to cultural resources constitute threat to social cohesion and would lead to resentment of the proposed project. However, should any cultural site or resources be found, the appropriate standard for chance finds will be applied.

5.6 Risk Assessment

Table 5.5 presents a comprehensive risk assessment for the SAPZ – AIH, Heipang project, identifying key environmental and socio-economic risks associated with the project activities. Each risk is evaluated based on several criteria: the likelihood of occurrence (L), frequency of occurrence (F), and potential impact (I). The table also assesses the significance of these impacts, providing a risk rating (R) and corresponding mitigation plans (P) to manage and mitigate these risks effectively.

The table covers a wide range of potential risks, from environmental concerns like air pollution and water contamination to socio-economic impacts such as employment opportunities and local economic growth. Each risk is categorized to provide a clear understanding of its potential effects and the steps required to mitigate these impacts, ensuring the project is conducted in a sustainable and responsible manner.

Key Elements of the Risk Assessment:

- Risk Description: Brief description of the identified risk.
- Likelihood (L): The probability of the risk occurring (Low, Medium, High).
- Frequency (F): How often the risk is likely to occur (Low, Medium, High).
- Impact (I): The potential severity of the risk's impact (Low, Medium, High).
- Impact Significance: Qualitative assessment of the impact's significance, considering both the duration and reversibility (e.g., Moderate, Short Term; Irreversible, Long Term).
- Risk Rating (R): Overall assessment of the risk, combining likelihood, frequency, and impact (Low, Medium, High).
- Mitigation Plan (P): Recommended strategies and actions to mitigate or manage the identified risk.

The detailed risk assessment aims to ensure that all significant risks are identified, evaluated, and managed through effective mitigation strategies, thereby minimizing negative impacts on the environment and local communities while maximizing the positive outcomes of the project.

Table 5.5: Risk Assessment

Risk Description	Likelihood (L)	Frequency (F)	Impact (I)	Impact Significance	Risk Rating (R)	Mitigation Plan (P)
Air Pollution	Medium	Medium	High	Moderate, Short Term	High	Install emission control systems, regular monitoring
Water Contamination	Low	Low	High	Irreversible, Long Term	Medium	Implement water treatment facilities, strict waste management
Soil Degradation	Medium	Medium	Medium	Revisable, Long Term	Medium	Adopt sustainable farming practices, soil restoration programs
Deforestation	Low	Low	High	Irreversible, Long Term	Medium	Reforestation efforts, compliance with land use regulations
Loss of Biodiversity	Low	Low	High	Irreversible, Long Term	Medium	Create conservation areas, monitor biodiversity regularly
Noise Pollution	Medium	High	Medium	Short Term, Moderate	Medium	Use sound barriers, limit noisy activities to daytime hours
Employment Opportunities	High	High	High	Long Term, Significant	High	Prioritize local hires, provide training and skill development

Local Economic Growth	High	High	High	Long Term, Significant	High	Support local businesses, invest in community infrastructure
Community Health Risks	Medium	Medium	High	Long Term, Significant	High	Health awareness programs, regular health check-ups for workers
Cultural Displacement	Low	Low	Medium	Long Term, Moderate	Medium	Engage with local leaders, ensure cultural considerations in planning
Resource Depletion	Medium	Medium	High	Long Term, Significant	High	Implement resource-efficient technologies, continuous resource monitoring
Economic Inequality	Medium	Medium	High	Long Term, Significant	High	Inclusive policies, equitable distribution of benefits, support for marginalized groups

5.7 Residual Impact Description

The Residual Impact Description provides a comprehensive evaluation of the ongoing environmental and social impacts that persist despite the implementation of mitigation measures outlined in the Environmental and Social Management Plan (ESMP) for the SAPZ Agro-Industrial Hub (AIH) in Heipang. This section is crucial as it identifies and assesses the impacts that cannot be fully eliminated but can be managed to acceptable levels through continuous monitoring and adaptive management strategies.

The implementation and operation of the SAPZ – AIH project will interact with various environmental and social components, resulting in certain residual impacts. These impacts are the remaining effects on the environment and society after all planned mitigation measures have been applied. The goal of this assessment is to ensure that even these residual impacts are managed in a way that minimizes their significance and promotes sustainable development.

5.7.1 Environmental Residual Impacts

Water Resources:

The project's activities, particularly those related to irrigation and industrial processing, will significantly increase the demand for water. Despite implementing water conservation measures such as efficient irrigation systems and water recycling, there will still be residual impacts on local water resources. These impacts will be monitored through regular water quality assessments and resource management strategies to ensure that the water demand does not adversely affect local ecosystems and communities.

Air Quality:

Operational activities, including biomass burning and emissions from vehicles and machinery, are likely to contribute to residual air quality impacts. Although emission control systems and regular monitoring are in place, these activities may still lead to elevated levels of pollutants. Adhering to strict emission standards and implementing best practices for air quality management will be essential in mitigating these residual impacts.

Biodiversity:

Construction and operational phases of the project may disturb local habitats, leading to potential residual impacts on biodiversity. While measures such as creating buffer zones and habitat restoration projects are planned, some impacts on local flora and fauna may still occur. Continuous monitoring of biodiversity and implementation of additional conservation efforts will be necessary to mitigate these effects.

Soil Quality:

Intensive agricultural activities can lead to soil degradation through erosion, nutrient depletion, and compaction. Despite adopting sustainable farming practices and soil conservation techniques, there may be residual impacts on soil quality. Regular soil health assessments and the application of organic fertilizers and soil amendments will help in maintaining soil productivity and mitigating these impacts.

5.7.2 Social Residual Impacts

Livelihoods:

The project aims to minimize displacement and provide alternative livelihood options for affected communities. However, there may still be residual impacts on local livelihoods due to changes in land use and economic activities. Providing continuous skills training and supporting income-

generating activities will be crucial in mitigating these impacts and ensuring that the affected communities can adapt to new economic conditions.

Cultural Heritage:

Despite thorough cultural heritage assessments and planned mitigation measures, there may be residual impacts on cultural sites and practices. These impacts could arise from land alterations and the influx of new populations. Engaging with local communities, respecting cultural practices, and implementing cultural preservation initiatives will help mitigate these residual impacts.

Health and Safety:

Operational activities pose certain health and safety risks to both workers and local communities. Despite implementing health and safety protocols, residual impacts such as exposure to pollutants and occupational hazards may still occur. Ongoing health monitoring, capacity building, and emergency response planning will be essential in addressing these impacts.

Community Relations:

Even with extensive stakeholder engagement and community involvement efforts, there may be residual impacts on community relations due to unforeseen circumstances or conflicts of interest. Establishing robust grievance mechanisms and maintaining open lines of communication with all stakeholders will be crucial in addressing and mitigating these impacts.

5.7.3 Cumulative Impacts

The cumulative impacts of the SAPZ – AIH project, in conjunction with other existing and planned projects in the region, may create additional environmental and social pressures. These pressures can result from the combined effects of multiple projects on local resources and communities. Conducting comprehensive cumulative impact assessments and collaborating with other stakeholders to implement joint mitigation efforts will be essential in managing these impacts. By addressing the cumulative effects, the project can contribute to a more sustainable regional development strategy.

Overall, the implementation of the SAPZ – AIH project will inevitably lead to some residual environmental and social impacts. However, the proactive mitigation measures outlined in the ESMP will be continuously monitored and adjusted to minimize these impacts. The project's commitment to ongoing stakeholder engagement and adaptive management strategies will be crucial in addressing any unforeseen residual impacts and ensuring the long-term sustainability of the project.

CHAPTER SIX

MITIGATION MEASURES

6.1 Introduction

This chapter presents appropriate and cost-effective mitigation measures to prevent, reduce, control, remedy, or compensate for adverse impacts and enhance the positive benefits of the proposed Heipang, SAPZ – AIH project. These measures aim to reduce impacts to As Low as Reasonably Practicable (ALARP). Residual impacts that may occur despite these mitigation measures are also acknowledged. Subsequently, Chapter Seven will detail management plans to oversee and monitor these mitigation measures through an effective Environmental and Social Management Plan (ESMP). The acceptability or suitability of a project is contingent on various factors, one of which is the mitigation of negative environmental and social impacts to tolerable levels. Typically, reducing impact significance involves implementing mitigation measures to address identified negative impacts.

6.2 Mitigation Objectives and Hierarchy

The primary objectives of mitigation measures are prevention, reduction, and possible control of impacts. For clarity, the following definitions are provided:

- **Avoidance:** Methods aimed at preventing the occurrence of negative impacts or impeding such occurrences from resulting in harmful environmental or social outcomes.
- **Minimization:** Limiting or reducing the degree, extent, magnitude, or duration of adverse impacts. Reduction can be achieved by scaling down, relocating, or redesigning project elements.
- **Control:** Ensuring that occurring impacts are reduced to a level as low as reasonably practicable.
- **Compensation:** Recompense for residual impacts through offsets.

Table 6.1: Summary of Mitigation Hierarchy.

Avoid at Source; Reduce at Source	Avoiding or reducing at source is essentially 'designing' the project so that a feature causing impact is designed out (e.g. pipeline re-route) or altered (e.g. reduced working width). Often called minimization.
Abate on Site	This involves adding something to the basic design to abate the impact-pollution controls fall within this category. Often called end-of-pipe.
Abate at Receptor	If an impact cannot be abated on-site, then measures can be implemented off-site. An example of this would be to instruct authorities in affected schools to increase the level of supervision of their pupils during the period of civil works.
Repair or Remedy	Some impacts involve unavoidable damage to a resource, e.g. agricultural land during pipeline construction. Repair essentially involves restoration and reinstatement type measures.

6.2.1 Environmental, Health and Safety Management

The ESIA and various E&S studies have identified key E&S aspects, risk and impacts requiring mitigation and control. Identification and assessment of impacts has been undertaken through a process comprising consultation, modelling, on-site observations, literature review and expert opinion based on experience of other similar projects. The contractor will develop an Environmental Management Plan that represents the policies, procedures, and standards for all its operations. This ESMP will accommodate the role of an Environmental Management System (EMS) in the absence of a fully developed EMS for the SAPZ – AIH, Heipang project.

The Environmental Management System (EMS) is a set of processes and practices which enables an organization to manage the impacts of its organizational activities on the environment and to increase its operating efficiency. It is a framework which helps the organization to achieve its environmental goals through consistent control of its operations. The framework includes organization's environmental programs in a comprehensive, systematic, planned, and documented manner and includes the organizational structure, planning and resources for developing, implementing and maintaining organizational policy for the protection of the environment. It provides a structured approach to planning and implementation of the environment protection measures.

6.2.2 Elements of an EMS

The Environmental Management System (EMS) encourages the organization to continuously improve its environmental performance. The basic elements of an EMS are as follows:

- The organization commits initially to an environmental policy.
- It includes review of the present status and future environmental goals of the organization.
- Analysis of the environmental impacts and the legal requirements.
- Keeping environmental policy as the basis, the organization sets the environmental objectives and targets for reducing environmental impacts and for complying with the legal requirements.
- Establishment of plans for improving the environment performance and for meeting the objectives and targets of the organization.
- Monitoring, measuring, and evaluating the progress for achievement of the objectives.
- To ensure environmental awareness and competence of the employees of the organization.
- To take corrective actions if the objectives and targets are not being met.
- To have regular review of the progress of the EMS and to make improvements on continuous basis.

6.2.3 Response Plan for Environmental and Social Impact Assessment (ESIA)

Response Plan for Environmental and Social Impact Assessment (ESIA) for the Proposed Special Agro-Processing Zone (SAPZ) – Agro-Industrial Hub (AIH) project will include the following:

Implementation of Mitigation Measures

- Ensure strict adherence to the Environmental and Social Management Plan (ESMP) throughout all project phases.
- Establish a dedicated team responsible for implementing and monitoring mitigation measures outlined in the ESMP.
- Conduct regular training sessions for project staff and contractors on environmental and social responsibilities and best practices.
- Integrate environmental and social criteria into procurement processes to ensure compliance with standards and regulations.

Stakeholder Engagement and Communication

- Develop a comprehensive stakeholder engagement plan to foster transparency, trust, and collaboration among all stakeholders.

- Organize regular meetings, workshops, and consultations with affected communities, local authorities, NGOs, and other relevant stakeholders to address concerns and gather feedback.
- Establish effective communication channels, such as hotlines and grievance mechanisms, to promptly address community grievances and complaints.

Monitoring and Evaluation

- Implement a robust monitoring and evaluation system to track the effectiveness of mitigation measures and identify any emerging environmental or social issues.
- Conduct regular environmental and social impact assessments to assess project performance and compliance with regulatory requirements.
- Review and update the ESMP based on monitoring results and stakeholder feedback to ensure continuous improvement.

Adaptive Management

- Adopt an adaptive management approach to proactively respond to changing environmental and social conditions and emerging risks.
- Establish early warning systems to identify potential environmental and social impacts and trigger appropriate corrective actions.
- Foster a culture of learning and innovation within the project team to continually improve environmental and social management practices.

Capacity Building and Knowledge Sharing

- Provide training and capacity-building programs for project staff, local communities, and relevant stakeholders on environmental and social issues, sustainable practices, and disaster preparedness.
- Facilitate knowledge sharing and collaboration with other similar projects, government agencies, research institutions, and NGOs to leverage lessons learned and best practices.

Compliance and Reporting

- Ensure full compliance with applicable laws, regulations, and international standards related to environmental and social management within Nigeria and global standards.
- Prepare regular environmental and social performance reports to stakeholders, regulatory authorities, and project funders, highlighting progress, challenges, and achievements.

- Facilitate independent third-party audits to verify compliance and effectiveness of environmental and social management practices.
- By implementing this comprehensive response plan, the SAPZ – AIH project at Heipang can effectively manage environmental and social risks, minimize negative impacts, and enhance positive outcomes for both the project and the surrounding communities.

6.3 Proffered Mitigation Measures

Table 6.2 summaries mitigation and adjustment measures for the project's identified potential and associated impacts. It presents the mitigation measures for individual project activities outlined in Chapter 5, Table 5.5.

Table 6.2: Summary of Mitigation Measures for all the Development Phases Project Activities

Pre-Construction				
Project Activity	**Associated and Potential Impacts**	**Impact Category Before Mitigation**	**Mitigation Measures**	**Impact Category After Mitigation**
Land-take and acquisition	Alteration of population characteristics if previous owners of acquired lands relocate to get farmlands elsewhere, leading to alteration of population structure.	Medium	Heipang, SAPZ - AIH shall ensure adequate compensation for all acquired land and crops thereon, aiming to minimize the necessity for relocation.	Low
	Livelihood that would normally result from tilling the land for agriculture would be lost, resulting in lower living standards for affected people.	High	Compensation payments shall encompass arrangements for loss of income, aligning with the provisions of IFC Performance Standards, the Equator Principles, and the AfDB Operational Safeguards	Low
	Conflicts could occur if compensation for acquired land is not properly handled.	Medium	Adequate compensation, as per mutually agreed guidelines between	Low

			landowners, the project proponent, and the Plateau State government, shall be provided for all acquired lands.	
Site clearing and preparation	Increased suspended particulate in ambient air and degradation of ambient air quality by emission from construction machinery.	High	Regular maintenance of project vehicles and machinery shall be conducted to meet international emission standards, minimizing emission levels. Regular sprinkling of open soil surfaces with water during trenching shall be performed. The bulk of construction activities shall be conducted during the rainy season to further reduce suspended particulates in the air.	Low
	Due to the project site's close proximity to surface water, surface water impacts may result from site clearing and preparation activities. During site clearing, runoff from cleared areas, especially if conducted during the rainy season, could carry sand and clay/silt particles into the water, increasing turbidity. Additionally, if vegetal materials from clearing are transported into the surface water, it could elevate organic matter levels, leading to increased biochemical oxygen demand (BOD) and heterotrophic microbe populations. Furthermore, waste materials such	High	Regular maintenance of project vehicles and machinery shall be conducted to comply with international emission standards. Regular sprinkling of open soil surfaces with water during trenching shall be performed. The bulk of construction activities shall be conducted during the rainy season.	Low

	as domestic and sanitary waste from on-site workers, as well as leaks or spills of lube and fuel from equipment and machinery, could also contaminate/pollute the surface water.			
	The key impacts of site clearing and preparation on soil is denudation and subsequent exposure to erosion	Medium	Adequate erosion control measures shall be implemented to prevent erosion of open soil surfaces, including channelizing runoff. Site clearing and preparation activities shall be confined to necessary areas only. Cleared but unused spaces shall be re-vegetated with fast-growing species.	Low
	Loss of vegetation and migration of wildlife from the area, leading to alteration of species composition and abundance	High	Site clearing and preparation activities shall be confined to necessary areas only. Noise attenuation measures, such as fencing and the use of mufflers, shall be implemented.	Low
	Influx of job seekers into the area will lead to an alteration of population characteristics in the project area	Moderate	A policy promoting the recruitment of workers from local/host communities shall be implemented. Positions shall be open to job seekers from outside host communities only if they cannot be filled locally.	Low
	Potential soil and /or water contamination form mishandling of	High	Proper waste handling and disposal measures will be	Low

	generated solid and liquid wastes, and construction waste.		implemented to prevent contamination.	
	Negative health effects on health of project workers and host communities by emissions and dust released from site clearing and preparation activities	High	Project clearing and grading equipment shall be maintained to meet international emission standards. Proper use of PPE for workers shall be ensured.	Low
	Conflicts may arise during site clearing and preparation activities due to inadequate consultations and/or perceived inequalities in employment	Medium	Adequate consultations with host communities, with the active involvement of the Plateau State Government, shall be conducted to minimize conflicts.	Negligible
Construction				
	Due to the project site's close proximity to surface water, potential impacts may arise from waste generated by workers on-site. This waste includes spent lube oils from vehicles and cranes. Additionally, sanitary waste from on-site workers could result in the introduction of heterotrophic microbes into the surface water. Improper disposal of food cans and tins may also lead to heavy metal contamination of the water.	High	All wastes originating from the project area shall be adequately contained to prevent inflow into surface and groundwater, thus averting contamination. These containment measures shall include proper stacking and segregation of wastes at the source, as well as the designation of certified waste handlers.	Low
Mobilization of materials, equipment	Heavy duty trucks used for mobilization could cause soil compaction, leading to structural changes. Wastes from construction camps could also cause soil contamination	Medium	Heavy trucks shall, to the extent possible, utilize existing roads and routes to minimize soil compaction. Wastes generated at construction camps shall be collected properly and	Low

and men to site			disposed of by an accredited waste management agency.	
	Loss of vegetation during setting up of construction camp as well as scaring wildlife species away with noise from vehicles and equipment used during construction.	Medium	Construction camps and stacking areas shall be limited to designated project areas to minimize vegetation loss. Noise attenuation measures, such as fencing and the use of mufflers, shall be implemented to mitigate noise effects on wildlife.	Low
	Emissions and noise from vehicles, machinery, and equipment used for mobilization and site lighting generators could degrade ambient air quality and elevate noise levels.	High	All project vehicles and machinery shall undergo proper maintenance to meet international emission standards, thereby minimizing emission levels. Noise attenuation measures, such as the provision of mufflers, shall be implemented wherever feasible.	Low
	Influx of job-seekers could alter population characteristics of the area. Pressure on existing infrastructure due to influx.	Medium	A policy favoring the recruitment of workers from local/host communities shall be implemented. Positions shall be open to job seekers from outside host communities only when they cannot be filled locally.	Low
	Project-related traffic could lead to congestion, negatively affecting local people.	Medium	Project transportation shall be planned to minimize interactions with local routine transport. Whenever feasible, project transportation shall be	Low

			scheduled to occur during off-peak periods.	
	Gaseous emissions from project equipment and machinery could cause health effects, mostly respiratory. Possible increase in communicable diseases due to influx is a possible impact.	High	All project vehicles and machinery shall undergo proper maintenance to meet international emission standards, thereby minimizing emission levels.	Low
	Conflicts could arise between project workers and host communities if adequate consultations are not held	Medium	Adequate consultations shall be conducted with host communities, with the active involvement of the Plateau State government, to minimize the occurrence of conflicts.	Negligible
Civil/Structural works and facility installations	Emissions from vehicles and machinery, as well as dust and suspendable particulates generated from trenching activities and machinery such as concrete mixers and piling machines, could lead to degradation of air quality and elevation of ambient noise levels.	High	Regular maintenance of project vehicles and machinery shall be conducted to comply with international emission standards. Regular sprinkling of open soil surfaces with water during trenching shall be performed. The bulk of construction activities shall be conducted during the rainy season.	Low
	Piles may be driven down to the upper water table level, potentially causing inadvertent infiltration of groundwater by cement and concrete. Abstraction of water from the aquifer could result in the depletion of groundwater resources, ultimately leading to subsidence.	High	Piling and foundation activities shall be conducted meticulously, adhering to international best practices. Additional hydrogeological studies shall be conducted to ensure adequate groundwater resources.	Low

	Additionally, the erection of transmission line poles in the water may disturb sediment, resulting in increased turbidity. Furthermore, cement and other hazardous materials from civil/structural works could be transported into surface water, causing contamination.			
	Potential infiltration and contamination of soil with hazardous materials may occur, potentially altering soil fertility status and inducing nutrient toxicity in plants.	High	Piling and foundation activities shall be conducted with care, adhering to international best practices. All open soil surfaces shall be paved to prevent infiltration of pollutants.	Low
	The productivity of plants may decrease due to a reduction in the photosynthetic area on leaves, blockage of stomatal pores, interference with transpiration and respiration, and mechanical damage to leaf surfaces. This could predispose plants to secondary infections. Additionally, noise generated by machinery may frighten wildlife species away from the site, resulting in their migration and potentially altering the composition and abundance of species in the area.	Medium	Proper machinery maintenance shall be implemented to reduce noise levels. Noise attenuation methods like barriers or mufflers shall be utilized. Erosion control measures shall be implemented to prevent soil disturbance and vegetation damage. Disturbed areas shall be re-vegetated promptly.	Low
	Potential health impacts on workers and host communities due to emissions from equipment and machinery. Injuries (and deaths) of site workers should be included as possible impact.	High	Emission standards for project vehicles and machinery shall be adhered to. Regular maintenance and watering of open soil surfaces during trenching shall be conducted to reduce	Low

			particulate suspension. Construction activities shall be conducted during the rainy season to minimize health risks.	
	Conflicts may emerge during site clearing and preparation activities due to insufficient consultations and/or perceived disparities in employment opportunities.	Medium	Adequate consultations with host communities, actively involving the Kaduna State Government, shall be conducted to minimize conflicts.	Low
Operation and Maintenance Phase				
Operation of the Heipang, SAPZ – AIH	Boom town effects and associated inflation, leading to price hikes without a corresponding increase in earning power of local communities. Impacts of excessive abstraction of underground water and storm water runoffs into surface water can affect water resources quality and availability for the local community.	High	Heipang, SAPZ – AIH exercises very limited to no control over this impact, and therefore, no mitigation measures are available.	Low
	Possible influx of people who will provide value added services such as schools, banks, hospitals, supermarket/stores, etc. could lead to influx of populations into project area, causing alterations to population structure in the area and pressure on existing facilities.	Medium	AIH will establish a policy promoting the recruitment of workers from local/host communities, with positions open to job seekers from outside the host communities only if local candidates are unavailable. This approach will help deter the influx of job seekers to some extent.	Low
	Traffic congestion may lead to physiological effects on individuals and increase the likelihood of	Medium	Project transportation shall be strategically planned to minimize interactions with local routine transport, with	Negligible

	accidents due to operational transportation.		efforts to schedule transportation during off-peak periods whenever possible.	
	Potential soil and /or water contamination form mishandling of generated solid waste, operation waste and sewer created by the project. Potential adverse effect from unsustainable management of effluent and wastewater generated from operations.	High	Certified waste management contractors shall be engaged for proper waste collection and disposal.	Low
	Conflicts may arise if communities perceive that they are not receiving fair treatment and if promises made by proponents are left unfulfilled.	Medium	Sufficient consultations shall be conducted with host communities, with the active participation of the Plateau State Government, to minimize conflicts.	Negligible
Routine maintenance of utility, plants, mills and facilities	During routine maintenance, the generation of hazardous materials such as spent lube oils, fuel and oil filters, and spent batteries is possible. If not managed appropriately, these wastes could be washed into nearby surface water by runoff or infiltrate into the soil and groundwater, leading to contamination and pollution. This poses a risk to local communities that rely heavily on surface and groundwater aquifers for their water supply.	High	Routine maintenance activities shall be meticulously conducted, adhering to international best practices to prevent contaminants from infiltrating groundwater. This will involve concrete paving of maintenance areas to ensure that hazardous materials cannot seep into groundwater. Certified waste management contractors will be engaged to handle waste collection and disposal on the site.	Low
	Accidental release of hazardous materials generated from routine	High	Rigorous adherence to international best practices	Low

	maintenance activities could lead to contamination of the soils, thus altering soil quality status		shall be implemented. This includes concrete paving of maintenance areas to prevent contaminants from infiltrating soils and altering soil quality status. Additionally, certified waste management contractors will be employed to handle waste collection and disposal on the site, further mitigating the risk of soil contamination.	
	The project activities may result in emissions from machinery and an increase in ambient noise levels due to the operation of maintenance equipment.	Medium	Project vehicles and machinery shall undergo regular maintenance and adhere to international emission standards to reduce emissions.	Negligible
Decommissioning and Closure Phase				
	Employees involved in the project may face job loss when decommissioning activities begin, impacting their employment and livelihood.	High	Adequate pension plans for project workers shall be ensured. Skills training shall be offered to provide alternative means of earning a living.	Low
Dismantling of facilities, buildings, utility and ancillary facilities	The impact of this activity on surface and groundwater quality will have both positive and negative aspects. On the positive side, the removal of piles and other structures will eliminate perturbations to surface and groundwater, returning conditions to pre-project levels. However, on the negative side, the dismantling of structures may	Low	Dismantling activities shall be conducted meticulously, adhering to international best practices. Dismantling areas shall be paved with concrete to prevent contamination.	Negligible

	disturb sediment, particularly if transmission line poles fall into surface water. Additionally, materials from dismantling could infiltrate groundwater, leading to contamination.			
	The use of vehicles, machinery, equipment for mobilization, and generators for lighting on site may emit gaseous emissions, particulates, and noise. These emissions and noise levels could contribute to the degradation of ambient air quality and an increase in ambient noise levels.	High	Regular maintenance of project vehicles and machinery shall be conducted to comply with international emission standards. Noise attenuation measures such as barriers or mufflers shall be implemented.	Low
	Noise generated by machinery may disturb wildlife species, causing them to flee the site and potentially leading to changes in species composition and abundance due to migration from the area.	Low	Noise attenuation measures such as barriers or mufflers shall be implemented. Disturbed areas shall be re-vegetated promptly to restore plant productivity and maintain biodiversity.	Negligible
	Potential soil and /or water contamination form mishandling of generated solid and liquid wastes, and other decommissioning and closure procedures related waste.	Medium	International best practices for waste management shall be adhered to. Certified waste management contractors shall be engaged for waste collection and disposal.	Low
	Traffic congestion could lead to physiological effects on individuals due to associated stress and frustration.	High	Project transportation shall be planned strategically to minimize interactions with local routine transport. Transportation shall be scheduled during off-peak periods whenever possible.	Low

	The influx of job seekers into the area may result in changes to the population characteristics of the project area.	Medium	Comprehensive pension plans for project workers shall be ensured. Skills training shall be offered to provide alternative means of livelihood.	Low

Table 6.3: Summary of Direct Biophysical and Socio-Economic Mitigation Measures.

Receptor	Summary of Mitigation Measures
Biophysical Environment	
Air Quality	▪ Ensure adequate maintenance and repair equipment and machineries ▪ Adopt a traffic management plan while avoiding congest routes ▪ Ensure that vehicles and machines are switched off when not in use ▪ Water surfaces to control dust emissions ▪ Avoid burning of materials resulting from onsite clearance ▪ Ensure that persons working in areas prone to dust are provided PPEs ▪ Ensure the use of high-quality diesel for generators and vehicles ▪ Maintain minimum traffic speed on-site and on access roads ▪ Ensure that construction materials and hazardous substances are well handled ▪ Cover all vehicles hauling materials likely to give off excessive dust emissions ▪ Regularly water spray surfaces to control dust emissions
Water Resources	▪ Ensure to install sediment and erosion control measures ▪ Follow guidelines and procedures for immediate cleanup of spillages (oil, fuel, chemicals) ▪ Cover open stockpiles of construction materials on site with tarpaulins during rainstorm events to prevent the washing away of construction materials ▪ Install natural or synthetic liners beneath chemical storage tanks ▪ Compact earthworks as soon as the final surfaces are formed to prevent erosion especially during the wet season ▪ Ensure to grade gravel roads for maintenance of existing drainage patterns ▪ Ensure the protection of riparian areas ▪ Ensure to avoid dumping of construction waste into water bodies ▪ Ensure that proper storage of chemicals and onsite materials

Aquatic Ecology	▪ Schedule construction activity to avoid heavy rainfall ▪ Ensure that hazardous materials are not discharge in aquatic ecosystems ▪ Ensure to construct fence at the perimeter of construction site to avoid cross pollution with aquatic resources ▪ Ensure to prevent dumping of oil, filter cans and other substances into aquatic ecosystem
Terrestrial Ecology	▪ Cautions must be accorded during vegetation clearing to minimize species loss and destruction ▪ Ensure that all species of conservation values are enumerated, conserved and reported to the designated conservation authority
Waste Water	▪ Ensure to obtain required permit for discharge of effluent and chemical wastes ▪ Ensure that all effluent and chemical wastewater meets at acceptable levels for discharging ▪ Ensure that the point of discharge of effluent and wastewater is approved prior to any discharge ▪ Ensure to adopt good house keep during construction phase and operation phase ▪ Ensure that washing water from vehicles is drained in a sand/silt
Biodiversity	▪ Ensure that no flora species classified as Vulnerable on the IUCN Red List are removed or cleared ▪ Ensure that no tree greater than 200 mm diameter at breast height is damaged ▪ Promote plantation of trees and green corridors along the project facility ▪ Ensure that no species discovered during excavation are traded for commercial value ▪ Minimize vegetation clearance ▪ Prevent any hunting activities ▪ Ensure to report fauna species of high conservation value ▪ Avoid all direct and indirect impact on areas of high ecological ▪ Ensure that sustainable management of solid and liquid waste emanating from construction and operation activities ▪ Ensure outdoor construction lighting is unobtrusive and turn off when not required
	▪ Landscape the excavated areas in a suitable way to allow native vegetation to regrow naturally ▪ Suspend activities during extreme rainfall events

Soil	▪ Ensure to Provide drainage channels and silt traps for all parts of the topsoil storage areas ▪ Ensure to rehabilitate areas with topsoil and revegetate after completion of activities ▪ Install sediment and erosion controls ▪ Use non-toxic and readily biodegradable chemicals on-site where feasible ▪ Install natural or synthetic liners beneath chemicals storage tanks ▪ Grade unpaved roads
Hydrocarbons and Hazardous Materials	▪ Ensure that disposal of obsolete chemicals, fertilizers, and other industrial processing chemicals occurs according to the EPA's standards ▪ Ensure that all chemicals are clearly label and stored in accordance with their respective Material Safety Data Sheet (MSDS) ▪ Ensure to store hazardous materials separately from non-hazardous materials ▪ Use oil traps ▪ Ensure to hydrocarbons in a separate area that has an impermeable floor, adequate space, ventilation and roof to prevent rainfall from seeping ▪ Carefully fuel/refuel vehicles, and machineries to avoid spillage
Noise	▪ Choose inherently quiet equipment ▪ Keep equipment speed as low as possible ▪ Minimize idling time for pickup trucks and other equipment ▪ Limit site working hours where feasible ▪ Ensure that all workers exposed to noise emanating environment are equipped with hearing protection and relevant PPEs ▪ Schedule noisy activities during the morning hours ▪ Enforce noise monitoring ▪ Inform the locals when noisy activities are planned ▪ Utilize and properly maintain silencers or mufflers that reduce vibration on construction equipment ▪ Operate only well-maintained mechanical equipment on-site

Socio-Economic	▪ Ensure to set up a formal compliant register system which responds to complaints about nuisances in a timely manner ▪ Adopt policies for recruiting locally and hiring local sub-contractors as much as possible ▪ Include local communities in the consultations and participation process throughout the project activities ▪ Ensure high rate of local employment to minimize influx of foreign workers ▪ Ensure equal employment opportunities ▪ Adhere to prohibition of child labor ▪ Prohibit discrimination in any form or manner such as religion, ethnicity, tribe, creed etc. ▪ Adopt a grievance mechanism to enable the communities and employees to relate concerns that arise from the Project or Contractors
Socio-Economic Environment	
Land and Land Use	▪ Conduct assessment to verify if project do not trigger relocation/resettlement ▪ Conduct thorough assessment of project area of influence to understand and address relevant environmental and social risks ▪ Utilize alternative designs to reduce and minimize land use impacts ▪ Adopt Chance Find Procedures for unanticipated discovery of finding of archaeological or historical significance
Waste Generation	▪ Promote recycling and reuse of general refuse ▪ Ensure that disposal of obsolete chemicals, fertilizers, and other industrial processing chemicals occurs according to the EPA's standards ▪ Prohibit the burning of refuse on the construction and operation site ▪ Ensure to obtain required authorization from the EPA for disposal of hazardous waste generated onsite ▪ Segregate chemical wastes and properly store and dispose hazardous waste according to the EPA's standards ▪ Recycle onsite whenever feasible ▪ Fence construction site to prevent flying materials to deposit in nature ▪ Ensure that vehicles transporting wastes are fully covered ▪ Ensure adequate onsite waste segregation ▪ Adopt good housekeeping practices during all phases of the project

	▪ Prohibit all forms of littering on-site
Health and Safety	▪ Provide surveillance and active screening of workers ▪ Provide health care benefits to workers ▪ Ensure that hazardous substances are kept in suitable, safe, adequately marked and locked storing place ▪ Conduct health awareness initiative ▪ Restrict access to the operation sites ▪ Ensure that employee/workers/ contractors are informed about the risks and prevention methods for Corvid 19, Ebola, HIV, STDs and others ▪ Conduct firefighting and leak checks training drills for staff ▪ Ensure that workers are qualified, well trained and instructed in handling their equipment, including PPEs ▪ Install warning signs at the entrance of the site to prohibit public access ▪ Provide appropriate PPE (impermeable latex gloves, working overalls, safety boots, safety helmets, safety goggles, hearing protein devices for workers exposed to noise levels exceeding 90 dBA, and lifesaving vests for sites near water bodies) ▪ Develop and implement an Emergency Preparedness & Response Plan ▪ Ensure containers of hazardous substances are clearly marked and that MSDS's are available ▪ Designate an area where contaminated materials and hazardous can be stored for proper disposal according to the EPA's standards ▪ Provide training to personnel on occupational health and safety and safety procedures prior to beginning work at sites ▪ Ensure that sensitive and dangerous areas with high risks are clearly designated ▪ Ensure that presence of an onsite first aid treatment facility ▪ Adopt good housekeeping practices for ensuring hygiene on site ▪ Ensure the presence of firefighting equipment such as dry powder extinguisher ▪ Ensure that safety specialist is recruited to manage the preparation, implementation and maintenance of a comprehensive safety program ▪ Ensure to eliminate pools of stagnant water, which could serve as breeding grounds for infectious diseases ▪ Install warning signs at places where dangerous and high risks operations are ongoing ▪ Ensure that protective materials are use at all times

Traffic	▪ Properly plan and develop traffic control plan ▪ Notify the affected communities regarding the operation schedule and consult with them about potential traffic issues ▪ Provide traffic re-rooting plan for the construction phase ▪ Limit the movement of heavy machineries to off-peak hours and provide prior notification to local communities ▪ Repair any road damage caused by increased traffic due to operations ▪ Pave road where heavy use is expected ▪ Speed limitation should be enforced for instance, onsite 10km/h, through towns and villages 35km/h and on the highway 80km/h ▪ Ensure safety of motorists through adequate warning, signing, delineation and channeling at least 500 m down and up-gradient form the construction site ▪ Ensure the prohibition of passenger siting on the back of trucks working for the Contractor/sub-contractor ▪ Ensure that all drivers are licensed and obey traffic rules and regulations
Visual Amenity	▪ Ensure that site cleanliness and sanitation is maintained ▪ Ensure outdoor construction lighting is unobtrusive and turn off when not required
Accident	▪ Ensure that all accidents and incidents are report and investigated ▪ Ensure that all workers are qualified, ell trained and instructed in handling their equipment, including health protection equipment ▪ Implement speed limits for trucks entering and exiting the construction facility ▪ Ensure that vehicles transporting wastes are fully covered ▪ Ensure adequate onsite waste separation ▪ Adopt good housekeeping practices during all phases of the project ▪ Ensure the presence of an onsite First Aid Provider ▪ Ensure that safety specialist is recruited to manage the preparation, implementation and maintenance of a comprehensive safety program ▪ Adopt good housekeeping practices for ensuring hygiene on site ▪ Ensure the presence of firefighting equipment such as dry powder extinguisher ▪ Ensure that safety specialist is recruited to manage the preparation, implementation and maintenance of a comprehensive safety program ▪ Ensure to eliminate pools of stagnant water, which could serve as breeding grounds for infectious diseases

	▪ Install warning signs at places where dangerous and high risks operations are ongoing ▪ Ensure that protective materials are use at all times ▪ Provide surveillance and active screening of workers ▪ Provide health care benefits to workers ▪ Ensure that hazardous substances are kept in suitable, safe, adequately marked and locked storing place ▪ Conduct health awareness initiative ▪ Restrict access to the operation sites ▪ Ensure that employee/workers/ contractors are informed about the risks and prevention methods for COVID-19, Ebola, HIV, STDs and others ▪ Conduct firefighting and leak checks training drills for staff ▪ Ensure that workers are qualified, well trained and instructed in handling their equipment, including PPEs ▪ Install warning signs at the entrance of the site to prohibit public access ▪ Provide appropriate PPE (impermeable latex gloves, working overalls, safety boots, safety helmets, safety goggles, hearing protein devices for workers exposed to noise levels exceeding 90 dBA, and lifesaving vests for sites near water bodies) ▪ Develop and implement an Emergency Preparedness & Response Plan ▪ Ensure containers of hazardous substances are clearly marked and that MSDS's are available
Cultural Heritage	▪ Ensure to apply the standard Procedures for Chance Finds

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Introduction

The Environmental and Social Management Plan (ESMP) serves as a stand-alone tool utilized to monitor the effectiveness of mitigation measures and project commitments outlined in the Environmental and Social Impact Assessment (ESIA). It is integrated into the project implementation process to minimize or eliminate adverse impacts and ensure compliance with environmental regulatory standards and corporate HSE policies. The ESMP outlines the commitments to implementing mitigation measures incorporated into the project design, as well as additional mitigations recommended in the ESIA. It also delineates the roles and responsibilities of various stakeholders. Furthermore, the ESMP emphasizes all biophysical and social environmental attributes to be monitored throughout the lifecycle of the proposed project, aiming to curtail associated negative, residual, and cumulative impacts, and identify any impacts not addressed in the ESIA report arising from project implementation.

7.2 Scope and Objectives of ESMP

The ESMP is designed to meet required standards and regulations on environmental and social management performance, aligning with ISO 14001: Environmental Management System (EMS) guidelines. It encompasses the entire project lifecycle from pre-construction to decommissioning phases and undergoes reviews and updates before activities commence. The main objective of the ESMP is to integrate environmental and social considerations into daily decision making, ensuring that environmental risks are managed throughout the project lifecycle. It serves as a working document for tracking, evaluating, and communicating environmental and social performance, with objectives including monitoring compliance, ensuring best practices management, and raising awareness of potential impacts.

Detailed objectives of the ESMP include defining contractors' roles and responsibilities, outlining monitoring and supervision by the National Investment Commission, ensuring high environmental protection, and working standards, assisting the contractor in implementing mitigation measures and preventing environmental damages, ensuring compliance with HSE policies and national legislations, and identifying and reducing risks associated with work processes.

Objectives:

i. To identify and assess potential environmental and social impacts of the AIH Project.
ii. To establish procedures and mechanisms for responding to and managing identified impacts.
iii. To ensure compliance with regulatory requirements and international standards for environmental and social management.
iv. To promote stakeholder engagement, transparency, and accountability in impact response activities as well as address concerns and issues raised in the EIA's stakeholder engagement process.
v. Incorporate environmental and social management into Project design and operating procedures.

7.3 Stakeholders Engagement Plan

Consistent with the African Development Bank Group Environmental and Social Policies and Guidelines, the stakeholder's engagement plan is designed to establish an effective platform for productive interaction with the potentially affected parties, disadvantaged groups, and others with interest in the implementation outcome of the Project. The stakeholder engagement plan will provide meaningful stakeholder engagement throughout the project cycle. The consultation is aimed to solicit views, concerns, comments, and inputs from wide range of stakeholders and project affected parties regarding project implementation.

The primary objectives of the Stakeholder Consultation are summarized below:

- Provide project related information and materials to affected and interested parties.
- Solicit feedback from stakeholders to inform project design, implementation, monitoring, and evaluation.
- Enhance project acceptance by clarifying project objectives and scope at an early stage and manage stakeholders' expectations.
- Assess and mitigate project environmental and social impacts and risks.
- Enhance project benefits.
- Address project grievance.

During the ESIA process, stakeholders from all levels (national, local government and residents in the project affected area) will be consulted and views be sought through interviews, group discussions and several public meetings. The SAPZ Project Stakeholder to be consulted will include:

- Federal Ministry of Environment (FMENV).
- Plateau State Urban and Regional Planning Board.
- Plateau State Ministry of Environment.
- Plateau State Ministry of Agriculture and Rural Development.
- Barkin Ladi Local Government Area (LGA).
- Federal Ministry of Agriculture and Food Security (FMAFS).
- Project Affected Persons (PAPs) and affected communities.
- Community Based Organizations.

The Public Consultation process will be initiated during the early stage of the project. Relevant stakeholders engaged and consulted regarding the prospects of the project, meetings conducted between the Consultant, and the project Implementation Team, Essential documents about the project to be reviewed and resources persons and experts' views solicited. Other sources of information and regulatory institutions will be consulted and detailed with use of specialized data collection and interpretation tools to facilitate the field assessments and surveys. Stakeholder consultation will be conducted at the local level to solicit inputs, views and comments from the project affected rural people.

The Consultation shall aim to:

- Promptly address issues and concerns raised to avoid conflict;
- Comply with national regulation and international best practices;
- Build consensus on identified potential adverse/beneficial impacts of the proposed project and proffering mitigation measures before the project commencement;
- Address any misconceptions concerning the development that may arise;
- Ensure that any apprehension and fears about the project, nature, scale, and impact of the operation have been addressed.

The proceedings take the form of:

- Introduction of the project to community members and stakeholders.
- Informing them of the locations for the proposed development and the nature of the project.
- Entertaining comments and questions from stakeholders.
- Addressing concerns raised by stakeholders.

7.3.1 Grievance Redress Mechanism (GRM)

The Grievance Redress Mechanism is designed to address concerns and complaints from affected stakeholders promptly and effectively. Key elements include:

Purpose: To provide a transparent, fair, and accessible process for stakeholders to raise grievances related to the project.

Procedure: Establishment of multiple channels for lodging complaints (e.g., hotlines, suggestion boxes, community meetings), clear timelines for response, and a step-by-step process for resolving issues.

Responsibility: Designated grievance officers to manage and monitor the process, ensuring all complaints are logged, acknowledged, and addressed in a timely manner.

Documentation: Maintenance of a grievance log to track all received complaints, resolutions, and any follow-up actions.

7.3.2 Security Management Plan

The Security Management Plan addresses the protection of project assets, personnel, and the surrounding community. Key elements include:

Risk Assessment: Identification of potential security threats and vulnerabilities related to the project.

Security Measures: Implementation of physical security measures such as fencing, surveillance cameras, and security personnel.

Protocols: Establishment of security protocols for various scenarios, including theft, vandalism, and emergency evacuations.

Community Relations: Coordination with local law enforcement and community leaders to ensure a collaborative approach to security.

7.3.3 Resettlement Action Plan (RAP) and Livelihood Restoration Plan (LRP)

The RAP and LRP are developed to mitigate the adverse impacts of land acquisition and ensure affected persons' livelihoods are restored or improved. Key elements include:

Resettlement: Detailed plans for relocating affected individuals, including compensation for lost assets and assistance with moving and rebuilding homes.

Livelihood Restoration: Programs to restore income and livelihood activities, such as skills training, employment opportunities, and support for small businesses.

Consultation: Ongoing engagement with affected communities to ensure their needs and concerns are addressed throughout the resettlement process.

Monitoring and Evaluation: Regular monitoring to assess the effectiveness of resettlement and livelihood restoration efforts and make necessary adjustments.

7.4 Environmental Health and Safety Plan

A Health and Safety Plan will be prepared for the construction, operation, and decommissioning phases of the project to ensure compliance with the Ministry of Health Guidelines for Occupational Health and Safety and IFC guidelines.

To ensure the health and safety of its employees, the SAPZ – AIH, Heipang plan will address the following topics:

- Safety devices to protect employees from injuries or hazardous conditions.
- Provision of safe drinking water.
- Immunizations, as applicable.
- Maintenance of a clean eating area.
- Availability of first aid facilities.
- Maintenance of sanitary conditions.
- Waste management, including bathrooms and proper disposal procedures.
- Provision of appropriate signage.
- Installation of fire prevention facilities, along with training and awareness programs.
- Provision of Personal Protective Equipment (PPE).

A safety specialist shall be responsible for preparing, implementing, and maintaining a comprehensive safety program, which will be periodically evaluated. The safety specialist will be provided with written safety instructions, including guidance on the correct storage, handling, and disposal of hazardous waste, as well as written contingency plans/guidelines for accidents, spills, and fires. The responsibility of the safety specialist includes conducting safety training, safety inspections, sessions, and drills. Additionally, the safety specialist will be responsible for investigating accidents. A safety committee would be formed and organize regular safety meetings.

7.4.1 Health, Safety, and Environment (HSE) Training Plan

The HSE Training Plan aims to ensure that all project personnel are adequately trained to perform their duties safely and responsibly. Key elements include:

Training Programs: Development of comprehensive training modules covering topics such as workplace safety, emergency response, environmental protection, and first aid.

Audience: Targeting different training programs for various groups, including management, workers, and contractors.

Frequency: Regular training sessions to ensure ongoing compliance and awareness, with refresher courses at specified intervals.

Evaluation: Assessing the effectiveness of training programs through feedback, quizzes, and practical drills.

7.5 Emergency Response Plan

An Emergency Preparedness and Response Plan (EPRP) will be prepared to assist project staff in effectively responding to emergencies associated with project hazards. The EPRP will comply with the Federal Ministry of Environment, Nigeria, EIA Procedural Guidelines, the ISO 14001 approach, and the Hazard and Effect Management Process (HEMP), International Labour Organization (ILO), Nigeria, Occupational Safety guidelines and performance standards. The EPRP will include:

- Roles and responsibilities of emergency personnel.
- Emergency contacts and communication systems/protocols, including procedures for interaction with local and regional emergency authorities.
- Specific emergency response procedures.
- Design and implementation of an emergency alarm system audible across the entire site and at the sub-stations.
- An evacuation plan will be read and practiced by all employees and contractors. The evacuation plan will include emergency escape routes, procedures for accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation.
- Identification of supplies and resources to be utilized during an emergency event, including emergency equipment, facilities, and designated areas.
- A training plan, which includes specific training and drill schedules for personnel who are responsible for rescue operations, medical duties, spill response, and fire response.

If an emergency develops, all persons on-site will be notified immediately, and efforts will be coordinated with others in the vicinity surrounding the project area to reduce impacts, if applicable. The National Emergency Management Agency (NEMA), Plateau State regional /local contact, local police, and all necessary authorities will be immediately notified. If an emergency is imminent, but has not yet begun, steps will be initiated to immediately advise persons in the vicinity of the emergency to evacuate, and notifications will be made to NEMA, the County Superintendent, local police, and all other authorities responsible for the emergency.

If there is a slowly developing emergency or an unusual situation where an emergency is not imminent but could occur if no action is taken, project personnel will notify NEMA, the local police, and all other authorities of the potential problem and keep them advised of the situation. These agencies will be requested to indicate if there are any immediate actions that should be taken to reduce the risk or severity of the emergency, and if necessary, what preventative actions will be implemented. In an emergency, equipment and supplies will be needed on short notice. Therefore, the Heipang, SAPZ – AIH will maintain an accurate inventory of emergency response equipment and supplies.

The EPRP will include an evacuation plan that will be read and practiced by all employees and contractors. The evacuation plan will include emergency escape routes, procedures for accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation. In general, the following evacuation procedures should be followed:

- Alert the Emergency Response Team to assist in the evacuation.
- Use communication tools that are appropriate for the type of incident and the time of occurrence, such as alarms or loudspeakers.
- When communicating an evacuation, speak clearly and succinctly: We have a [state the type of emergency]. Evacuate to [state the assembly point].
- Turn equipment off, if possible.
- Take emergency supplies and staff rosters, if possible.
- Account for personnel.
- Wait at the assembly point for further instructions.

The EPRP will have specific information on fire safety and explosion response, which will provide additional details specific to these emergencies.

7.6 Waste Management Plan

Waste management guidelines and disposal options is very necessary for the running of a plant. The continuous use of the principle of waste reduction, recycling, recovery, and reuse will make the company to be more environmentally friendly.

The Heipang, SAPZ – AIH will develop a project-specific waste management plan to ensure proper management of all waste generated during project activities, including agricultural waste and waste from agro-allied industrial development, in accordance with applicable laws, regulations, and international standards relevant to the power distribution industry. The Waste Management Plan will encompass:

- Description of the types of waste generated, including agricultural waste and agro-allied industrial development related waste.
- Opportunities for waste minimization, including strategies tailored to agricultural and agro-allied industrial activities.
- Methods for waste management, addressing the unique characteristics of agricultural waste and agro-allied industrial development related waste.
- Good housekeeping practices, including manifest and waste tracking forms specific to agricultural and agro-allied industrial waste.

In addition to the previously mentioned waste categories, agricultural waste like crop residues, processing by-products, and packaging materials, will be considered. These waste types will be

managed through appropriate methods, including composting, recycling, and reuse, where feasible and environmentally sound. During the construction phases, efforts will be made to minimize agricultural waste generated from land clearing activities and to properly manage any waste produced. Similarly, waste generated from agro-allied industrial development activities, such as processing operations, will be managed according to the Waste Management Plan's guidelines.

Chemical waste generated from agricultural activities, such as pesticide containers and residues, will be segregated and managed in accordance with hazardous waste protocols outlined in the plan. Similarly, waste from agro-allied industrial processes, such as chemical processing or manufacturing, will be handled according to relevant regulatory requirements. The Waste Management Plan will outline specific procedures for the storage, handling, and disposal of chemical and agricultural waste, ensuring their proper management throughout the project lifecycle.

For proper handling and disposal, wastes shall be well defined at source and the definition transmitted along with the waste to the final disposal points. The required basic information that would be provided, as a minimum, for adequate definition of wastes include:

- Waste type identification.
- Proper waste categorization.
- Waste segregation information.
- Location of generation.
- Recommended management practices.

Waste Characterization and Quantification

- Conduct a comprehensive waste characterization and quantification study to identify the types, quantities, and sources of waste generated by the project activities, including solid waste, liquid waste, and hazardous waste.
- Classify waste streams based on their composition, toxicity, and potential environmental impacts to facilitate appropriate management practices.

Waste Reduction and Minimization

- Implement measures to reduce waste generation at the source through process optimization, resource efficiency, and product design improvements.
- Promote the use of eco-friendly materials, packaging, and technologies that minimize waste generation and facilitate recycling and reuse.
- Encourage the adoption of circular economy principles, such as closed-loop systems and product stewardship, to minimize waste and maximize resource efficiency.

Waste Segregation and Collection

- Establish a waste segregation program to separate different types of waste at the source, including organic waste, recyclables, and hazardous waste.
- Provide adequate waste collection infrastructure, such as bins, containers, and collection points, to ensure proper segregation and containment of waste materials.
- Train project staff and contractors on waste segregation protocols and best practices to minimize contamination and facilitate recycling and recovery efforts.

Recycling and Resource Recovery

- Develop partnerships with local recycling facilities and waste management companies to facilitate the recycling and recovery of recyclable materials, such as plastics, glass, paper, and metals.
- Establish on-site facilities for composting organic waste and converting biomass into renewable energy sources, such as biogas or biofuels.
- Explore opportunities for value-added utilization of waste materials, such as converting agricultural residues into bio-based products or using treated wastewater for irrigation.

Hazardous Waste Management

- Identify hazardous waste generated by project activities, including agrochemicals, pesticides, and chemical solvents.
- Implement procedures for the safe handling, storage, transportation, and disposal of hazardous waste in compliance with regulatory requirements.
- Provide training and personal protective equipment (PPE) to personnel involved in hazardous waste management to minimize health and safety risks.

Monitoring and Reporting

- Establish monitoring protocols to track waste generation, segregation, collection, recycling rates, and disposal practices.
- Regularly monitor and evaluate the effectiveness of waste management measures and adjust strategies as needed.
- Prepare periodic reports on waste management performance and compliance with regulatory requirements for submission to relevant authorities.

The project hopes to construct the following infrastructures below as part of the common structures in the AIH

- **Sewerage Collection and Treatment System**: An underground sewerage network has been designed to collect sewage from each plot and convey it to a sewage treatment plant (STP). At the STP, the sewage would be treated to acceptable standards and the treated sewage will be used for irrigation purpose for which pipe network is considered.
- **Effluent Collection and treatment system**: The major effluent generated will be from the Yam processing plant through washing and from the cassava processing plant generated through washing and from the centrifuge. The effluent treatment will be through a series of anaerobic and aerobic treatment. The treated effluent will meet the standard to be supplied back for washing and agriculture purposes.

7.7 Climate Management Plan

Using the Climate and Disaster Risk Screening Tool, a comprehensive assessment was conducted for the proposed site, enabling the consideration of both short- and long-term climate and disaster risks during the early stages of project design. Integrating resilience-building measures against climate and geophysical hazards is crucial in combating poverty and promoting sustainable development. By screening for risks associated with these hazards, the likelihood and longevity of project success are significantly enhanced.

The project-level Climate and Disaster Risk Screening facilitates preliminary evaluation of climate and disaster risks during the conceptual phase of project development. The results of this screening tool, focusing on selected subsectors such as crops and land management, livestock, rural transport, and storage and processing, indicate the types of Climate Risk Management Measures to be implemented for the project (Table 7.1).

To ensure the adoption of Climate-smart agriculture (CSA) practices at the farm level, the project should prioritize enhancing livelihoods and food security, particularly for smallholders, through improved management and utilization of natural resources. This involves implementing suitable approaches and technologies for the production, processing, and marketing of agricultural commodities.

Key elements to be integrated into climate-smart agricultural approaches for the project include:

- Enhanced management of farms, crops, livestock, aquaculture, and capture fisheries to optimize resource utilization, increase productivity, and enhance resilience.
- Ecosystem and landscape management strategies aimed at conserving critical ecosystem services to improve resource efficiency and bolster resilience.

- Provision of support services for farmers and land managers to facilitate the adoption of necessary changes and ensure the successful implementation of climate-smart agricultural practices.

7.7.1 Greenhouse Gas (GHG) Emissions Mitigation

- A comprehensive GHG emissions assessment to identify sources and quantify emissions associated with the project activities will be conducted.
- Energy-efficient technologies and renewable energy sources (such as solar or biomass) for powering the AIH facilities to minimize carbon footprint will be implemented.
- Sustainable agricultural practices, including conservation agriculture and agroforestry, to sequester carbon in soils and vegetation will be promoted.
- The use of low-emission transportation methods for goods and personnel, such as electric vehicles or biofuel-powered vehicles will be implemented.

7.7.2 Climate Risk Assessment and Adaptation

- A climate risk assessment to identify potential climate hazards (e.g., flooding, drought, extreme temperatures) and their impacts on the project site and surrounding communities will be conducted.
- Infrastructure and facilities resilient to climate hazards, incorporating measures such as flood-resistant construction, water management systems, and heat-resistant building materials will be designed.
- Early warning systems and emergency response plans to mitigate the impacts of climate-related disasters on project operations and personnel will be developed.
- With local communities to integrate indigenous knowledge and traditional practices for climate adaptation into project planning and implementation will be engaged.

7.7.3 Monitoring, Reporting, and Evaluation

- To establish monitoring and evaluation mechanisms to track the implementation of climate management measures and their effectiveness in reducing emissions and enhancing climate resilience.
- Regularly report on climate performance indicators, including GHG emissions reductions, climate risk management outcomes, and sustainable resource management practices.
- Conduct periodic reviews and assessments to identify lessons learned, update climate management strategies, and ensure continuous improvement in environmental performance.

Table 7.1: Climate Risk Management Measures

Objective	Focus
Optimize crops and land management practices	- Tailoring cropping practices to suit specific crops and anticipated rainfall patterns. - Advocating for investments in sustainable land use practices. - Broadening agricultural production to reduce reliance on rainfed crops. - Advocating for land tenure and property rights reforms to enhance local natural resource management. - Equipping farmers with drought- and heat-tolerant crop varieties. - Creating new insurance mechanisms to mitigate climate-related risks. - Assisting smallholders in crop diversification to enhance resilience against changing climate conditions. - Implementing measures to curtail detrimental agricultural practices that contribute to erosion and soil degradation.
Improve livestock practices	- Enhance national animal health services. - Advocate for the adoption of livestock breeds suited to the local climate. - Promote integrated crop-livestock systems and improved water, feed, and animal management practices to enhance livestock productivity.
Improved Irrigation and Drainage	- Prioritize irrigation for drought-sensitive farming and ecosystems. - Enhance capacity to incorporate climate change scenarios into water resources policy planning. - Implement technical measures to enhance water use efficiency in rainfed and irrigated agriculture. - Adopt high-efficiency irrigation methods, such as drip and trickle irrigation. - Explore techniques for water reuse, rainwater harvesting, and sustainable drainage. - Utilize farm ponds, farm drainage, and expand micro irrigation systems. - Evaluate investments in small and medium reservoirs and water supply projects for irrigation purposes. - Enhance water supplies for agricultural use.

Protect/Harden	- Revise design standards to incorporate anticipated storm surge levels. - Deploy wind protection strategies to mitigate potential damage. - Restore vegetation on unstable slopes to stabilize soil and prevent erosion. - Enhance drainage infrastructure to manage increased rainfall and mitigate flooding.
Retreat/Relocate	- Assess the feasibility of raising critical facilities to mitigate overflow and inundation risks. - Develop relocation plans for affected communities to safer areas. - Consider relocating crops to alternative land plots to avoid flood-prone areas. - Explore options for moving infrastructure to more inland locations to reduce vulnerability to coastal hazards.
Build training and information systems	- Enhance institutional capacity to comprehend and manage the impacts of climate change on both institutions and rural communities - Expand accessibility to climate information, including long-term weather forecasts and improved seasonal predictions for informed decision-making in agricultural activities - Establish early warning systems offering daily weather updates and seasonal forecasts to aid in crop selection and timing - Enhance training and educational programs focused on sustainable agriculture practices and the adoption of efficient irrigation techniques
Strengthen policies, planning and systems	- Incorporate climate information into system planning processes. - Enhance coordination of policies and programs among agriculture ministries and other government agencies to address climate change challenges. - Bolster the capabilities of disaster risk management and meteorological departments to enhance the quality of decision-making information.

7.8 Environmental Management Plan

The primary object of environmental monitoring is to ensure that mitigation measures are implemented, and the potential negative impacts are reduced, minimized to acceptable levels. The primary objective of the Special Agro-Industrial Processing Zone Monitoring Plan includes the following:

- To assess the changes in environmental conditions.
- To assess performance and the effectiveness of the mitigation measures adopted.
- To determine project compliance with regulatory requirements and adopt remedial action.
- To identify potential gaps and promptly implement of corrective measures.

The project monitoring scope is divided into two (2) main phases namely;

3. Impact detection monitoring which includes periodic sampling to assess the impact of project operations on the environment and human health, and to ensure progress towards minimizing project's negative impact. This is also referred to as Institutional monitoring which be conduct by the project Environmental Officer and team of sustainable staff.
4. Compliance monitoring is conducted to ensure that all project and sub-project activities are in full compliance with the Environmental Protection Agency regulations and standards. It is usually commissioned by a Third-Party Evaluator accredited by the FMEnv.

7.8.1 Monitoring Parameters

The receptors required monitoring include:

j) Air Quality
k) Water Resources
l) Soil Quality
m) Waste Generation & Management
n) Occupational Health and Safety
o) Odor
p) Noise Quality
q) Landscape and Visual
r) Biodiversity
s)

EHS Management Plan to Be Developed for The Project Include:

- Development of an Environmental Health and Safety Plan
- Development of a Project Specific Emergency Response plan
- Development of a Project Specific management Plan
- Development of a Spill Contingency Management Plan
- Completion of a "Bridging" process with contractors to evaluate their EHS procedures.

7.8.2 Development of an Environmental Health and Safety Plan

A Health and Safety Plan will be prepared for the construction, operation and decommissioning phases of the project to ensure compliance with the Ministry of Health Guidelines for Occupational Health and Safety and IFC guidelines.

To ensure its employees' health and safety, the SAPZ plan will address the following topics:

- Safety device to protect employees from injuries or hazardous conditions;
- Safe drinking water;
- Immunizations, as applicable;
- Clean eating area;
- First aid facilities;
- Sanitary conditions;
- Waste management, including bathrooms, and proper disposal procedures;
- Appropriate signage;
- Fire prevention facilities, training, and awareness; and
- Personal Protective Equipment (PPE).

A safety specialist assigned by SAPZ II will be responsible for the preparation, implementation and maintenance of a comprehensive safety program, which will be periodically evaluated. The safety specialist will be provided with written safety instructions including instructions on correct storage handling and disposal of hazardous waste and written contingency Plans / guidelines of action for accidents, spills, and fire. The responsibility of the safety specialist includes performing safety training and conducting safety inspections, sessions and practice. The safety specialist will also be responsible for the investigation of accidents. A safety committee should be formed by SAPZ II and regular safety meetings should be organized.

7.8.3 Development of an Emergency Response Plan

- An Emergency Preparedness and Response Plan (EPRP) will be prepared to assist project staff in effectively responding to emergencies associated with project hazards. The EPRP will comply with the IFC Occupational Safety guidelines and performance standards. The EPRP will include:
- Roles and responsibilities of emergency personnel;
- Emergency contacts and communications systems/protocols, including procedures for interaction with local and regional emergency authorities;
- Specific emergency response procedures;
- Design and implementation of an emergency alarm system audible across the entire site at the sub-stations;
- An evacuation plan will be read and practice by all employees and contractors. The evacuation plan will include emergency escape routes, procedures for accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation;

- Identification of supplies and resources to be utilized during an emergency event, including emergency equipment, facilities, and designated areas; and
- A training plan, which includes specific training and drill schedules for personnel
- Who are responsible for rescue operations, medical duties, spill response, and fire response?

If an emergency develops, all persons on site will be notified immediately and efforts will be coordinated with others in the vicinity surrounding the project area to reduce impacts, if applicable. The EPRP will include an evacuation plan which will be read and practiced by all employees and contractors. The evacuation plan will include emergency escape routes, procedures, for accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation. In general, the following evacuation procedures should be followed:

- Alert the Emergency Response Team to assist in the evacuation.
- Use communications tools that are appropriate for the type of incident and the time of occurrence, such as alarms or loudspeakers.
- When communicating an evacuation, speak clearly and succinctly: “we have a [state the type of emergency]. Evacuate to [state the assembly point]”.
- Turn equipment off, if possible.
- Take emergency supplies and staff roasters, if possible.
- Account for personnel.
- Wait at the assembly point for further instructions.

The ERPP will have specific information on the fire safety and explosion response, which will provide additional details specific to these emergencies.

7.8.4 Development of a Waste Management Plan

The SAPZ will develop a project specific waste management plan to ensure that all waste for the project activities are properly managed in accordance with applicable laws and regulations, and international standards relevant to the power distribution industry. The waste Management Plan will include:

- Description of the types of waste that will be generated.
- Waste minimization opportunities.
- Waste management methods.
- Good housekeeping practices, including manifest and waste tracking forms.

The following general categories of waste are anticipated to be generated from the project at this time:

- Hazardous waste such as construction wastes and debris from exaction materials, unused paint, lubricant, batteries, or similar chemicals that exhibit flammability, corrosive or reactive characteristic.
- Liquid waste discharged such as sanitary wastewater and gray water, macerated food waste.
- Solid wastes, such as packaging materials, containers, used PPE.
- Special and recyclable waste, e.g. Batteries, used oil, paper aluminum cans, fluorescent light boils, mercury light builds.
- Domestic waste, e.g. refuse.

The plan will specify the proper storage, handing and disposal procedures for each waste identified.

During the construction phases, these will be generation of construction debris because of various construction activities. The generate materials will be used for reclamation purposes whenever applicable. Nevertheless, care will be taken to ensure the absence of contaminated fill material and the adequacy of the physical and chemical properties of such material to limit potential adverse impacts on water and soil and ensure the safety of the project. Construction waste will also be minimized through careful planning during the design stage, whereby reducing or elimination overpowering of construction materials to decrease waste generation and reduce project costs (cost of surplus materials). Sorting of construction and demolition waste will be encouraged, as well as adoption of a re-use/recycle program on site whenever deemed feasible.

Chemical waste generated include containers that were used for storage of chemical waste on site, the chemical residue as well as contaminated material. These materials will be segregated as hazardous and non-hazardous and properly stored and disposed of. Storage will be place in a separate area t6hat has an impermeable floor, adequate ventilation, and a roof to prevent rainfall from entering. In addition, all chemical waste must be clearly labeled in English, stored in corrosion resistant containers, and arranged that incompatible materials are adequately separated.

7.8.5 Spill Contingency Management Plan

The SAPZ will prepare and implement a spill contingency management plan that identifies this procedure to prevent, contain, cleanup, and report spill and release of fuel oil and their hazardous materials. Mitigation measure to prevent contamination from hazardous materials are primarily aimed at preventing their release into the environment in the first place and will include:

- Keeping equipment maintained.

- Inspecting equipment and containers for spill and leaks, corrosion, or other signs of deterioration,
- Maintaining spill response equipment near material storage areas and on heavy equipment.
- Training employees on material storage, transfer, and transportation procedures, spill response procedures, and reporting requirements.

If a fuel spill occurs at the project sites, prompt action will be taken to contain the leakage or spillage in the event of a spill of leak, all combustible, flammable, and ignition sources (such as running engines) likely to result in a fire will be removed from the vicinity of the spill and anyone in the area will be advised to stay upwind. Spill kits will be kept at the project sites and the transport vehicles to readily clean up small spills. Large spills will be contained by constructing a berm around the spell area to control runoff to surface water.
All soil contaminated by previous spills will be excavated and disposed of in accordance with the SAPZ hazardous waste management procedures.

Contractor Management

SAPZ will expect its contractors to follow IFC Guidelines for Occupational Health and Safety and Environmental Management. SAPZ will issue a set of Environmental, Social, Health and Safety safeguards to the construction contractor to follow, which include standards that are expected to be followed and programs that the contractors are expected to have in place (e.g. Environmental Health and Safety Management System).

Air Quality: Generation of Air Emissions from Disturbance

Control techniques for minimizing temporary particulate matter (PM) emission during construction will involve watering of surfaces, chemical stabilization, or surface wind speed with windbreak or source enclosures. Furthermore, surface improvements offer long-term control techniques. These includes covering the road surface with a new material of lower site content, such as covering a dirt road with gravel or slag. Also, regular maintenance practices, such as grading of gravel roads, help to retain larger aggregate size on the traveled portion of the road and thus help reduce emissions. The amount of emissions reduction is tied directly to the reduction in surface site content.

Other mitigation measures include, maintaining good housekeeping prates throughout the construction phase. These low-cost measures include:

- Proper site enclosure through appropriate hoarding and screening
- On-site mixing and unloading operations.
- Proper handling of cement material.
- Maintain minimal traffic speed on-site and on access roads to the tower construction sites.
- Covering all vehicles hauling materials likely to give off excessive dust emissions.

- Ensure adequate maintenance and repair of construction machinery and vehicles.
- Avoid burring of material resulting from site clearance.
- Cover any excavated dusty materials or stockpile of dusty materials entirely by impervious sheeting.
- Proper water spraying when necessary.

Generation of Air Emission from Vehicles and Equipment Engines

In addition to PM generation, emissions will consist of combustion emission from vehicles and diesel-driven mobile construction equipment (such as, concrete trucks, dump trucks, excavators, and backhoes. The engines emit primarily CO2, Co, NO2, Sox, and HC. Measures to reduce combustion emissions include proper truck and engine maintenance, adoption of a traffic management plan while avoiding congested routes, proper maintenance of construction equipment, and the quality of diesel fuel used. In addition, equipment will be turned off when not in use, while would reduce power needs as well as emissions of pollutants. The supervising consultant will have the responsibility of ensuring the implementation of these measures by the contractor.

Degradation of Water Quality Due to Storm Water Runoff

The removal of vegetation and disturbance of soil in the construction work areas may result in erosion and sedimentation causing increased turbidity in water within the project area.

Additionally, degradation of water quality may occur from pollutants in storm water runoff from material and equipment storage areas and spills and leaks from construction equipment

Special care must be taken to decrease impacts where work is or near the marshland/wetland and mangrove areas to keep disturbance of the ecosystems to a minimum.

Degradation of Water Quality Due to Accidental Spills and Leaks

SAPZ will develop and implement a measures/plan to prevent and mitigate spills of oils or hazardous material to surface water bodies and groundwater. Storage of fuel and hazardous material should not occur within 30m of a surface water body. If any pumps are needed for removal of water during tower construction within 30m of marshland/wetland water body. They will utilize proper secondary containment. Oil leakage or spillage will be contained and cleaned up immediately. Spent oil and lubricants will be collected and stored for recycling of proper disposal. In addition, all fuel tanks and chemical storage areas will be provided with locks and located within secondary containment structure. Oil/water separators will be installed at storm water channels to remove oils from contaminated waters such as from workshops.

Soil Contamination and Erosion Due to Erosion

Prior to commencement of construction activities, SAPZ will implement an erosion and sediment control Plan, SAPZ will demonstrate, to the satisfaction of NESERA that any substantial risk of increased sediment discharges from the project sites will not occur during any stage of the project

- Soils excavated for tower foundations will be used for re-filling and will not be left exposed to wind or water for long periods
- The contractor will avoid steep terrain during the transportation material by using alternative route or use light vehicles where appropriate
- Heavy machinery will be used as needed in the clearance of construction work areas to minimize soil compaction, which makes the soil susceptible for erosion
- Riverine and surface water body associated vegetation will be minimally disturbed during the construction phase to reduce soil erosion and safeguard bank protection
- Disturbed areas will be replanted with local species common in the area complement natural vegetation regeneration to improve cover
- In are prone to soil erosion, suitable sediment binding grasses will be planted in degraded substrates.

Noise Management

Typical mitigation measures that will be enforced during construction to minimize noise levels are:

- Effectively utilizing material stockpiles and other structures, where feasible; to reduce noise from on-site construction activities.
- Choosing inherently quiet equipment.
- Operating only well-maintained mechanical equipment on-site.
- Keeping equipment speed as low as possible.
- Shutting down or throttling down to minimum equipment that may be intermittent in use, between work periods.
- Utilizing and properly maintaining silencer or mufflers that reduce vibration on construction equipment during construction works.
- Restricting access to the site for truck traffic outside of normal working hours.
- Utilizing proper site logistics and planning.
- Limiting site working hours the morning hour.
- Scheduling noisy activities strictly during the morning hours.
- Consulting with local communities and informing the locals when noisy activities are planned.

- Enforcing noise monitoring.
- Enforce the use of hearing protection actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140dB(C), or the average maximum sound level reaches 110db(A).
- Installing warning signs in area high noise levels.
- Consider the use of acoustic insulating materials, isolation of the noise source, and other engineering controls to minimize noise impact.

The noise control measure will be included within the construction contracts and be considered as requirements from contractors. The supervising consultant will have the responsibility of ensuring the implementation of these measure.

Impact Detection Monitoring

Includes periodic sampling to assess the impact of project operations on the environment and human health, and to ensure progress towards minimizing project's negative impact. This is also referred to as Institutional monitoring which be conduct by the project Environmental Officer and team of sustainable staff. The objective of Impact detection monitoring compliance monitoring includes:

- Identify the most probable source.
- Verify the proper implementation of the specified mitigation measures.
- Review the effectiveness of environmental management plans including mitigation measures and propose alternative actions as appropriate.

Compliance Monitoring

Compliance Monitoring is conducted to ensure that all project and sub-project activities are in full compliance with the Environmental Protection Agency regulations and standards. It is usually commissioned by a Third-Party Evaluator accredited by the Federal Ministry of Environment. Objectives of the party include;

- To monitor performance and effectiveness of environmental management plans.
- Evaluate project compliance with regulatory requirements.
- Provision of safety at all difference locations of the working area and retention of records.
- Capacity development and training of staff, operators, technicians, staff etc.
- Adequate analytical instrumentations.

Table 7.2: Summary of the Environmental and Social Management & Monitoring Plan

Project Phase	Project Activities	Associated and Potential Impacts	Mitigation Measure	Implementation Responsibility.	Parameters to be Measured	Method of Measurement	Performance Indicator	Responsibility Action party for Monitoring
Preconstruction Phase	Site survey and geotechnical investigations	Dust generation	- Use water spraying to control dust.	Contractor	Dust levels	Visual inspection, dust meters	Acceptable dust levels	Environmental Officer
	Land acquisition and compensation	Disruption of local water sources	- Conduct hydrological assessments and ensure alternative water supplies.	Project Proponent	Water quality parameters (pH, turbidity, etc.)	Water sampling and laboratory analysis	Water quality meets regulatory standards	Environmental Officer
	Community consultations and stakeholder engagement	Loss of vegetation	- Minimize vegetation clearing and promote reforestation efforts.	Contractor	Area of vegetation cleared	Site surveys and vegetation mapping	Minimal vegetation clearance	Environmental Officer
	Site clearing and excavation	Increased dust and emissions	- Use dust suppression techniques and maintain equipment.	Contractor	Dust and emission levels	Dust and emission monitoring equipment	Acceptable levels of dust and emissions	Environmental Officer

Project Phase	Project Activities	Associated and Potential Impacts	Mitigation Measure	Implementation Responsibility.	Parameters to be Measured	Method of Measurement	Performance Indicator	Responsibility Action party for Monitoring
Construction Phase	Construction of infrastructure	Potential contamination of water sources	- Implement water management plans to prevent contamination.	Contractor	Water quality parameters (pH, turbidity, etc.)	Water sampling and laboratory analysis	Water quality meets regulatory standards	Environmental Officer
	Installation of utilities	Habitat destruction	- Create buffer zones, relocate fauna where necessary.	Contractor	Presence of buffer zones, relocated fauna	Site inspections, wildlife surveys	Established buffer zones, successful relocation	Environmental Officer
	General construction activities	Generation of construction waste	- Implement waste management plans, recycle where possible.	Contractor	Volume of waste generated, recycled waste	Waste tracking records	High recycling rate, proper waste disposal	Environmental Officer
	Use of machinery and equipment	Noise from construction activities	- Restrict construction to daylight hours, use noise dampening equipment.	Contractor	Noise levels	Noise monitoring equipment	Noise levels within acceptable limits	Environmental Officer

Project Phase	Project Activities	Associated and Potential Impacts	Mitigation Measure	Implementation Responsibility.	Parameters to be Measured	Method of Measurement	Performance Indicator	Responsibility Action party for Monitoring
Operational & Maintenance phases	Operation of facilities and equipment	Emissions from operational activities	- Use clean technologies and regularly maintain equipment.	Facility Operator	Emission levels	Emission monitoring equipment	Emissions within regulatory limits	Environmental Officer
	Routine maintenance and repairs	Water use and potential contamination	- Implement water conservation measures and monitor water quality.	Facility Operator	Water usage, water quality parameters	Water meters, water sampling and analysis	Efficient water use, water quality standards	Environmental Officer
	Waste management and disposal	Generation of operational waste	- Implement comprehensive recycling and waste reduction programs.	Facility Operator	Volume of waste generated recycled waste	Waste tracking records	High recycling rate, proper waste disposal	Environmental Officer
	Use of operational machinery	Noise from operational machinery	- Use noise reduction strategies and maintain equipment to minimize noise.	Facility Operator	Noise levels	Noise monitoring equipment	Noise levels within acceptable limits	Environmental Officer

Project Phase	Project Activities	Associated and Potential Impacts	Mitigation Measure	Implementation Responsibility.	Parameters to be Measured	Method of Measurement	Performance Indicator	Responsibility Action party for Monitoring
Decommissioning Phase	Dismantling and removal of structures	Dust and emissions from dismantling activities	- Use dust suppression and emission control measures.	Contractor	Dust and emission levels	Dust and emission monitoring equipment	Acceptable levels of dust and emissions	Environmental Officer
	Site cleanup and remediation	Potential contamination from dismantling waste	- Implement water protection measures and ensure proper waste disposal.	Contractor	Water quality parameters (pH, turbidity, etc.)	Water sampling and laboratory analysis	Water quality meets regulatory standards	Environmental Officer
	Post-decommissioning land use planning	Habitat disruption and biodiversity loss	- Restore habitats and promote biodiversity in site restoration plans.	Contractor	Area restored, biodiversity indices	Site surveys, biodiversity assessments	Successful habitat restoration	Environmental Officer
	Disposal of dismantling waste	Generation of dismantling waste including hazardous substances	- Develop a waste management plan for safe disposal of all materials.	Contractor	Volume and type of waste generated hazardous waste	Waste tracking records, hazardous waste manifests	Proper waste disposal, minimal hazardous waste	Environmental Officer

Project Phase	Project Activities	Associated and Potential Impacts	Mitigation Measure	Implementation Responsibility.	Parameters to be Measured	Method of Measurement	Performance Indicator	Responsibility Action party for Monitoring
	Use of dismantling machinery	Noise from dismantling activities	- Schedule dismantling during less sensitive times, use noise barriers.	Contractor	Noise levels	Noise monitoring equipment	Noise levels within acceptable limits	Environmental Officer
	Cultural heritage assessments	Impact on cultural heritage during site clearance	- Monitor for cultural artifacts and consult with cultural heritage experts.	Contractor	Discovery of cultural artifacts	Site inspections, reports from cultural experts	Preservation of cultural heritage	Cultural Heritage Expert
	Health and safety assessments	Risks from dismantling activities to workers and nearby communities	- Implement strict health and safety protocols, provide appropriate PPE and training.	Contractor	Number of incidents, use of PPE	Safety reports, incident logs	Zero incidents, proper use of PPE	Health and Safety Officer

7.9 ESMP Costing and Schedule

To ensure the successful implementation of the environmental and social management measures proposed within the ESMP, the Plateau State Government (Ministry of Agriculture) will allocate the required budgetary resources for the project components. The tentative budget for each project will encompass environmental management expenses beyond standard engineering practices, including the costs associated with environmental and resettlement monitoring. Additionally, all administrative expenses related to ESMP costing is detailed in Table 7.3 while the implementation will be accounted for in the budget, as detailed in Table 7.4. The ESMP Implementation Schedule is delineated in Table 7.5.

Table 7.3: ESMP Costing

Monitoring Activity	Monitoring parameter	Monitoring location	Phase	Frequency Cost	Cost	Responsibility	Implementation responsibility
Air Quality							
Visual Assessment, routine and if necessary, in response to a compliant through the Grievance Mechanism	Dust levels in the atmosphere	Construction areas, places of heavy traffic flow	Construction	Daily & during period of dust generating activity or in response to a compliant through the Grievance Mechanism	Under the general responsibilities of the construction supervisor --No material additional costs associated with this activity	Construction Contractor (CC)	Construction Contractor (CC)
Soil Quality							
Soil sampling	Soil contaminants including heavy metals, non-metallic contaminants, organic	Specific sampling points identified at the project locations and areas where	Construction	Prior to construction and after remediation of contaminated sites	Laboratory fees		Environmental Manager

	and non-organic compounds, pesticides, and biological organisms	dangerous activities are ongoing.					
Water Resources							
Surface water	pH, Conductivity, RCRA, COC, SVDC, Suspended solids, dissolved solids, oil, and grease, BTEX	Lake/River in closed proximity to the project location to be identified as monitoring point	Construction	Quarterly	Laboratory Fees	NIC	NIC Environmental Manager
Ground water	pH, Conductivity, Dissolved Oxygen, Temperature, & Turbidity	Groundwater wells in or around project location	Operation	Prior to commencement of construction, during and then quarterly during operations	Capital cost of Multiparameter probe		Environmental Manager
	RCRA, VOC, Suspended solids, dissolved solids oil and grease BTEX	Ground water samples in close proximity to the project location	Operation	Quarterly	Laboratory Fees:		Environmental Manager
Health and Safety							
Health and Safety	Proper use of PPEs,	Construction and	Construction &	Construction	Under the general		Contractor and or

surveys, documentation of injuries and accidents	Presence of signs, First Aid Kit, and Firefighting Devices	operation sites where activities are undertaking	Operation		responsibilities of the Environmental Manager —No significant material costs associated with this activity		Environmental Manager
Solid Waste							
Solid Waste Generation and Disposal	Visual inspection and photographic documentation and audit	Project site and disposal sites	Construction & Operation	Continuous	Under the General responsibilities of the Environmental Manager--- No significant material costs associated with this activity		Environmental Manager
Landscape and Visual Amenity							
Monitor to ensure that dust control and visual screening measures are implemented effectively	Ensure the effective implementation of mitigation measures	Entire project area where activities are undertaking	Construction & Operation	Quarterly	Under the General responsibilities of the Environmental Manager—No significant material costs associated with this activity		Environmental Manager
Noise							

Measurements of existing ambient noise will be carried out at the most sensitive locations prior to the start of the construction	Noise level, LAeq, 1 hour	Nearest houses to the project construction sites	Construction	Prior to construction and during activities that are likely to produce the highest noise outputs	Capital costs (onsite noise monitoring meter-)		Qualified Acoustic Survey Technicians

Table 7.4: Summary of Indicative Budget for Implementing the ESMP

S/No	Element	Responsible	₦
1	Mitigation Measures	State Ministry of Agriculture, Investors, and Contractor	XXXXXX
2	Monitoring & Audit		XXXXXX
3	Training	Contractor/HSE Officer, Consultant, and Management	XXXXXX
Sub-total			
	10% contingency		
Grand total			XXXXXX

Table 7.5: ESMP Implementation Schedule

S/N	Activity Description	Responsible	Construction		
			Pre	During	Post
1	Disclosure of Environmental Assessment Report	Ministry of Agriculture			
2	Allocating Budget for ESMP	Ministry of Agriculture			
3	Appointing Support Staff of ESMP	Ministry of Agriculture			
4	Review and Approval of Contractor's ESMP and Safety Plan	Ministry of Agriculture			
5	Finalizing site and layout plan of constructionplan	Ministry of Agriculture			
6	Finalization of Borrow and Excavation Areas	Ministry of Agriculture			
7	Implementation of Mitigation Measures	Ministry of Agriculture			
8	Supervising ESMP Implementation	Ministry of Agriculture			
9	Environmental Auditing	Ministry of Agriculture			
10	Monitoring a Reporting on ESMPImplementation	Ministry of Agriculture			
11	Environmental Training	Ministry of Agriculture			

CHAPTER EIGHT

DECOMMISSIONING, ABANDONMENT AND REMEDIATION PLAN

8.1 Introduction

The ESIA process requires that project of this status contain an environmentally sound decommissioning and Abandonment plan. The SAPZ II Agricultural Industrial Hub (AIH) shall be designed, built, and maintained to operate efficiently for about 50 years after which, it shall be decommissioned and or abandoned in conformity with a plan that meets local and international regulatory requirements and standards. These plans need to be fully prepared a few years before decommissioning and abandonment would take place and consider the best applicable technology at that time. A general approach shall be to commence detailed planning of decommissioning and abandonment activities five years to the decommissioning date.

Decommissioning heralds the end of a project facility. At decommissioning stage, the facility is taken out of operational service with isolation of all process streams and services and the removal of all hazardous materials. When the facility has undergone this process, it is referred to as a decommissioned facility. All decommissioning and restoration activities will be carried out in line with the decommissioning and restoration guidelines provided in the EIA Act Cap E12, LFN 2004 of Federal Ministry of Environment (FMEnv). The aim of decommissioning is to ensure the environment is returned to, as much as reasonably practicable, its original/baseline conditions. The lifespan may sometimes be less than planned, while in some cases, it can be extended with proper planning and maintenance. Appropriate provisions shall be made to cater for decommissioning plan right from operational phase before the proposed project reached the end of its life span. To this end, 1% of the profit made monthly right from the operational phase shall be set aside for this plan.

8.2 Decommissioning and Abandonment Principle

Plateau State Government (PLSG) shall:

1) Commence activities related to decommissioning, at least, one year before close of project activities.
2) Put in place a decommissioning plan report for approval by FMENV. The plan shall include:
    - identification of all components of the project that shall be removed/exhumed.
    - method(s) for removal or re-use of any project equipment/ material if applicable
    - effort being put in place to mitigate any environmental impacts associated with the decommissioning process.
    - appropriate site remediation/rehabilitation programme

3) Ensure the safety of operation, taking into consideration all appropriate international conventions, regulatory requirements, and corporate policies.
4) Remove all structures (surface and sub-surface structures) with due regard for the protection of the environment.
5) Inform and discuss with staff, employees, contractors, Federal Ministry of Environment, Plateau State Ministry of Environment as well as stakeholder communities.

8.3 Decommissioning/ Abandonment Process

All installations buried or fixed on land shall be removed entirely. All wastes items arising from decommissioning process shall be managed in line with PLSG's Waste Management Plan (WMP). Decommissioning shall be carried out in line with standard decommissioning procedure.

The content of the plan will take into consideration the extent of the decommissioning (temporary or permanent, partial, or complete shutdown), plans for future use of the site, and the condition of the site and environment at the time of decommissioning. A detailed post-operational study of the impact of the project on the environment shall be conducted to determine appropriate restoration and remedial measures.

At this stage, only preliminary plans exist for decommissioning and abandonment. Besides and upon commencement of production, part of the revenue from the production shall be set aside in an escrow account to cover the cost of decommissioning and abandonment. Additional details shall be developed as the project progresses. In general, however, decommissioning activities shall be conducted in compliance with applicable regulations and guidelines. The plans will also include regulations and risk and cost analysis of the various options. The abandonment plan will consider all facilities associated with the Project.

8.4 Reporting

As required by regulations, a post decommissioning report (PDR) shall be prepared and submitted to FMEnv. The report will provide the following details:

- Overview of decommissioned facilities.
- Details of methods used for decommissioning.
- Nature of decommissioning (partial or whole).
- Record of consultation meetings.
- Details of recyclable/reusable materials/facility components.
- Decontaminated facilities.
- Decommissioning Schedule.
- State of the surrounding environment.
- Waste Management Plan.
- Plans for restoration/remediation where necessary.

Table 8.1 shows the comprehensive Environmental and Social Management Plan (ESMP) of the proposed Agricultural Industrial Hub (AIH) during the Decommissioning Phase

Table 8.1: Environmental and Social Management Plan (ESMP) of the Decommissioning Phase for the Proposed Agricultural Industrial Hub (AIH)

Project Activity	Identified Impact	Mitigation Measures	Indicator Parameters	Frequency	Responsible Action Party
Demolition and Evacuation	Interference with road transportation	• PLSG shall monitor the number of trucks per day to know if there is need to create other accessible roads • PLSG shall develop a transport management plan specifying routes, speeds, times of travel and key roads/waterway in terms of local services; • Consideration shall be given to avoid reliance on public transport and contractors shall be required to use private vehicles	Inventory of approved journey management forms	During Decommissioning	PLSG
	Noise and vibration nuisance	PLSG Plc shall ensure that: • electric power generators are fitted with effective silencers; • there shall be regular maintenance of vehicles and generators; • generators and vehicles are switched off when not in use; • soundproof electric power generators are engaged	Compliance monitoring report	During Decommissioning	PLSG/Plateau State Ministry of Environment/ FMEnv

		• PPEs are used			
	Impairment of air quality	PLSG Plc shall ensure: • Maintenance of engines and exhaust gas check; Adoption of engine off policy at construction site • that nose masks and earmuffs are worn by site workers during excavation • that water shall be sprayed on construction sites to reduce dust levels especially during dry season.	Compliance monitoring report	During Decommissioning	PLSG/Plateau State Ministry of Environment/ FMEnv
	Contamination of surface and Groundwater & soil	PLSG shall ensure: • Soil disturbance shall be kept to minimum required for operation and safety • Oil spill containment shall be provided to reduce oil spill from getting to the soil and surface/ groundwater • Follow FMEnv guidelines on waste management • Cleanup in compliance with relevant national and international guidelines, involving the removal of the waste, etc.	Compliance monitoring report	During Decommissioning	PLSG/Plateau State Ministry of Environment/ FMEnv

		• Restoration to a condition in no way inferior to the condition prior to the commencement of work.			
	Solid waste generation and impact on disposal facility	PLSG shall • treat and dispose all wastes in accordance with regulatory requirements and best practice using approved contractors • ensure that none of these wastes are disposed into any water body or on land • follow safety measures while disposing wastes • keep all waste consignment, treatment and disposal records for regulatory verification • Ensure proper disposal of solid waste from labour camps; • Ensure storage of lubricants, fuels and other hydrocarbons in self-contained enclosures; • Ensure sanitation arrangements at work sites/facilities to avoid release of wastewater to the environment • Ensure all other wastes generated including environmentally deleterious materials generated by construction activities will be	Site inspection report Waste Management Policy/ tracking sheet	During Decommissioning	PLSG/Plateau State Ministry of Environment/ FMEnv

		disposed offsite in an appropriate, legal, and safe manner. • Ensure there is minimum generation of waste • Ensure unsuitable excavated materials shall be systematically carried away from areas prone to erosion; • Ensure reuse of waste materials wherever possible • Ensure wastes shall be segregated, stored, and disposed by an accredited state waste collector			
	Loss of job	PLSG shall • Counsel worker who losses job. • Give enough notice. • Assist staff that are likely to lose job in skill acquisition. • Assist in setting small scale business			
	Injury / fatalities in workforce /communities	PLSG shall • Ensure Safety awareness training for workforce. • Ensure Emergency response procedures shall be put in place and enforced.	Contract documents/ list of community members employed		PLSG/Plateau State Ministry of Environment/ FMEnv

		• ensure use of PPE • provide first aid and clinic on site		During Decommissioning	
	Kidnapping of workers and visitors on site	PLSG shall ensure that • both contractor and PLSG Plc personnel develop a high level of security consciousness both within and outside the work area • Daily security reports shall be reviewed by the PLSG Plc Project Manager • Special security force shall be established and deployed for the project. This shall include deploying some of PLSG Plc police to strengthen security in the area. • a liaison to foster partnership with the community to guarantee security for the project is established and sustained. • support from government authorities by aiding with equipment e.g. patrol vehicles, to ensure improved security. • safety workshops to identify, evaluate and recommend contingency plans for all security risks are regularly organized	Daily/weekly security report	During Decommissioning	PLSG/Nigeria Police Force/ Nigeria security and Civil Defence Corps

	Third Party Agitation due to Employment Issues and Loss of Benefits as Host Communities	PLSG shall • Assist staff that are likely to lose job in skill acquisition. • Assist in setting small scale business	Contract documents/ list of community members employed	During Decommissioning	PLSG/Plateau State Ministry of Environment/ FMEnv
	Revegetation	PLSG shall ensure restoring of vegetation after decommissioning of facility	Site inspection and progress report	During Decommissioning	PLSG/Plateau State Ministries of Environment/FMEnv

CHAPTER NINE
CONCLUSION AND RECOMMENDATION

9.1 Conclusion

Finally, the study has indicated that the establishments of the proposed project will have less negative impact on the existing environmental, social and health as well as safe conditions of the people, locally, nationally, or internationally.

The study indicates that the establishment of the proposed Special Agro-Industrial Processing Zones (SAPZ) – Agro-Industrial Hub (AIH) in Heipang Local Government Area of Plateau State, Nigeria, will not severely or negatively impact the existing environmental, social, health, and safety conditions of the local, national, or international communities.

The project is highly desirable due to its significant environmental, health, and socio-economic benefits, which far outweigh any potential negative impacts that may arise during implementation. No impacts of sufficient magnitude were detected that could disrupt the project's execution. Although some negative impacts may occur due to project activities, adequate and SMART (Specific, Measurable, Achievable, Relevant, Time-bound) measures have been proposed to address them. Mitigation measures and management plans have been developed to handle these negative impacts, and an appropriate institutional framework will be established to implement these measures. The proposed monitoring programs will be activated as soon as possible.

Assessing and identifying potential environmental, social, cultural, and health risks and impacts, and recommending measures to mitigate, reduce, or offset these impacts to acceptable levels, ensures project acceptance by the local affected parties and successful implementation. While major stakeholders urgently support project approval and implementation, it is crucial to consider dissenting views and concerns expressed by affected parties and stakeholders to ensure the project is environmentally sound and socially sustainable. Therefore, a detailed assessment must be conducted to determine the level and extent of resettlement that may be required.

The overall impacts of the project are minimal, and the recommended mitigation measures are effective in addressing, reducing, and offsetting these impacts. Importantly, impacts identified during the construction phase range from direct, indirect, short-term, temporary, irreversible, and most often are under the proponent's control. The impacts during the operation phase are relatively low, and adequate environmental management systems will be employed to address and mitigate

them. Baseline surface and groundwater within the project's area of influence were evaluated to assess their characteristics before the implementation of the project activities. Socio-economic surveys revealed that most local and rural people are engaged in traditional agricultural practices, including farming, hunting, and charcoal production.

BOLBEN Ltd. asserts that all environmental and social impacts associated with the Special Agro-Industrial Processing Zones (SAPZ) – Agro-Industrial Hub (AIH) in Heipang Local Government Area have been identified. The mitigation and management measures outlined are sufficient to address these impacts when implemented accordingly. Assessing and identifying potential environmental, social, cultural, and health risks is crucial for ensuring the project's acceptance and successful implementation by local affected parties. Implementing recommended measures to mitigate, reduce, or offset these impacts to acceptable levels is paramount. While there may be pressing demands from key stakeholders for project approval and implementation, it is essential to consider dissenting views and concerns expressed by affected parties and stakeholders to ensure the project's environmental and social sustainability.

9.2 Recommendations

The Plateau State government shall ensure that the proposed project is developed and operated in an environmentally sustainable manners in compliance with the relevant National and International Standards; by properly managing the process/activities that may bring about disturbances to the environment through the implementation of the recommended mitigation disturbances measures and the ESMP. Continuous monitoring of the environmental and social performance of the project shall also be maintained, including periodic consultation with the relevant stakeholders (affected communities, regulatory authorities, and project neighbours).

It is recommended that a comprehensive stakeholder engagement plan be developed and implemented to address the concerns of all parties and to ensure transparent communication throughout the project's lifecycle.

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APPENDIX ONE

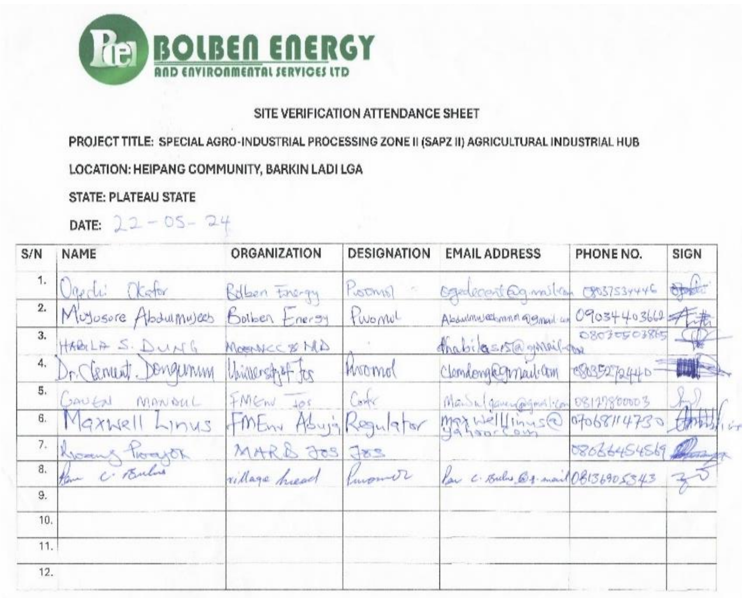
Plate 1: The Proposed Project Site

Plate 2: FMEnv and other Officials during the Site Verification

Plate 3: Pictorial Evidence of Soil Sampling Exercise

Plate 4: Recording of Air Quality Parameters

APPENDIX TWO



BOLBEN ENERGY AND ENVIRONMENTAL SERVICES LTD

SITE VERIFICATION ATTENDANCE SHEET

PROJECT TITLE: SPECIAL AGRO-INDUSTRIAL PROCESSING ZONE II (SAPZ II) AGRICULTURAL INDUSTRIAL HUB

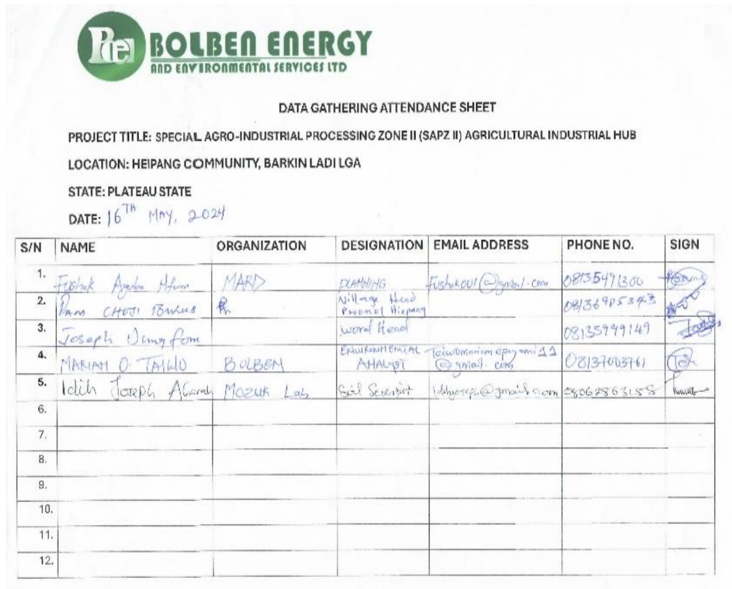
LOCATION: HEIPANG COMMUNITY, BARKIN LADI LGA

STATE: PLATEAU STATE

DATE: 22-05-24

S/N	NAME	ORGANIZATION	DESIGNATION	EMAIL ADDRESS	PHONE NO.	SIGN
1.	Ogedi Okafor	Bolben Energy	Pwomol	ogedeoeri@gmail.com	08037534446	
2.	Moyosore Abdulmujeeb	Bolben Energy	Pwomol	Abdulmujeebmma@gmail.com	09034403662	
3.	HABILA S. DUNG	MOENVCC & MD		dhabilas15@gmail.com	08030503865	
4.	Dr. Clement Dongurum	University of Jos	Pwomol	clemdong@gmail.com	08035272440	
5.	GAVEN MANDUL	FMEnv Jos	Cofe	Mandulgaven@gmail.com	08127800003	
6.	Maxwell Linus	FMEnv Abuja	Regulator	maxwelllinus@yahoo.com	07068114730	
7.	Kwang Pwajok	MARD Jos	Jos		08066454569	
8.	Pam C. Bulus	village head	Pwomol	Pam C. Bulus@g-mail	08136905343	
9.						
10.						
11.						
12.						

Plate 5: Site Verification Attendance



BOLBEN ENERGY AND ENVIRONMENTAL SERVICES LTD

DATA GATHERING ATTENDANCE SHEET

PROJECT TITLE: SPECIAL AGRO-INDUSTRIAL PROCESSING ZONE II (SAPZ II) AGRICULTURAL INDUSTRIAL HUB

LOCATION: HEIPANG COMMUNITY, BARKIN LADI LGA

STATE: PLATEAU STATE

DATE: 16TH MAY, 2024

S/N	NAME	ORGANIZATION	DESIGNATION	EMAIL ADDRESS	PHONE NO.	SIGN
1.	Fushak Ayuba Mhwan	MARD	PLANNING	fushakou1@gmail.com	08135491300	
2.	Pam CHOJI BULUS		Village Head Pwomol Hiepang		08136905343	
3.	Joseph Dung Fom		ward Head		08135999149	
4.	MARIAM O. TAIWO	BOLBEN	ENVIRONMENTAL ANALYST	taiwomariam opeyemi11@gmail.com	08137003761	
5.	Idih Joseph Abarah	MOZUK Lab	Soil Scientist	idihjoseph@gmail.com	08062863155	
6.						
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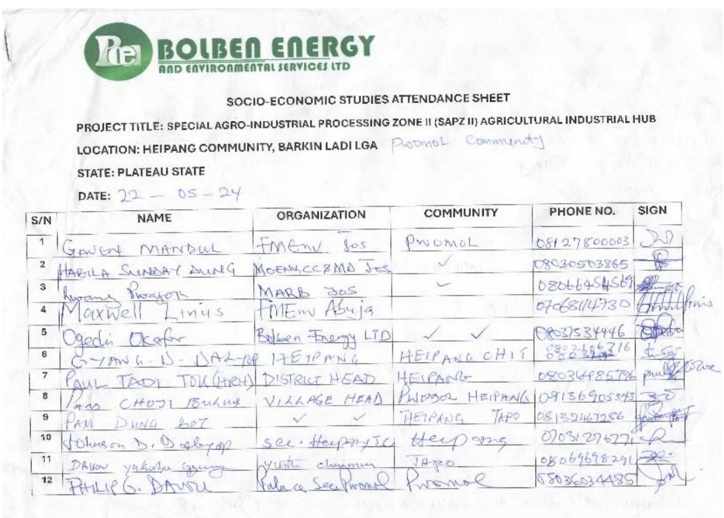
Plate 6: Data Gathering Attendance



BOLBEN ENERGY AND ENVIRONMENTAL SERVICES LTD

SOCIO-ECONOMIC STUDIES ATTENDANCE SHEET

PROJECT TITLE: SPECIAL AGRO-INDUSTRIAL PROCESSING ZONE II (SAPZ II) AGRICULTURAL INDUSTRIAL HUB

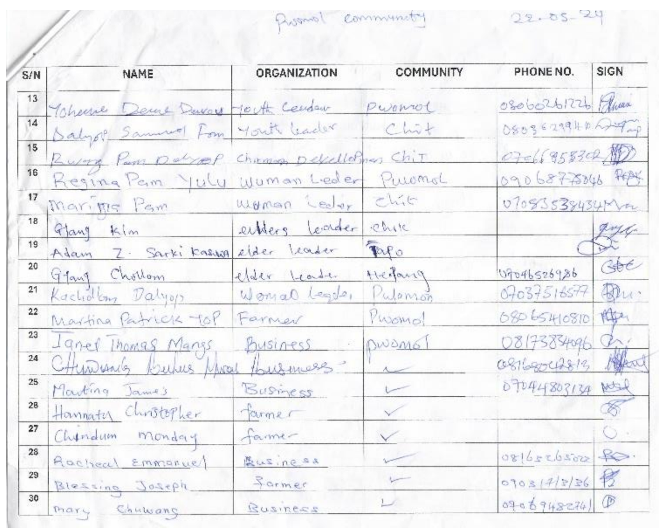
LOCATION: HEIPANG COMMUNITY, BARKIN LADI LGA Pwomol Community

STATE: PLATEAU STATE

DATE: 22-05-24

S/N	NAME	ORGANIZATION	COMMUNITY	PHONE NO.	SIGN
1	GAVEN MANDUL	FMEnv Jos	PWOMOL	08127800003	
2	HABILA SUNDAY DUNG	MOENV,CC&MD Jos	✓	08030503865	
3	Kwang Pwajok	MARD JOS	✓	08066454569	
4	Maxwell Linus	FMEnv Abuja		07068114730	
5	Ogedi Okafor	Bolben Energy LTD	✓ ✓	08037534446	
6	GYANG D. DALYOP	HEIPANG	HEIPANG CHIT	08032166716	
7	PAUL TADI TOK (HRH)	DISTRICT HEAD	HEIPANG	08036485796	
8	Pam CHOJI BULUS	VILLAGE HEAD	PWOMOL HEIPANG	08136905343	
9	PAM DUNG BOT	✓	✓ HEIPANG TAPO	08132467286	
10	Johnson D. Dalyop	sec. Heipang JC	Heipang	07031276771	
11	DAVOU yakubu gyang	youth chairman	JAPO	08069698291	
12	PHILIP G. DAVOU	Palace Sec. Pwomol	Pwomol	08036034485	

Plate 7: Socio Economic Attendance



Pwomol community 22-05-24

S/N	NAME	ORGANIZATION	COMMUNITY	PHONE NO.	SIGN
13	Yohanna Demo Davou	Youth Leader	Pwomol	08060261226	
14	Dalyop Samuel Fom	Youth leader	Chit	08036299410	
15	Rwang Pam Dalyop	Chairman Development	Chit	07066958302	
16	Regina Pam Yulu	Woman Leder	Pwomol	09068778046	
17	Marijis Pam	Woman Leder	Chit	07083538434	
18	Gyang Kim	elders leader	chit		
19	Adam Z. Sarki Kasuwa	elder leader	Tapo		
20	Gyang Chollom	elder leader	Heipang	07046526986	
21	Kachollom Dalyop	Woman Leader	Pulomon	07037516577	
22	Martina Patrick Top	Farmer	Pwomol	08065410810	
23	Janet Thomas Mangs	Business	Pwomol	08173834096	
24	Chuwang Bulus Musa	Business	✓	08168042813	
25	Marting James	Business	✓	07044803134	
26	Hannatu Christopher	farmer	✓		
27	Chindum monday	farmer	✓		
28	Racheal Emmanuel	Business	✓	08165265022	
29	Blessing Joseph	Farmer	✓	07031718136	
30	mary Chuwang	Business	✓	07069482741	

Plate 8: Socio Economic Attendance

APPENDIX THREE

AGRICULRURAL PROCESSING FIRM SOCIO-ECONOMIC IMPACT ASSESSMENT QUESTIONNAIRE

The Plateau State Government plans to embark on an Agricultural Processing Project in Heipang Community, Barkin Ladi Local Government Area, Plateau State. As part of the exercise, BOLBEN Energy and Environmental Services Limited is saddled with the responsibility of identifying the potential socio-economic impacts of the project on the local communities. Therefore, your assistance is required in filling out this brief survey. The questionnaire can be completed by ticking in the preferred boxes like this √ and providing appropriate answers in the available spaces.

Background Information A

1. Name of Community .....

2.Gender (a) Male ☐ (b) Female ☐

3. Age (a) 18 – 30 yrs.☐ (b) 31 – 45 Yrs. ☐ (c) 46 – 54 Yrs. ☐ (d) 55 Yrs. and above ☐

4. Education: (a) Informal Education ☐ (d) NCE/ND ☐
(b) Primary School ☐ (e) HND/B.Sc. ☐
(c) Secondary School ☐ (f) Others (Specify) .....

5. Occupation: (a) Farming ☐ (b) Business ☐ (c) Civil Servant ☐ Others (Specify) .....

6. Monthly Income: (a) #5, 0000 - #10, 000 ☐ (b) #11, 000- #20,000 ☐ (c) # 31, 000-#50, 000 ☐
(d) #51,000 and above ☐

7. Duration of stay in the community (a) 1 -5 Yrs. ☐ (b) 6–10 Yrs. ☐ (c) 11–19 ☐ (d) 20 and above ☐

8. Types of language spoken in the communities .....
.....

Existing Socio-Economic Condition of the Study Area

9. The types of crops cultivated in the area includes .....
.....

10. The types of economy trees existing in the area are .....
.....

11. Indicate the traditional economic activity practiced by member so the community:
(a) Traditional Craft Work ☐
(b) Wildlife Hunting ☐
(c) Natural Resource Tapping ☐
(d) Wild Fruit Gathering ☐
(e) Recreational use ☐

12. The existing social amenities in the local community includes:
(a) School ☐ (b)Health Centre ☐ (c) Borehole ☐ (d) Others (Specify) .....

13. Traditional laws are still observed strictly in the local communities YES ☐ NO ☐

14. Spiritual (Sacred) places are still valued in the local communities. YES ☐ NO ☐

Potential Socio-Economic Impact of the Agricultural Processing Firm Project

15. Do you think the community members are fully aware of the new project to be developed in their locality? YES ☐ NO ☐

16. If NO, do you think there is a need of workshop to create more awareness on the project among the community members? YES ☐ NO ☐

17. If NO, do the local communities see themselves as stakeholders in development of the project? YES ☐ NO ☐

18. Do you feel that community members should be involved in decision making about the project? YES ☐ NO ☐

19. Indicate the social associations existing in your community: (a) Youth Association ☐ (b) Women Association ☐ (c) Farmers Association ☐ (d) Others Specify .....

20. Which of the associations listed in question 18 above do you think will benefit more from the developmental project? .....

21. Which neigbouring communities do you think will benefit from the new developmental project? .....

22. Indicate how you feel the project will benefit members of the mentioned neigbouring communities:
    (a) Employment Opportunity ☐ (d) Economic Diversification ☐
    (b) Increase in income ☐ (e) Carrier development ☐
    (c) Improvement in social lifestyle ☐ (f) Infrastructural development ☐

23. What do you think is the attitude of your community members towards the new developmental project? .....
    .....
    .....

24. Indicate the problem you think the new developmental project will cause to the nearby communities.
    (a) Change in social/cultural life style ☐ (d) Increase of in- and out- migration ☐
    (b) Alteration of Aesthetic outlook ☐ (e) Pressure on housing availability ☐
    (c) Breakage of social ties ☐ (f) Rise in cost of living ☐

25. Suggest the suitable measures you think can be adopted to avoid or minimize any unforeseen challenges to be caused by the project on the benefiting communities .....
    .....