ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

FOR THE

ANAMBRA STATE SPECIAL AGRO-INDUSTRIAL PROCESSING ZONES (SAPZ II) PROGRAMME

FINAL REPORT

BY THE

Submitted To

FEDERAL MINISTRY OF ENVIRONMENT (FMENV)
MABUSHI ABUJA-FCT, NIGERIA

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS AND ACRONYMS

%	Per Cent
°	Degree
℃	Degree Centigrade (Also Known as Degree Celsius)
°E	Degree East
°N	Degree North
μScm-1	Microsiemen Per Centimetre
5Rs	Reduce, Reduce, Reuse, Recycle, Recover
AAS	Atomic Absorption Spectroscopy
AfDB	African Development Bank
AIHs	Agro-Industrial Hubs
Al	Aluminium
ALARP	As Low As Reasonably Possible
AMIC	Anambra State Mixed Industrial City
ANSEPA	Anambra State Environmental Protection Agency
ANSG	Anambra State Government
ANSIPPA	Anambra State Investment Promotion and Protection Agency
ANSMA	Anambra State Ministry of Agriculture
ANSME	Anambra State Ministry of Environment
ANSMoH	Anambra State Ministry of Health
ANSMWSW	Anambra State Ministry of Women and Social Welfare
ANSPPB	Anambra State Physical Planning Board
APHA	American Public Health Association
APP	Agriculture Promotion Policy
Al	Aluminium
As	Arsenic
ASFSNS	Agricultural Sector Food Security and Nutrition Strategy
ASTM	American Society for Testing and Materials
ASWAMA	Anambra State Waste Management Authority
ATCs	Agricultural Transformation Centres
ATR	Animist/ African Traditional Religion
Aw	Tropical wet-dry climate (Köppen climate classification)
BMPs	Best Management Practices

BOQ	Bill of Quantity
Ca	Calcium
CBOs	Community-Based Organisations
CCMP	Climate Change Mitigation Plan
Cd	Cadmium
CEC	Cation Exchange Capacity
C-ESMP	Contractor ESMP (ESMP as defined below)
CFU	Colony Forming Unit
CFU/kg	Colony Forming Unit Per Kilogramme
CFU/Ml	Colony Forming Unit Per Millilitre
CH_4	Methane
CIA	Cumulative Impact Assessment
CLO	Community Liaison Officer
Cmol	Centimole
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CoC	Chain of Custody (In sample analysis)
CoC	Code of Conduct (In AfDB OSS)
COD	Chemical Oxygen Demand
CoE	Centres of Excellences
Cr	Chromium
CRC	Community Resettlement Committee
CSOs	Civil Society Organisation
CSR	Corporate and Social Responsibility
Cu	Copper
d	Margalef's Index
D	Menhinick Index
D	Simpson's Dominance Index
dB	Decibel
DG	Diesel Generator
DI	Ductile Iron
DO	Dissolved Oxygen

E	East (In Meteorology)
E&S	Environmental and Social
EDTA	Ethylenediamine-Acetic Acid
EEDC	Enugu Electricity Distribution Company
EHSMP	Environmental Health and Safety Management System
OHSP	Occupational Health and Safety Plan
EIA	Environmental Impact Assessment
ELSR	Elevated Level Service Reservoirs
EPRP	Emergency Preparedness and Response Plan
ESAP	Environmental and Social Assessment Procedures
ESHS	Environmental, Social, Health, and Safety:
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESMP	Environmental and Social Management Plan
E-waste	Electronic waste
F	Fluoride
FCT	Federal Capital Territory
Fe	Iron
Fe^{3+}	Ferric iron
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FGN	Federal Government of Nigeria
FI	Financial Intermediaries
FMAFS	Federal Ministry of Agriculture and Food Security
FMEnv	Federal Ministry of Environment) Regulations and Guidelines:
FMS&T	Federal Ministry of Science and Technology
G	Gramme
G/cm	Gramme Per Centimetre
GO	Grievance Officer:
GPS	Globally Positioning System
GRM	Grievance Redress Mechanism
GRP	Grievance Redress Procedure
H	Shannon-Wienner Diversity Index

H_2S	Hydrogen Sulphide
Ha	Hectare
HAVS	Hand-Arm Vibration Syndrome
HCO_3	Carbonate and bicarbonate
HDPE	High-Density Polyethylene
HIA	Health Impact Assessment
HVRM	Highly Vulnerable Rural Minorities
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IMM	Impact Mitigation Monitoring
In	Natural logarithm
IRM	Independent Review Mechanism
IsDB	Islamic Development Bank
ISS	Integrated Safeguards System:
j	Equitability Index Also Known as Equitability Evenness)
K	Potassium
KV	Kilovolts
kVA	KiloVolts Ampere
L	Litre
LED	Light Emitting Diode
LFN	Law of the Federation of Nigeria
LGA	Local Government Area
LT	Low Tension
LTI	Lost Time Injury
M/S	Metre Per Second
Max	Maximum
MC	Moisture Content
Mg	Magnesium
Mg/l	Milligram Per Litre
Min	Minimum
MM	Millimetre
Mn	Manganese
MOU	Memorandum of Understanding

MSDS	Material Safety Data Sheet
MSIP	Management Strategies and Implementation Plans
MVA	Megavolt-Amperes
n	Time lapse in Years Between Base Year and Current Year
N	Total Number of Individuals or Abundance (In Biodiversity Studies)
NA	Not Analysed (In Sample Analysis)
Na	Sodium
NAFDAC	National Agency for Food and Drug Administration and Control
NASC	National Agricultural Seeds Council
NBS	National Bureau of Statistics
NE	Northeast (In Meteorology)
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGOs	Non-Governmental Organisations
n_i	Abundance of Species i (In Biodiversity Studies)
Ni	Nickel
NiMet	Nigerian Meteorological Agency
NLTP	National Livestock Transformation Plan
NO_2^-	Nitrite
NO_2	Nitrogen Dioxide
NO_3	Nitrate
NPC	National Population Commission
NURPA	Nigerian Urban and Regional Planning Act
OD	Operational Directive
OEMs	Original Equipment Manufacturers
OHS	Occupational Health and Safety
OS	Operational Safeguard
P	Phosphorus
PAC	Project Advisory Committee
PAP	Project Affected Person
Pb	Lead
PCU	Project Coordinating Unit
PG	President General
pH	Potential of Hydrogen

PM	Particulate Matter
P_o	Population in the base year
PO_4^{3-}	Phosphate
PPE	Personal Protection Equipment
Ppt	Parts Per Thousand
PSA	Public Service Announcement
PWSN	Persons With Specific Needs
r	Estimated Annual Growth Rate of Population
RAP	Resettlement Action
RH	Relative Humidity
RM	Resettlement Manager
RMZ	Riparian Management Zone
RSC	Resettlement Steering Committee
S	South (In Meteorology),
S	Species Diversity (Total Number of Species in Biodiversity Studies)
SAPZ	Special Agro-industrial Processing Zones
SEP	Stakeholder Engagement Plan
SEPA	State Environmental Protection Agency
SO_2	Sulphur Dioxide
SO_4	Sulphate
SPIU	State Programme Implementation Unit
SR	Significance Ranking
SW	Southwest (In Meteorology)
TBD	To Be Determined
TCC	Total Coliform Count
TDS	Total dissolved solids
Temp	Temperature
TMP	Traffic Management Plan
TOC	Total Organic Carbon
US EPA	United States Environmental Protection Agency
UV	Ultraviolet
VOCs	Volatile Organic Compounds
W	West (In Meteorology)

WS	Wind Speed
X-Ca	Exchangeable Calcium
X-K	Exchangeable Potassium
X-Mg	Exchangeable Magnesium
X-Na	Exchangeable Sodium
Zn	Zinc

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EXECUTIVE SUMMARY

ES1: Introduction

ES1.1 Background

The Anambra State Government (ANSG) plans to participate in the Special Agro-Industrial Processing Zone (SAPZ) II Programme to boost agro-industrial development through the establishment of an Agro-Industrial Hub (AIH) and three Agricultural Transformation Centres (ATCs). SAPZ is a major investment program of the Federal Government of Nigeria (FGN), driven by the Federal Ministry of Agriculture and Rural Development (FMARD) in collaboration with the state governments, African Development Bank (AfDB) and other 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 aligned with the FGN's priority agenda and a flagship programme of the AfDB's Feed Africa Strategy. The first phase of the SAPZ programme is being implemented across Nigeria's six geopolitical zones and the Federal Capital Territory (FCT).

The SAPZ II Programme aligns with the Anambra State Government's vision for the Anambra State Mixed Industrial City (AMIC) Project focusing on economic transformation through industrialisation and agriculture. While the project promises substantial socioeconomic benefits, it may also have adverse environmental and social impacts. Consequently, the ANSG commissioned Grim & Green Consult Limited (GGCL) to undertake an Environmental and Social Impact Assessment (ESIA) for the proposed Anambra State SAPZ II Programme in line with the requirements of the Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004 and the AfDB's Integrated Safeguards System (ISS). The ESIA will help to identify and assess the Programme's potential and associated environmental and social impacts, evaluate alternatives and propose measures to manage significant adverse effects, ensuring the overall sustainability of the project throughout its lifecycle. This ESIA is thus executed in compliance with both the Nigerian EIA Act and the AfDB ISS.

ES1.2 Programme Components

The AN SAPZ II comprises four main components, including:

- **Climate-Adapted Infrastructure for the Agro-Industrial Hub:** Development of essential infrastructure, including roads, water, power, and processing facilities, with a focus on climate resilience and sustainability.
- **Agricultural Productivity and Production Boost:** Enhancement of farm infrastructure, including irrigation and access roads, and establishment of Agricultural Technology Centres (ATCs) to support farmers with resources and training.
- **Policy & Institutional Development:** Creation of a supportive legal framework, one-stop shops for business registration, and capacity-building for institutions to attract private investment.
- **Program Coordination and Management:** Oversight of project implementation, staff training, and establishment of monitoring and evaluation systems for effective management.

ES1.3 Project Proponent

The primary proponent of the Anambra SAPZ II programme is the Anambra State Government (ANSG), with its headquarters located at Government House, Awka, along the Onitsha-Enugu Expressway, Awka South Local Government Area, Anambra State. Key partners include the African Development Bank (AfDB) and the Federal Government of Nigeria (FGN) through the Federal Ministry of Agriculture and Rural Development (FMARD).

ES1.4 Project Location

The proposed locations for the Anambra SAPZ II are as follows:

1. **SAPZ AIH:** AMIC in Ogboji, Orumba South Local Government Area (LGA), Anambra State, 5.994683° N, 7.278838° E.
2. **Ugbene ATC:** Nuke Farm, Ugbene Town, Awka North LGA, 6.408411° N, 7.082986°E.
3. Omor ATC: Isiokwe-Orenja, Omor Town, Ayamelum LGA, 6.498969° N, 6.98698° E.
4. **Ogbunka ATC**: Isiokpu Village, Orumba South LGA, 5.994683° N, 7.278838° E.

ES1.5 Administrative and Legal Framework

The Federal Ministry of Environment (FMEnv) is the primary authority for overseeing Environmental and Social Impact Assessments (ESIA) in Nigeria, as established by the EIA Act Cap E12 LFN 2004. ESIA studies must adhere to a comprehensive framework of national, state, and local laws, regulations, and policies. Key regulations include:

- The Nigerian Constitution and National Policy on the Environment: Provide a constitutional basis for environmental protection and sustainable development.
- **EIA Act and FMEnv Guidelines:** Define the procedures and standards for conducting environmental impact assessments and project categorisation.
- **NESREA Regulations:** Enforced by the National Environmental Standards and Regulations Enforcement Agency, these regulations cover environmental standards.
- **Sector-Specific Regulations:** Address issues in agriculture, waste management, occupational safety, and public health.
- **Applicable Anambra State Laws and Local Government By-Laws:** Regulate various local environmental and social aspects.
- **Ratified International Agreements and Conventions:** Reflect Nigeria's commitments to global environmental standards.

For projects funded by the African Development Bank (AfDB), adherence to the Bank's Operational Safeguards is mandatory. These include:

- OS 1: Assessment and Management of Environmental and Social Risks and Impacts
- OS 2: Labour and Working Conditions
- OS 3: Resources Efficiency and Pollution, Prevention and Management
- OS 4: Community Health, Safety, and Security
- OS 5: Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement
- OS 6: Habitat and Biodiversity Conservation, and Sustainable Management of Living Natural Resources
- OS 7: Vulnerable Groups

- OS 8: Cultural Heritage
- OS 9: Financial Intermediaries
- OS 10: Stakeholder Engagement and Information Disclosure.

ES2: Project Justification

ES2.1 Rationale for the Project

AN SAPZ II implementation is justified in its potential to transform the agricultural sector by enhancing agro-industrial efficiency, reducing post-harvest losses, and creating employment opportunities. It is strategically important for Nigeria's economic diversification efforts, supporting value-added industries and attracting private sector investment to rural areas, ultimately contributing to poverty reduction and economic growth.

ES2.2 Need for the Project

The AN SAPZ II is driven by socioeconomic productivity challenges in the agricultural sector, including low productivity, inadequate infrastructure, and limited market access. The SAPZ project aims to address these challenges, thereby stabilising economic benefits for farmers, improving food security, and reducing dependence on food imports.

ES2.3 Sustainability of the Project

Sustainability is a key focus of the project, with comprehensive plans in place to ensure technical, economic, environmental, and social sustainability. The project will employ advanced technologies, create jobs, and boost local economies while adhering to environmental and social safeguards. This approach ensures that the benefits of the SAPZ project will be long-lasting, fostering sustainable development in Anambra State.

ES2.4 Project Options and Alternatives

The SAPZ project evaluated various alternatives for implementation, location, processing technologies, energy sources, waste management, and supply chain strategies.

- For project implementation, the "Go-Ahead" option was favoured based on its potential to deliver substantial economic, technical, social, and environmental benefits.
- In terms of location, Ogboji was selected as the optimal site for the Agro-Industrial Hub (AIH) based on land availability, connectivity, and existing infrastructure. The Agricultural Transformation Centres (ATCs) were situated in Ogbunka, Omor, and Ugbene due to their strategic proximity to agricultural areas, good connectivity, and favourable legal and feasibility conditions.
- For processing technologies, a blend of traditional and modern equipment will be utilised, aiming to balance efficiency, cost-effectiveness, and environmental considerations. The exact mix will be tailored to the specific processing needs of different products.
- On the energy front, a hybrid model combining the national grid with onsite renewable energy (solar PV) is preferred, ensuring both reliable and sustainable energy sources.
- Water supply sources proposed include surface water, groundwater and rainfall.
- In waste management, innovative methods such as composting and recycling are prioritised over traditional landfill options to minimise environmental impact and enhance sustainability.

- Regarding the supply chain, local sourcing is emphasised to boost the local economy and reduce transportation expenses, although long-distance sourcing may be employed for particular products or when local resources are inadequate.

Overall, the chosen alternatives for the SAPZ project aim to achieve a balance of economic feasibility, environmental stewardship, logistical efficiency, and social benefit, ensuring the project's success and alignment with its long-term objectives.

ES3 Project Description

ES3.1 Project Technology and Processes

ES3.1.1 APZ Agro-Industrial Hub (AIH)

The AIH will be a central processing facility for agricultural products, featuring advanced equipment and infrastructure. It will prioritise sustainability through waste management, water conservation, and energy efficiency. The AIH will integrate with AMIC, fostering synergy and supporting efficient operations. Overall, it will play a crucial role in driving agricultural transformation and economic development in Anambra State.

ES3.1.2 Agricultural Transformation Centres (ATCs)

The ATCs will serve as crucial hubs within the SAPZ project, connecting local farmers to the AIH and facilitating agricultural product processing. Located in Ogbunka, Omor, and Ugbene, each ATC will feature facilities for pre-processing, storage, and value addition.

These centres will play a vital role in supporting local farmers, enhancing agricultural productivity, and ensuring a reliable supply of raw materials to the AIH. The ATCs will also offer essential services such as training, market information, and infrastructure for livestock and crop management.

ES3.2 Raw Materials

Core raw materials include cereals and pulses for milling and food processing, oilseeds like sesame and oil palm for oil extraction, timbers for packaging materials, and a variety of fruits and vegetables for processing, cold storage, and packaging. Additionally, livestock products, including meat and dairy, will be processed and preserved at the hub.

ES3.3 Water Needs and Infrastructure

The combined daily water demand for the AIH and three ATCs is estimated at 11,358.4 cubic meters, including potable and non-potable water. To meet this demand, the project will rely on groundwater from boreholes drilled at the site, surface water from River Ahomiri, rainwater harvesting, and wastewater recycling. Efficient water management strategies will include water meters, smart monitoring, and minimising water losses. The project will also have substantial storage capacities, including underground storage and overhead tanks, to ensure a reliable and sustainable water supply.

ES3.4 - Energy Demand and Supply

The SAPZ project will rely on a combination of the national grid (via the Enugu Electricity Distribution Company’s Oko Injection Substation and the planned 150 MVA substation in Onitsha) and onsite renewable energy to meet its energy needs. The project will be integrated into the existing and proposed national grid infrastructure, ensuring a reliable power supply. Additionally, rooftop solar PV panels will be installed to reduce the project's carbon footprint and provide a sustainable energy source.

The estimated power demand for the project is:

- Construction Phase: The total power demand is 143 kVA, with 110 kVA required for the AIH and 33 kVA for the three ATCs combined.
- Operational Phase: The total power demand is 25.3346 MVA, including 19.49 MVA for the AIH and 5.8446 MVA for the three ATCs combined.

During the construction phase, temporary arrangements like portable generators can be used. For the operational phase, the project will leverage the national grid and solar PV panels to meet its power requirements.

ES3.5 Project Phases and Activities

The AN SAPZ II implementation involves five main phases, including:

- **Feasibility Studies:** Initial studies assess market demand, technical needs, financial viability, and environmental/social impacts, ensuring the project's overall feasibility.
- **Pre-construction Phase**: This involves land acquisition, environmental and social impact assessments, and site preparation. Key tasks include site clearing, utility setup, construction camp establishment, and logistics planning.
- **Construction Phase:** The focus is on physical infrastructure development, including foundation works, building construction, infrastructure setup (roads, drainage, water, sewage, power), landscaping, and equipment installation.
- **Operational Phase:** This phase involves managing and maintaining facilities, tenant management, commissioning, daily operations, environmental monitoring, community engagement, maintenance, and compliance. Continuous evaluation ensures operational efficiency and alignment with project goals.
- **Decommissioning Phase:** Upon project completion, a decommissioning plan will be implemented to safely dismantle facilities and restore the site, considering environmental and social factors.

ES3.7 Health and Safety Management

The AN SAPZ II will implement a robust Health, Safety, and Environment (HSE) strategy for the SAPZ project, adhering to national and international standards and the AfDB's Operational Safeguard 5. Key measures include a comprehensive Occupational Health and Safety (OHS) policy, safety training, PPE provision, and emergency response planning. Environmental management will focus on sustainability, including air and noise control, soil conservation, water management, and waste reduction. A dedicated HSE team will ensure compliance, stakeholder engagement, and continuous improvement throughout the project.

ES3.8 Waste Management

The Anambra SAPZ II programme will comply with the National Environmental (Sanitation and Wastes Control) Regulations 2009, the Hazardous and Solid Waste Regulation 1991 and other relevant regulations and standards. The programme will implement a waste management plan based on the "5 Rs" hierarchy: Refuse, Reduce, Reuse, Recycle, and Recover. The plan includes segregation, inventorying, classification, quantification, tracking, and safe disposal of waste. Solid waste will come from food processing, construction debris, and packaging materials; liquid waste from wastewater and used oils. E-waste will be managed through buy-back agreements with OEMs or state-accredited contractors.

ES3.9 Project Schedule

The SAPZ project, a component of the Anambra Mixed Industrial City (AMIC), is set for completion within six years. The project will follow a phased approach with SAPZ becoming functional within two years.

ES4 Baseline Environment

ES4.1 Baseline Overview

Anambra State is within latitudes 5.6904° N to 6.8041° N and longitudes 6.6294° E to 7.3386° E. The state features diverse topography, from low-lying floodplains along the River Niger to higher northern elevations. Key baseline data includes climate, air quality, geology, hydrology, soil, vegetation, and wildlife. It provides a reference for assessing potential environmental impacts and guiding sustainable project practices.

ES4.2 Baseline Data Acquisition Method

Baseline data were gathered through literature review, reconnaissance visits, and field surveys employing a multidisciplinary approach. The Federal Ministry of Environment (FMEnv) permitted one-season sampling. Primary data were obtained through comprehensive field surveys conducted from July 9-13, 2024, and July 29 to August 1, 2024, during the rainy season. This data included assessments of groundwater, hydrobiology, soil, air quality, noise, local meteorology, and socio-economic conditions. Representative samples were collected to establish baseline conditions. All laboratory analyses were conducted at the FMEnv-accredited Mozuk Scientific and Analytics Laboratories in Abuja, CS35 Drive 2 Corner Shop Prince and Princess Estate, Abuja, adhering to federal and international standards. Furthermore, socio-economic data collection continued throughout the ESIA study. All data gathering adhered to the provisions of Act CAP E12 LFN 2004 and the FMEnv EIA Procedural Guidelines 2017.

Secondary data was obtained from publications from FMEnv, NESREA, National Bureau of Statistics (NBS), National Population Commission (NPC), peer-reviewed scientific papers, and long-term meteorological data from the Nigerian Meteorological Agency (NiMet) were reviewed. Additionally, the previously approved EIA for Coscharis Farms Limited (2020) (dry season) was used to compare data obtained for groundwater, surface water and soil.

4.3 Baseline Biophysical Environment

ES4.3.1 Climate and Meteorology

Anambra State experiences a tropical monsoon (Am) climate, characterised by high temperatures and distinct rainy (April to October) and dry (November to March) seasons. Historical climate data from NiMet covering 1991 to 2020 from their Onitsha Meteorological Station was used to describe the climate of the state.

- **Rainfall**: The average annual rainfall in Onitsha, according to NiMet data, was 1,825.56 mm, with the driest month in January (2.37 mm) and the wettest in June (287.85 mm).
- **Temperature**: The NiMet data shows an average monthly temperature of 28.20°C. The highest temperatures are recorded in February, with an average maximum of 35.57°C, while the coolest months are July and August, with an average minimum of 23.42°C. During the study, average daytime temperatures ranged from 28.3°C to 38.2°C.
- **Relative Humidity (RH):** The NiMet data indicates that the average minimum monthly RH at 1500 hrs is 68.5% in January, and the maximum is 87.8% in August. During the study, RH values ranged from 51.1% to 69.2%, lower than the NiMet averages for July (87.0%).
- **Wind Speed and Direction:** Wind speeds in Onitsha ranged from 1.8 m/s (October 2013) to 5.3 m/s (March 2020), with an average of 3.62 m/s. The study site recorded an average wind speed of 1.80 m/s, lower than NiMet's 3.60 m/s average for Onitsha in July. Wind direction typically shifts from the northeast during the dry season to the southwest during the wet season.

ES4.3.2 Air Quality

The assessed air quality parameters were generally low. PM2.5 and PM10 concentrations were consistently below FMEnv limits. Carbon dioxide (CO_2) levels show some variability across sites but remained within acceptable ranges. Nitrogen dioxide (NO_2) was detected in specific instances, such as Ogboji and Ugbene, but overall levels were not significant. The presence of carbon dioxide (CO_2), sulphur dioxide (SO_2), ammonia (NH_3), hydrogen sulphide (H_2S), methane (CH_4), and ozone was negligible or non-detectable. SO_2 had one instance of marginally exceeding the limit of 0.1 ppm at Omor. Volatile organic compounds (VOCs) levels, although detected occasionally, do not present a significant pollution concern. The stable and low levels of most air quality parameters suggest that the current air quality is relatively good, with minimal pollution sources in the area.

ES4.3.3 Noise

The baseline noise levels across the four sites ranged from 45.9 dB(A) to 62.7 dB(A). The overall mean noise level across all sites was approximately 51.1 dB(A). The primary noise sources at these locations were agricultural activities, with variations observed due to differences in the intensity of farming operations across the sites.

ES4.3.4 Land Use

The primary land use in Anambra State is agricultural and agroforestry, comprising 70.04% of the total area. Urban and built-up areas make up 27.17%. Flooded vegetation and bare ground account for 0.28%, and water bodies cover 2.16%.

ES4.3.5 Landscape

The project areas display distinct landscape features:

- **Ayamelum LGA:** Predominantly flat with elevations below 60 metres, prone to seasonal flooding and waterlogging due to its proximity to major rivers.
- **Awka North LGA:** Elevations range from 16 to 139 metres, with the terrain being flat to gently sloping. Flooding is a concern during heavy rains, and potential future development near the capital could impact the landscape significantly.
- **Orumba South LGA:** Undulating terrain and elevations between 55 and 341 metres, prone to erosion and landslides due to steep slopes. Extensive sand mining and rapid urbanisation have further degraded the landscape, leading to reduced vegetation and increased environmental challenges.

ES4.3.6 Geology and Hydrogeology

- Ogboji (Orumba South LGA): Underlain by erodible Nanka Sands, with high groundwater yield. Boreholes range from 110-150 meters deep, and water table depths average 20-40 meters. High pore water pressures contribute to erosion.
- Ogbunka (Orumba South LGA): Also underlain by Nanka Sands but with more stable slopes. Borehole depths are around 200 meters, and water table depths average 40 meters. The area has reliable groundwater resources and lower erosion risk.
- Ugbene (Awka North LGA): Features Imo Shale and Nanka sandstone, with semi-confined and unconfined aquifers. Borehole depths range from 6-30 meters, and water table depths are between 11-56.5 meters. Groundwater is stable with high yield potential.
- Omor (Ayamelum LGA): Characterised by alluvial deposits and clay soils, leading to high sedimentation and pollution. Borehole depths are 35-50 meters, with shallow water tables.

ES4.3.7 Local Drainage Systems

- **Ogboji (Orumba South LGA):** Features a dendritic drainage pattern with the Eso Stream closest to the project site. Additional streams include Nweze, Ako Okpa, Nkwukwo, and Ngene Ogbo, all converging into River Ogbo, which feeds into River Otalu and Ahommiri.
- **Ogbunka (Orumba South LGA**): Close surface water to the site is the Uruokpukpo River, a tributary to Mmiri Unyo, which joins the Imo River. The river system includes Mmiri Ngele Ojie, also a tributary to Mmiri Unyo.
- **Ugbene (Awka North LGA):** Closest surface water to the project site is the Nnamuzu River, a tributary to the Ezu River, which joins the Omambala (Anambra) River, eventually draining into the Niger River.

- **Omor (Ayamelum LGA):** The closest surface water to the site is Mmiri Otakpu, flowing into the Ezu River and, subsequently the Omambala River.

ES4.3.8 Soil

ES4.3.8.1 General Soil Characteristics

Two main types of soil occur in Anambra State. The first, found in low wet areas like Ayamelum, are alluvial soils formed from river deposits, characterised by their fine texture and greyish colour. The second type, located on sands and sandstones in elevated regions such as Orumba and Awka, includes slope wash and talus slope soils. These soils are coarser and are formed from weathered rocks on steeper slopes.

The soil characteristics of the Ogbunka, Ogboji, and Ugbene project areas exhibit distinct variations in appearance, texture, and particle size composition.

ES4.3.8.2 Physical Soil Characteristics in Project Areas

Ogbunka: Soils are predominantly dark brown to reddish brown. The top 0-15 cm layer is mainly loam, which supports good plant growth, while the deeper 15-30 cm layer has increased clay content, affecting drainage. Control samples are uniformly dark greyish-brown clay, indicating a more consistent texture. Particle size composition reveals sand content ranging from 22.10% to 47.55% in the top layer and 25.00% to 47.85% in the deeper layer. Silt content varies from 24.90% to 39.40% (0-15 cm) and 25.35% to 50.10% (15-30 cm), while clay ranges from 13.24% to 45.98% (0-15 cm) and 17.42% to 44.60% (15-30 cm).

Ogboji: Soils are characterised by a dark red hue at both depths, with clay being the predominant texture. This suggests high water retention but potentially lower aeration. Some sites exhibit clay loam or loam textures, which are more conducive to agriculture. Sand content ranges from 22.00% to 32.50% (0-15 cm) and 25.00% to 34.00% (15-30 cm). Silt ranges from 19.60% to 47.64% (0-15 cm) and 25.35% to 50.10% (15-30 cm). Clay content is high, ranging from 21.99% to 47.90% (0-15 cm) and 21.00% to 49.11% (15-30 cm).

Ogbunka: Soil colours range from dark brown to reddish brown and red. Most samples are loam, suitable for plant growth, though some areas exhibit clay and clay loam textures, which may impact drainage. Sand content in the 0-15 cm layer varies from 26.10% to 37.81% and 28.00% to 37.85% in the 15-30 cm layer. Silt content ranges from 12.19% to 56.10% (0-15 cm) and 10.00% to 60.00% (15-30 cm). Clay ranges from 10.90% to 50.00% (0-15 cm) and 10.00% to 52.15% (15-30 cm).

Ugbene: Soils exhibit a range of colours from brown to yellowish brown and dark grey. The texture varies from sandy to loam and clay, with deeper layers showing heavier textures. Control samples consistently show clay. Sand content ranges from 23.7% to 55.66% (0-15 cm) and 25.1% to 59.72% (15-30 cm). Silt ranges from 26.7% to 55% (0-15 cm) and 27.26% to 53% (15-30 cm). Clay content ranges from 13.73% to 50% (0-15 cm) and 10.03% to 40% (15-30 cm).

ES4.3.8.3 Heavy Metals

Omor: Heavy metals like Aluminium (Al), Cadmium (Cd), Chromium (Cr), and Lead (Pb) generally show low concentrations, often below detection limits. Iron (Fe) levels are higher but consistent across depths, while Nickel (Ni) is slightly elevated in deeper layers. Zinc (Zn) concentrations are lower than typical uncontaminated soil levels. Overall, the data suggests minimal heavy metal contamination, with values mostly within natural or low anthropogenic ranges.

Ogboji: Al and Cr levels were generally low, often below detection limits. Cd and Ni showed slightly higher concentrations in deeper layers, with Cd being a toxic metal, and Ni exhibited non-detectable levels in control samples. Fe was consistent across depths, while Pb had marginally higher concentrations in the surface layer. Zn levels were comparable between layers, with control samples showing slightly higher concentrations. Overall, heavy metal concentrations in Ogboji soil were within natural or low anthropogenic ranges, indicating minimal contamination.

Ogbunka: In Ogbunka soil, Al and Fe were consistently detected across samples, with Fe levels similar to those in control samples, while Al concentrations were slightly lower in the deeper layers. Cr was found only in a few isolated samples, and Pb was detected in two samples with concentrations above detection limits. Cd and Ni were not detected in any samples. Zn levels were higher in the subsoil compared to control samples, indicating some variation but still within low contamination levels. Overall, the heavy metal concentrations in Ogbunka soil are minimal, suggesting a low environmental impact.

Ugbene: The assessment of heavy metals in the samples reveals significant seasonal and spatial variations. Cd and Cr were consistently below detection limits across all samples. Al was detected only in one rainy season sample but not in the dry season, with the control samples showing higher concentrations. Fe and Zn were present in measurable amounts in both seasons, with higher concentrations during the rainy season. Pb and Ni were absent in the rainy season but detected in the dry season, though at low levels. Control samples generally had higher metal concentrations than the project area samples, highlighting the potential impact of seasonality, parent material, and land use on soil composition.

ES4.2.9 Groundwater

Omor: Most groundwater parameters met FMEnv/NESREA standards. However, cadmium levels (0.008 - 0.1 mg/L) exceeded WHO guidelines. Nickel levels exceeded WHO limits in GW1 and GW3 during the rainy season. Microbiological analyses showed elevated total coliforms and bacteria, particularly in GW3, exceeding recommended limits.

Ogboji: Most groundwater parameters in the Ogboji project area met NESREA standards. However, cadmium levels were notably low (0.001 mg/L) and within WHO guidelines. Iron levels exceeded NESREA's desirable limit of 0.1 mg/L, with a concentration of 1.0 mg/L. Microbiological analyses indicated elevated total coliform counts and total bacteria, particularly with higher values compared to the control sample.

Ogbunka: Most groundwater parameters in the Ogbunka project area met NESREA standards. However, the pH levels (6.3–6.4) were below the NESREA standard range of 7.0–8.5, indicating slightly acidic conditions. Cadmium levels in GW1 (0.057 mg/L) exceeded the WHO guideline value of 0.01 mg/L. Additionally, microbial contamination was high, with total coliform counts (2.4–12 Cfu/ml x 10^2) and total bacteria counts (3–15.8 Cfu/ml x 10^2) surpassing recommended limits.

ES4.3.10 Surface Water

ES4.3.10.1 River Otakpu (Omor) and River Nnamuzu (Ugbene)

Water quality assessments of rainy season samples of Otakpu River in Omor and River Nnamuzu in Ugbene, tributaries of River Ezu, show notable seasonal differences with the dry season samples from Ezu River. During the rainy season, both rivers had higher turbidity (20.0 to 30.0 TCU) compared to the Ezu River's lower turbidity (3.7 to 5.0 TCU) in the dry season. Otakpu River exhibited higher conductivity and TDS, while Nnamuzu River showed significant variability in TDS. Nitrate and phosphate levels were higher in the Otakpu and Nnamuzu Rivers, reflecting increased agricultural runoff, while the Ezu River had lower nutrient levels. Microbiological counts were higher in Otakpu and Nnamuzu Rivers during the rainy season, with minimal microbial activity in Ezu River's dry season samples. These findings highlight the impact of seasonal runoff and land use differences on water quality

ES4.3.10.2 River Uruokpukpo Ogbunka Surface Water Quality Summary

Most assessed parameters were within NESREA's standards for fisheries and recreational use. Nutrient levels are generally low for nitrate and sulphate, slightly high for nitrite, and elevated for phosphate. However, heavy metals present significant concerns. Al levels were high, with a mean of 2.85 mg/L, Cr was elevated in SW2, and Fe was high, with a mean of 1.03 mg/L. Microbiological analysis revealed high coliform counts, particularly in SW2, and significant bacterial presence in SW3. *Bacillus* spp. were found.

ES4.3.10.3 Eso Stream, Ogboji

Most physiochemical parameters of Eso Stream were within NESREA standards. However, phosphate levels exceeded NESREA's 3.5 mg/L guideline. Elevated concentrations of Al (1.365 mg/L), Cr (0.665 mg/L), Cd (0.02095 mg/L), and Fe (0.35 mg/L) above NESREA's limits were measured in the samples. Pb, Ni and Zn were within limits. Microbiological results showed high total coliforms and faecal contamination in SW2. *Bacillus* spp. were found in SW2, while *Pseudomonas aeruginosa* was absent.

ES4.3.11 Sediment

Sediment samples from the Eso Stream and River Uruokpukpo were analysed.

Physiochemistry: Sediments from Eso River were red and loamy, while those from River Uruokpukpo transitioned from very dark grey upstream to reddish brown downstream, with a higher sand content and lower clay than Eso River. The pH was slightly acidic for both rivers, with Eso River at 5.99 and River Uruokpukpo ranging from 5.98 to 6.04. Electrical conductivity was similar across the rivers' sediment samples, while chloride levels were higher in the Eso River. Total Organic Carbon was higher in the Eso River, and nutrient levels varied with higher phosphate and ammonium in River Uruokpukpo.

Heavy Metals: Al levels were low in both sediment samples, with slightly higher values in the Eso River. Fe concentrations were significantly higher in Uruokpukpo compared to Eso River, while Zn levels varied, being higher in Uruokpukpo. Cd, Cr, Pb, and Ni were below detection limits in both rivers.

Microbiology: Eso River sediments had higher bacterial and fungal counts than Uruokpukpo, with total coliforms and Bacillus spp. also more prevalent in Eso River. Pseudomonas aeruginosa was present in both rivers but showed greater variability in Uruokpukpo.

ES4.3.12 Hydrobiology

ES4.3.2.12.1Phytoplankton

Phytoplankton assessments were conducted in samples from Otakpu River (Omor), River Uruokpukpo (Ogbunka), and River Nnamuzu (Ugbene), with sampling at upstream, midstream, and downstream locations. 22 species across six divisions were identified: Bacillariophyta (diatoms) with six species; Chlorophyta (green algae) with five species; Cyanophyta (blue-green algae) with five species; Dinophyta (dinoflagellates) with four species; Euglenophyta with one species; and Xanthophyceae with one species.

Diatoms were the most abundant, making up 38.8% of the total phytoplankton count, particularly prevalent in River Nnamuzu. Cyanophyta accounted for 21.8%, while Chlorophyta comprised 17.8%. Dinophyta and Xanthophyceae contributed 9.9% and 8.0%, respectively, with Euglenophyta (*Euglena acus*) making up 3.9%.

ES4.3.12.2 Zooplankton

1,639 zooplankton individuals from 37 distinct forms were identified and classified into Cladocera, Copepoda, Rotifera, and Meroplankton. Cladocera, with 16 species across five families, was the most abundant group, contributing 40.4% of the total count. The Moinidae family was the most diverse within Cladocera, while other families had fewer species. Copepoda, with nine species and one nauplius larva across three families, represented 33.4% of the total count, with the highest numbers found in Otakpu River. Rotifera, consisting of five species from five families, accounted for 17.0%, with the highest counts in the Nnamuzu River. Meroplankton, including forms like shrimp and polychaete larvae, made up 9.2% of the total, showing significant variability across sampling stations, with the highest counts in Otakpu River.

ES4.3.12.3 Macrobenthic Fauna

Benthic studies were carried out in River Uruokpukpo in Ogbunka and River Nnamuzu, A total of 24 macrobenthic species were observed distributed across four groups, including five species from the Phylum Annelida (*Capitella* sp., *Nereis pelagica, Notomastus abserans, Eiseniella tetrahedral* and *Tubifex* sp.), ten from Class Crustacea (*Alpheus pontederiae*, *Balanus* sp., *Callinectes Amnicola, Cardisoma armatum, Clibanarius* sp., *Cthamalus dentatus, Macrobrachium macrobrachium, Mysis* sp., *Sesarma alberti,* and *Uca tangeri*, five species from Class Gastropda (*Littorina* sp.*, Nerita glabrata, Pachymelania aurita, Thais* sp. *and Tympanotonus sp*. And four species from Class Insecta (*Baetis* sp.*, Coenagrion* sp., *Chironomus* sp. *and Libellula* sp.). The abundance of species ranged from 40 to 53, while the diversity was similar across the sampled stations.

ES4.3.13 Vegetation

The vegetation types around the project areas are tropical rainforests, derived savannahs, freshwater swamps, and secondary forests. There are also agricultural farmlands interspersed among the different vegetation types. The area is home to species such as bamboo (*Bambusa vulgaris*), and oil palms (*Elaeis guineensis*), alongside various indigenous trees and grasses. The survey identified 154 plant species from 53 families, with no species classified as vulnerable or endangered, though *Irvingia gabonensis (*Ogbono tree) is Near Threatened (NT) and requires monitoring. Plant species exhibit diverse growth forms, including climbers, creepers, grasses, herbs, sedges, shrubs, suckers, and trees.

ES4.3.14 Wildlife

A total of 29 wild animal species were identified, distributed across different groups as follows: mammals (9 species), reptiles (6 species), birds (11 species) and amphibians (3 species). Though not targeted during the study, the following five invertebrate species were identified during the study: *Achatina achatina* (giant land snail) of Family Achatinidae, *Macrotermes* sp. (termite) of Family Termitidae, *Musca domestica* (housefly) of Family Muscidae, *Zonocerus variegatus* (grasshopper) of Family Pyrgomorphidae, and *Anax imperator* (dragonfly) of Family Aeshnidae.

ES4.4 Baseline Socioeconomic Environment

ES4.4.1 Stakeholder Identification and Consultation

The community engagement process included a series of meetings across various towns to discuss the SAPZ project, highlighting the input received from stakeholders such as communities, government agencies (MDAs), and local leaders.

Scoping Workshop (July 10, 2024, at International Conference Centre, Awka): Attended by representatives from ANSIPPA, FMEnv, ANSMA, ANSME, and affected communities (24 participants). Discussions centred on the project presentation by ANSIPPA and the ESIA process. Stakeholders emphasised the importance of direct engagement with local leaders, adherence to regulatory standards, and the inclusion of local labour for empowerment. The project team is committed to ensuring ongoing engagement to address security and socioeconomic concerns.

Focus Group Discussions:

- **Ugbene Town (July 29-30, 2024):** The community expressed interest in the ATC's location, job creation for youth and women, and infrastructure expansion, including roads and telecommunication services. The ESIA team clarified that while infrastructure would focus on the facility, they would communicate additional requests to the government.
- **Omor Town (July 29, 2024):** Community members inquired about reviving a non-functioning recycling plant and potential air pollution concerns. The ESIA team assured that these matters **would be addressed in communications with the state government.**
- **Aguluezechukwu Town (July 30, 2024):** Participants thanked the government and confirmed their willingness to provide land for the project, emphasising the need for clear delineation of project boundaries.
- **Ogbunka Town (July 13, 2024):** Residents expressed enthusiasm for the project and a willingness to assist in identifying neighbouring communities for potential

benefits. They requested improved infrastructure and processing facilities, particularly for oil palm.

- **Ogboji (July 30-31, 2024):** The participants welcomed the project and highlighted the need for access roads and support for farming practices, expressing unanimous support for the project. Participants also sought clarity on the project's location, questioning its overlap with the proposed Pharmaceutical Manufacturing Park site.

In summary, stakeholders highlighted key concerns and expectations related to infrastructure development, job creation, and community participation. The ESIA team committed to incorporating this feedback into project planning and maintaining open lines of communication throughout the project's lifecycle.

ES4.4.2 Affected Communities

Aguluezechukwu in Aguate LGA, Ogboji and Ogbunka in Orumba South LGA, Omor in Ayamelum LGA and Ugbene in Awka North LGA. The people are Igbo. The main religion is Christianity with some traditional religion adherents. The communities are headed by the Igwe and his Igwe-In-Council. The next level is the town union led by a president-general and his executives, while each town has its own chairman. There are also women and youth groups as well. Conflict resolutions normally start at the village level and may be escalated up to the Igwe level.

ES4.4.3 Socioeconomic Factors

ES4.4.3.1 Demography

The 2024 estimated population of the LGAs is 1,026,889, with estimates of 184,433 for Aguata, 259,987 for Awka North, 279,090 for Ayamelum, and 303,379 for Orumba South.

ES4.4.2 Respondents Age Distribution

Most respondents in Ogboji and Ugbene are aged 31-45, while in Ogbunka, Omor, and Aguluezechukwu, the majority are 46-60 years old. The age distribution is broader in the middle age groups, with fewer older respondents.

ES4.4.3 Household Size

Respondents in Aguluezechukwu, Ugbene, Ogboji, and Ogbunka mostly come from households of 5-8 people, while Omor has larger households with more than 8 members. This suggests large families with many dependents, could be affected by changes in farming land.

ES4.4.4 Housing Types

Modern houses are built with bricks, while mud houses are common, often with poor ventilation, flooring, and roofing. Many houses lack toilet facilities. Approximately 47.3% of houses use cement blocks with zinc roofs and 36% use cement blocks with asbestos roofs. Overcrowding is common, with an average of three people per room.

ES4.4.5 Education

In Aguluezechukwu, Ugbene, Ogboji, Omor, and Ogbunka, the proportion of respondents without formal education ranges from 0% to 11.2%, with Omor having the highest and

Ogbunka none. Most respondents have a First School Leaving Certificate or SSCE, reflecting a low level of formal education. Ogbunka shows the highest educational attainment among the communities.

ES4.4.6 Occupation

Agriculture is the primary occupation, especially in Aguluezechukwu (85.7%) and Omor (84.7%). Trading is the second most common occupation.

ES4.4.7 Income

Income-generating activities include crop farming, trading, artisanship, livestock rearing, and self-employment. Most respondents did not disclose their monthly income, but those who did earn mainly between N50,000 and N100,000. Ogboji had many respondents earning between N0-10,000, indicating significant poverty. Omor had dominant income ranges of N10,000-30,000 and N30,000-50,000. Overall, low incomes indicate widespread poverty.

ES4.4.8 Main Source of Energy

Electricity from the national grid is the primary source of lighting, with kerosene lamps and petrol-powered generators also used. Fuelwood is the main cooking energy source due to its affordability compared to electricity. Solar and candles are less frequently used.

ES4.4.9 Vulnerable Groups

Among the 410 respondents, only one person in Ugbene identified as living with a disability (left arm amputation). No other disabilities were reported in the other communities.

ES4.4.10 Conflict Resolution Mechanisms

Conflict resolution in the communities is managed by councils of elders and traditional rulers. These institutions handle various conflicts, including gender-based violence, land disputes, family issues, and value-based disagreements, promoting peace and mutual respect.

ES4.4.11 Perception About the Project

All 410 respondents across the project areas indicated their support for the SAPZ II project. The principal reasons advanced by respondents for supporting the initiative include improvements in agricultural production, economic activities, and food security, along with providing employment opportunities.

ES4.5 Health Survey

Sources of Drinking Water: The communities depend on rivers and springs, with rainwater used seasonally. Borehole water is limited and unreliable.

Toilet System and Sanitation Status: Aguluezechukwu, Ogboji, and Ogbunka use water closet systems. In Omor, 76.5% of respondents lack toilets and practice open defecation.

Health Services Profile: The communities have private and government health facilities, including healthcare centres and dispensaries. Facilities are often poorly equipped, with both orthodox and non-orthodox providers present.

Accessibility and Affordability of Health Services: Access to health services is limited due to a lack of government-owned facilities, with respondents reporting moderate access to the nearest health facilities.

Condition and Frequency of Government Healthcare Services: Primary healthcare centres are under-resourced, with limited medical staff and functional laboratories, resulting in poor service quality.

Health Problems and Cost Implications: Malaria is the most prevalent health issue in the surveyed communities.

ES5 Associated and Potential Impact and Mitigation

ES5.1 Impact Significance Methodology

Impact prediction in the ESIA involves identifying potential changes in environmental and social receptors due to project activities and comparing the predicted situation with the baseline conditions to assess the significance of the impact.

Key steps in impact prediction include identifying potential changes, evaluating impact magnitude, assessing impact sensitivity, assessing impact probability and calculating impact significance, using the following formula:

Significance Evaluation Score = Magnitude (A + B + C + D) x Probability (Z), where

A = Environmental legislation and corporate policy

B = Stakeholder concern/interest

C = Severity of environmental impact

D = Scale of impacts

Impacts with scores 1-25 have significance, 26-50 have medium significance and >50 have high significance. A negative score means a positive impact.

ES5.2 Identified Negative Impact Categories

1. **Involuntary Displacement:** Loss of livelihoods, food security challenges, social disruption (Preconstruction)
2. **Livelihood Impacts:** Changes in household income, employment rates, livelihood diversification, market access, food security, access to quality education and health facilities (Pre-construction, Construction, Operational, Decommissioning)
3. **Economic Impacts:** Impacts on local businesses, shifts in regional economic activities (Operational)
4. **Community Dynamics:** Changes in social cohesion, potential conflicts, impacts on community structure (Preconstruction, Construction, Operational, Decommissioning)
5. **Biodiversity Loss:** Reduction in biodiversity, habitat loss, and species decline (Pre-construction, Construction, Operational)
6. **Flood Risk:** Elevated runoff, frequent and severe flooding (Pre-construction, Construction, Operational, Decommissioning)

7. **Soil Erosion/Land Degradation**: Loss of topsoil, land use changes, reduced land availability, increased gully erosion rate, increased sedimentation (Pre-construction, Construction, Operational, Decommissioning)
8. **Flooding:** (Loss of topsoil, land use changes, reduced land availability, increased gully erosion rate, increased sedimentation Pre-construction, Construction, Operational, Decommissioning)
9. **Soil Contamination**: Elevated levels of contaminants (heavy metals, pesticides, or hydrocarbons) in soil and groundwater, dramatic changes in soil pH, significant increases in organic carbon/matter in soil and groundwater, and the presence of faecal coliforms in soil and groundwater. (Pre-construction, Construction, Operational, Decommissioning)
10. **Water Quality Impairment**: Increased levels of pollutants, changes in water chemistry, reduced aquatic life (Pre-construction, Construction, Operational, Decommissioning)
11. **Noise Pollution:** Noise levels, health impacts, community disturbance (Pre-construction, Construction, Operational, Decommissioning)
12. **Air Quality Impairment**: Increased air pollutants, reduced visibility, and respiratory health impacts (Pre-construction, Construction, Operational, Decommissioning)
13. **Traffic Congestion**: Increased travel time, fuel consumption, emissions, accidents (Construction, Operational)
14. **Poor Waste Management:** Waste generation, improper disposal, pollution, health risks, community impacts (Pre-construction, Construction, Operational, Decommissioning)
15. **Excessive Resource Consumption:** Water scarcity, energy shortages, material scarcity, economic impacts (Construction Operational, Decommissioning)
16. **Energy Use and Efficiency:** Increased energy consumption, resource overexploitation, impacts on sustainability and environmental efficiency (Operational, Decommissioning)
17. **Climate Change Resilience:** Changes in vegetation cover, resilience to extreme weather events, greenhouse gas emissions (Pre-construction, Construction, Operational, Decommissioning)
18. **Health and Safety Risks:** Risks to the health and safety of workers and local communities, accidents, hazardous conditions (Preconstruction, Construction, Operational, Decommissioning)

ES5.3 Mitigation Approach

The approach to managing significant environmental and social impacts follows a hierarchy of strategies:

- **Avoidance:** Prevent negative impacts by adjusting project components, e.g., establishing green buffers.

- **Minimisation:** Reduce the severity of impacts using best practices, e.g., silt fences.
- **Rectification:** Repair or restore the environment if impacts occur, e.g., bioremediation for soil contamination.
- **Compensation:** Offset unavoidable impacts with alternative benefits, e.g., resettlement plans.
- **Monitoring and Adaptive Management:** Continuously monitor and adjust strategies, e.g., regular water quality assessments.

Mitigation measures are implemented as part of the process of impact management. They can also be used to enhance or increase the probability of realising positive impacts.

ES5.4 Illustrative Mitigation Measures

1. **Disagreements over Land Proceeds:**
    - Reach agreements on compensation amounts and timelines for landowners/communities.
    - Obtain necessary licenses and engage relevant stakeholders.
    - Resolve issues before mobilisation and maintain effective communication through regular consultations.
2. **Involuntary/Voluntary Resettlement:**
    - Ensure transparent communication with affected communities and provide fair, prompt compensation.
    - Set up systems to track resettlement progress and address grievances effectively.
3. **Loss of Topsoil/Erosion/Land Degradation:**
    - Implement erosion control measures and maintain natural vegetation cover where possible, replanting promptly after disturbance.
4. **Soil and Water Contamination:**
    - Ensure proper storage and containment of hazardous materials and regularly inspect equipment for leaks.
    - Properly collect and transfer wastewater
5. **Deforestation/Loss of Biodiversity:**
    - Minimize site clearance and develop biodiversity management plans.
    - Conduct habitat restoration and engage local communities in conservation efforts.
6. Cultural Heritage Loss or Damage:
    - Avoid known archaeological sites and conduct assessments before construction.
7. Air Quality Deterioration:

- Connect to the national grid and implement dust suppression measures.
- Maintain equipment according to manufacturer guidelines.

8. Elevated Noise Levels:

- Install noise barriers and restrict noisy activities to daytime hours.

9. Health and Safety Risks:

- Implement comprehensive health and safety management systems and conduct regular safety audits.

10. Traffic Congestion:

- Develop traffic management plans and provide real-time traffic information to commuters

11. Influx of Migrant Workers:

- Prioritise local hiring to mitigate the impact of population influx.

12. Increased Risk of STDs:

- Implement health education programs for migrant workers and ensure access to healthcare services.

13. Community Culture, Safety, and Security:

- Establish open communication channels and provide cultural sensitivity training.

14. Waste Generation:

- Develop a waste management plan and ensure proper disposal by accredited contractors.

ES6 Environmental and Social Management Plan

The Environmental and Social Management Plan (ESMP) for the Anambra SAPZ II programme is designed to mitigate, monitor, and enhance the project's environmental and social impacts while ensuring compliance with regulatory standards and best practices. The ESMP is structured to be cost-effective and includes clear responsibilities, accountability mechanisms, and a comprehensive institutional framework.

ES6.1 Responsibilities and Accountability

The ESMP assigns specific roles to all stakeholders, including contractors, government agencies, regulators, the State Programme Implementation Unit (SPIU), and the African Development Bank (AfDB). This ensures all actions comply with regulatory standards and international best practices. Effective and transparent monitoring programs are central to the ESMP's implementation.

ES6.2 Institutional Capacities

The State Programme Implementation Unit (SPIU) established by the Anambra State Government (ANSG) and AfDB, is responsible for overseeing the project's implementation, including the ESMP and Resettlement Action Plan (RAP). The SPIU will engage an independent consultant to manage these plans and invite relevant NGOs to monitor the RAP's effective execution. Training and capacity building are essential, as many institutions involved are not fully familiar with the AfDB Integrated Safeguards System (ISS). The ESMP includes a training program to address these gaps.

ES6.3 Contractual Management

Contractors are responsible for implementing many of the ESMP's mitigation measures during the pre-construction and construction phases. These measures must be incorporated into their proposals and contracts.

ES6.4 Organisational Capacity and Competency

Competence in ESMP implementation is crucial. Given the current lack of dedicated safeguard units and relevant staff in some state agencies, the project recommends recruiting or training Environmental and Social (E&S) Safeguard personnel. A training program is proposed to enhance the capacities of those involved in the ESMP's execution, focusing on key aspects such as gender issues, labour influx, climate change, and grievance redress mechanisms (GRM).

ES6.5 Management Plans

The Management Plans are essential tools for ensuring compliance with the Environmental and Social Management Plan (ESMP) throughout the Anambra SAPZ project. They outline the specific processes necessary to manage identified impacts while aligning project activities with the environmental and social guidelines established in the ESIA report. The key plans include:

- **Occupational Health and Safety Management Plan:** This plan addresses health and safety risks and impacts, ensuring the protection of workers and communities.
- **Emergency Preparedness and Response Plan:** It details the actions required during emergencies, ensuring swift and effective responses.
- **Traffic Management Plan**: This plan manages traffic-related impacts, promoting safety and minimising disruptions.
- **Waste Management Plan**: It outlines procedures and strategies for the safe handling, treatment, and disposal of waste, thereby promoting environmental protection.
- **Environmental Management Plan:** This plan manages impacts associated with various environmental aspects, supporting sustainability throughout the project.
- **Social Management Plan:** It focuses on addressing social impacts and fostering positive relationships with local communities.

Additionally, the Environmental and Social Management Monitoring Plan (ESMMP) is used to track and assess the implementation of the ESMP. This ensures compliance with environmental standards and facilitates timely adjustments to management strategies as needed.

ES6.6 Grievance Redress Mechanism (GRM)

The GRM for the Anambra SAPZ II project is a structured process designed to address community grievances related to social and environmental impacts, in alignment with AfDB requirements. It provides stakeholders with accessible, culturally appropriate channels to voice concerns, ensuring timely acknowledgement and resolution of complaints.

Key Features of the GRM:

Procedures: Stakeholders can raise concerns regarding project impacts, compensation, and resettlement. The GRM guarantees no-cost submissions and timely responses.

- **Grievance Redress Committee (GRC) Structure:** The GRC is integral to the GRM, providing dedicated committees at community, ministry, and independent levels. Each committee employs tailored strategies that reflect local customs and align with the project's objectives, ensuring a culturally sensitive approach to grievance handling.
    - **Community-Level GRC:** This mechanism empowers local representatives to handle complaints, ensuring grievances are addressed promptly at the local level. GRC members are selected from community stakeholders and trained to facilitate the grievance process effectively.
- **Cost of GRM Implementation:** A budget of NGN 23,500,000.00 is allocated for GRM activities, including training, awareness campaigns, and operational costs. Additional costs related to mitigation measures implemented by contractors and the State Programme Implementation Unit (SPIU) are outlined separately.
- **Structure:** The GRM operates through a multi-level system:
    - **Project-Level Mechanism:** Managed by the SPIU, focusing on local grievances with defined steps for resolution through designated community representatives.
    - **Independent Recourse Mechanism (IRM):** Provides an external review process for unresolved grievances, ensuring compliance with AfDB policies.
- **Cultural Appropriateness:** The GRM adapts existing community grievance mechanisms, promoting inclusivity and respect for local customs, which enhances community engagement.
- **Escalation Process:** Grievances unresolved at the community level can be escalated to higher committees within the GRM framework, ensuring accountability and oversight, with specified response timeframes at each level.

Overall, the GRM aims to enhance project accountability and community trust while effectively managing grievances throughout the project lifecycle.

ES6.7 Monitoring Programme

The ESMP includes a detailed monitoring programme, covering aspects such as air and noise quality, soil and water health, and biodiversity. Monitoring activities are scheduled across the preconstruction, construction, and operational phases, with systematic documentation and regular reporting to relevant stakeholders, including the AfDB, FMEnv, ANSME, ANSMA, SPIU and ANSIPPA. The monitoring framework sets out the specific environmental, social, or OHS element to be tracked; the Action, detailing the specific tasks to manage or assess that aspect; the Responsibility, identifying the stakeholders accountable for each task; When indicating the timing or frequency of these tasks; and the Deliverables, outlining the expected outputs that confirm compliance and effective implementation. Specific components include:

- Air Quality Monitoring: Conducted quarterly by the E&S Safeguard Unit to assess emissions and ensure adherence to air quality standards.
- Noise Level Assessments: Quarterly noise assessments conducted by an external acoustic consultant to ensure compliance with noise regulations, with results reported to the project manager.
- Soil and Water Quality Monitoring: Biennial sampling and analysis by an accredited laboratory to monitor the impacts on local water sources, overseen by the E&S Safeguard Unit
- Waste Management Audits: Monthly audits of waste disposal practices by the E&S Safeguard Unit to ensure compliance with waste handling and disposal regulations.
- Biodiversity Impact Assessments: Annual assessments performed by a specialised ecological consulting firm to monitor and mitigate impacts on local biodiversity, with findings submitted to the E&S Safeguard Unit and the Anambra SAPZ SPIU.
- Social Monitoring: Ongoing monitoring of community dynamics, social cohesion, and project impacts on livelihoods by the E&S Safeguard Unit.
- Health & Safety Monitoring: Continuous monitoring of OHS management, including regular safety audits and health impact assessments by the OHS Manager.

ES6.8 ESMP Disclosures

Following the review and approval of the ESMP by the FMEnv/AfDB, it will be disclosed at the National and local levels by ANSIPPA/ANSMA/SPIU in line with the applicable Nigerian EIA laws and regulations.

ES6.9 Cost of Implementation

The indicative budget for the implementation of the Environmental and Social Management Plan (ESMP) totals NGN 192,170,000.00 (one hundred ninety-two million, one hundred seventy thousand naira). This budget encompasses key cost components essential for effectively managing the environmental and social impacts of the project, including various mitigation strategies.

The breakdown of the budget is as follows:

- Mitigation Strategies: NGN67,000,000.00
- Environmental Sampling Monitoring: NGN52,420,000.00
- Staff Remuneration: NGN40,000,000.00
- Capacity and Competency Training: NGN8,750,000.00
- ESMP Disclosure: NGN500,000.00
- Grievance Redress Mechanism: NGN23,500,000.00

Costs for mitigation measures embedded in the contractor's contract are not part of this estimate. This structured budgeting approach reflects a strong commitment to addressing environmental and social impacts comprehensively and effectively.

ES 7 Conclusion

The Environmental and Social Impact Assessment (ESIA) for the Special Agro-Industrial Project Zone (SAPZ II) in Anambra State was conducted in compliance with Nigerian laws. It identified and evaluated the project's impacts on biophysical and socio-economic components, proposing mitigation and enhancement measures. The ESIA used literature reviews and field measurements to assess the project's environmental and social context. The Environmental Management Plan (EMP) provides a framework for managing impacts, ensuring the sustainability of the environment and improving the quality of life for local communities.

CHAPTER 1 INTRODUCTION

Anambra State Government (ANSG) is developing a Special Agro-Industrial Processing Zone (SAPZ) Phase II project in partnership with the African Development Bank (AfDB) and the Federal Government of Nigeria (FGN). The programme aims to support inclusive and sustainable agro-industrial development in Anambra State by establishing an Agro-Industrial Hub (AIH) and three Agricultural Transformation Centres (ATCs). The project will be funded by the African Development Bank (AfDB) and other Development Partners, such as the Islamic Development Bank (IsDB) the International Fund for Agricultural Development (IFAD), ANSG and private investors.

1.1 Project Background

The first phase of the SAPZ programme is being implemented across Nigeria's six geopolitical zones in Cross River, Imo, Kaduna, Kano, Kwara, Ogun, and Oyo states, as well as the Federal Capital Territory (FCT). It aligns with the priority agenda of the Federal Government of Nigeria and the African Development Bank's Feed Africa Strategy, which aims to stimulate the development of effective agriculture value chains with a focus on sustainable agriculture practices, including the development of maritime products and the blue economy. The central strategy of the SAPZ programme is to stimulate private sector investments to drive a market-oriented agricultural transformation across Nigeria.

To achieve this, the programme establishes AIHs and ATCs as critical infrastructures. These specialised zones, or enclaves, are designed to provide essential infrastructure, including but not limited to roads, power, processing equipment, water supply and commercial facilities. Additionally, innovation hubs will be created within these enclaves to promote capacity building and knowledge exchange, ensuring farmers and agro-processors can access the latest technologies and best practices. The programme also aims to connect producers and buyers, shorten the time produce is moved from farms to markets, reduce operational costs, empower rural agricultural communities, boost competitiveness, and unlock the state's agricultural potential.

Given the programme's enormous potential for socioeconomic impact, the Anambra State Government is keen to leverage the opportunities presented by the second phase of SAPZ (SAPZ II), which aligns closely with the state government's vision for the Anambra State Mixed Industrial City (AMIC) Project, a strategic initiative to transform the economic landscape of Anambra State and Nigeria as a whole. AMIC is designed to attract 2,000 small, medium, and large industries, serving as Centres of Excellence (CoE) with modern infrastructure and shared services to expedite economic growth. The programme also aligns with the ANSG's commitment to transforming the state's economy through industrialisation and agriculture, enhancing the livelihoods of Anambrarians, and contributing to national goals of food security, poverty alleviation, economic diversification, and job creation.

However, the development and operation of the SAPZ may also lead to some adverse impacts on natural and human environments. These impacts may include degradation of terrestrial and aquatic habitats, loss of flora and fauna species, physical and economic displacement and resettlement of affected persons and businesses, and increased health and safety risks.

Consequently, the Anambra State Government commissioned Grim & Green Consult Limited to undertake an Environmental and Social Impact Assessment (ESIA) for the proposed Anambra State SAPZ in line with the requirements of the Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004, which mandates all major public and private developments to go through the EIA process. The ESIA will identify and assess the potential and associated environmental and social impacts and risks of the proposed project, evaluate alternatives and propose appropriate measures to manage significant adverse effects, ensuring the programme's sustainability throughout its lifespan. This ESIA is executed in compliance with both the Nigerian EIA Act and the Integrated Safeguards System (ISS) of the AfDB.

1.2 Project Objectives

The overarching goal of the SAPZ II[1] Programme is to contribute to Nigeria's economic and agricultural development and food security, through the following objectives:

- Increase household incomes and create job opportunities, particularly for youths and women in rural areas.
- Enhance food and nutritional security by boosting agricultural production, improving access to nutritious food, and ensuring a stable and high-quality food supply for rural populations.
- Promote inclusive and sustainable agro-industrial development by supporting value chain creation, encouraging private sector investment, and adopting sustainable agricultural practices.
- Strengthen the competitiveness of selected agricultural value chains by enhancing productivity, improving market access, and adding value to agricultural products.

1.3 Project Proponent

The primary proponent of the Anambra SAPZ (AN SAPZ) II programme is the Anambra State Government (ANSG), with its headquarters located at Government House, Awka, along the Onitsha-Enugu Expressway, Awka South Local Government Area, Anambra State. ANSG serves as the lead implementing agency, driving the project to achieve its development objectives for the state. The Anambra State Ministry of Agriculture and the Anambra State Investment Promotion and Protection Agency (ANSIPPA) function as the Project Coordinating Unit (PCU), overseeing the project's day-to-day operations and implementation.

Key partners in the project include the African Development Bank (AfDB) and the Federal Government of Nigeria (FGN). The AfDB provides significant financial and technical support, while the FGN offers policy and institutional support that aligns the project with national agricultural development goals.

1.4 Project Location

Anambra SAPZ II AIH will be located within the Anambra Mixed Industrial City (AMIC) in Ogboji, Orumba South Local Government Area (LGA), Anambra State. AMIC is designed to provide a critical infrastructure to support the development of the industrial supply chain. The

[1] SAPZ Nigeria Objectives

SAPZ AIH will occupy about 451 hectares (ha) out of the 1,695.29 ha earmarked for AMIC. Ogboji is surrounded by the following neighbouring towns:

- Aguluezechukwu, Akpo and Achina in Aguata LGA
- Ndiokolo, Ndiokpalaeke, Ndiokpalaeze and Ndiowu in Orumba North LGA
- Agbudo, Akpu and Onneh in Orumba South

The three ATCs will be located in:

i. Ugbene Town in Awka North LGA: Neighbouring communities include:
   - Oba Ofemiri, Ugbenu and Achalla in Awka North LGA, Anambra State
   - Ogulogu in Eziagu LGA, Enugu State

ii. Ogbunka Town in Orumba South LGA: The town borders the following communities:
   - Eziagu, Nawfija, Owerre-Ezukala, Ufuma, Umuchukwu (formerly Nkerehi), and Umunze in Orumba North, Anambra State
   - Eziama Nneato in Umunnochi LGA, Abia State
   - Awlaw in Oji-River LGA, Enugu State

iii. Omor Town in Ayamelum LGA. The town shares boundaries with the following towns:
   - Anaku, Umuerum, Umumbo, Ifite Ogwuari, and Igbakwu in Ayamelum LGA, Anambra State
   - Ogbosu-Umulokpa in Uzo Uwani LGA, Enugu State

Table 1.1 summarises the location geographical characteristics of the project locations, while Figure 1.1 shows the administrative map of Anambra State highlighting the proposed project areas.

Table 1.1: Geographical Locations of Project Sites

S/N	Project Site	Land Area (Ha)	Latitude (ºN)	Longitude (ºE)	LGA
1	Ogboji (AMIC)	451.53	6.010337	7.132317	Orumba South
2	Ogbunka	4.5	5.994683	7.278838	Orumba South
3	Ugbene	4.5	6.408411	7.082986	Awka North
4	Omor	4.5	6.498969	6.986988	Ayamelum

Source: ANSG, June 2024

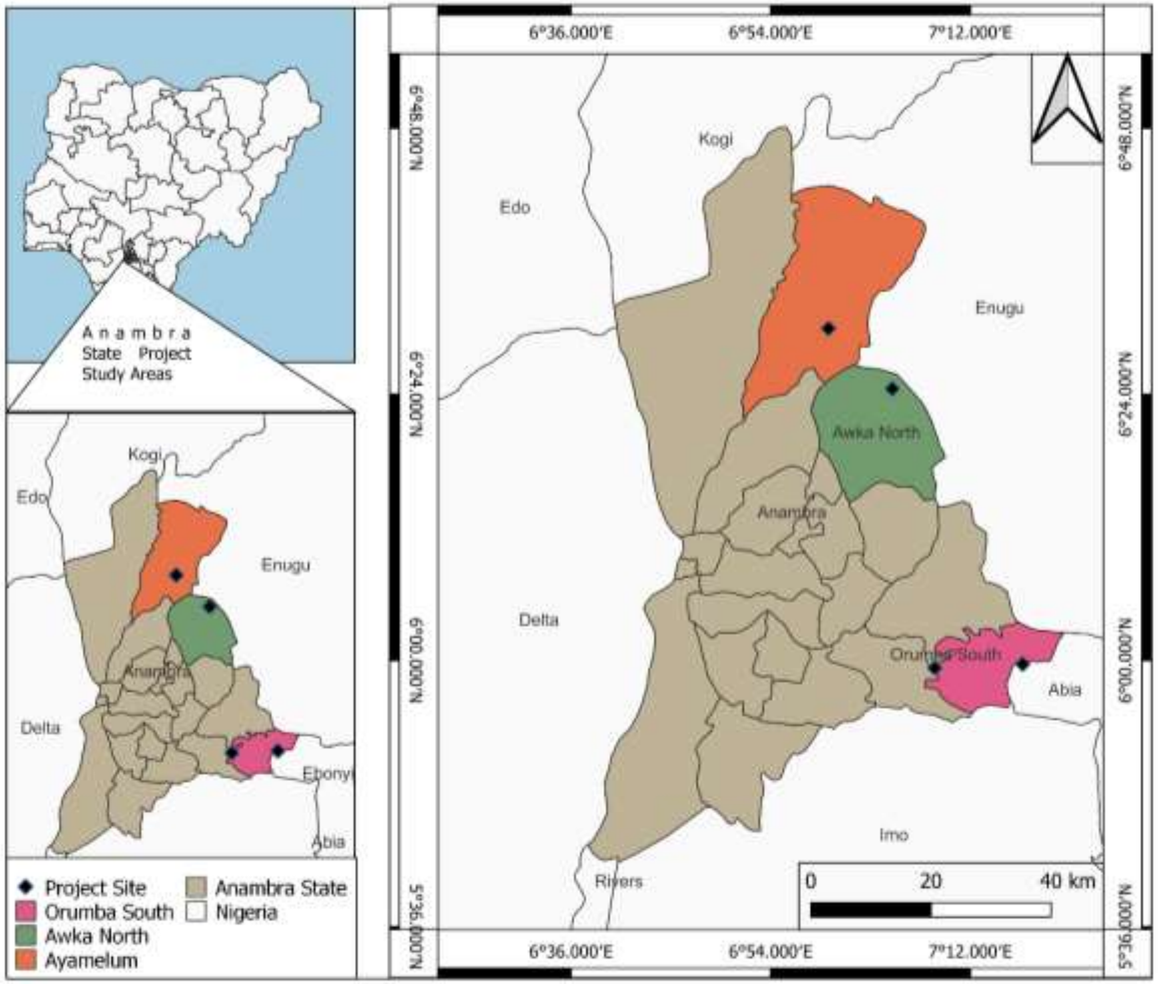


Figure 1.1: Administrative Map of Anambra State Highlighting Proposed Project Areas

1.4 Objectives of the ESIA

The overall objective of this ESIA is to identify and evaluate all potential adverse environmental and social impacts and effects that could arise from the activities associated with the construction and operation of the proposed AIH/ATC processing facilities and ancillary infrastructure. Once potential adverse environmental and social impacts are identified, appropriate mitigation measures will be developed to mitigate the identified negative impacts on the bio-physical and social environment. Ultimately, the outcome of this ESIA will be mainstreamed into the final project designs and project implementation processes to ensure the sustainable management of the environment during project implementation Specific objectives of the ESIA include:

- Facilitate stakeholder consultations to exchange ideas and ensure project goals are achieved while avoiding conflict and promoting fair treatment.
- Establish the baseline environmental and social conditions of the project area, including sensitive components.
- Describe the existing socioeconomic and health characteristics of the area.
- Assist in project design and planning by identifying project activities (location, construction, operation, decommissioning) that may have environmental, health, or socioeconomic impacts.
- Recommend appropriate measures to enhance positive impacts on livelihoods, economic opportunities, and agricultural productivity throughout the project lifecycle.
- Recommend appropriate mitigating measures for significant adverse environmental and social impacts throughout the project lifecycle.
- Develop a cost-effective Environmental and Social Management Plan (ESMP) to manage identified impacts.
- Identify applicable environmental frameworks to guide the project.
- Ensure compliance with the ISS policy of the African Development Bank.

1.6 Scope of the ESIA

The project scope encompasses all activities necessary to prepare and gain approval for the ESIA report. These activities include:

1. Project Scoping and Description:
    - Define the project's area of influence and assess potential environmental and social impacts (considering gender issues, resettlement, social conflicts, environmental risks, and climate change).
    - Review relevant environmental, social, and safeguard policies, regulations, and investment planning processes.
    - Describe project components with visual aids (plans, maps, diagrams) showing the project location and potentially affected areas.

2. Baseline Data Collection and Analysis:

- Collect baseline data on the physical, biological, and social environment.
- Compare alternative project approaches considering environmental, social, and cultural factors.

3. Environmental and Social Impact Assessment (ESIA):

- Assess potential environmental and social impacts of project activities.
- Propose mitigation measures to address the impacts.
- Develop a monitoring plan to track impacts over time.
- Estimate the cost of implementing the Environmental and Social Management Plan (ESMP) and also the capacity of the Borrower/proponent to implement the ESMP and assure the sustainability of the project.

4. Subproject Screening and Mitigation:

- Screen subprojects for potential environmental and social impacts.
- Develop mitigation measures for subprojects with adverse impacts.

5. Grievance Redress Mechanism:

- Engage stakeholders, including vulnerable groups (e.g., women, people with disabilities, the aged, and very young people).
- Establish a mechanism to address grievances related to the project.

6. ESIA Report Submission and Approval:

- Prepare a concise ESIA report with findings, conclusions, and recommendations.
- Submit the report for approval by relevant authorities (FMEnv).

7. Additional ESIAs (if applicable):

- Conduct ESIAs for specific project components as needed.
- Given that the project will lead to the displacement of people (i.e., Project Affected Persons [PAP]), a Resettlement Action Plan (RAP) and a Livelihood Restoration Plan (LRP) will need to be developed to ensure that PAP and affected communities are adequately compensated and supported during and after the transition.

8. Liaison with Authorities:

- Work with ANSIPPA to obtain final ESIA approval from the Federal Ministry of Environment (FMEnv).

1.7 Administrative and Legal Framework

This section reviews the relevant legal and administrative framework governing the project to ensure environmental sustainability. The study was conducted according to approved regulations, guidelines and standards of the FMEnv, the AfDB's Integrated Safety Systems (ISS), and all other applicable national legislation and international agreements and conventions to which Nigeria is a signatory. These laws, regulations, guidelines and policies form the proposed project's administrative and legal framework.

1.7.1 The Nigerian Constitution and the National Policy on the Environment

Section 20 of the Constitution of the Federal Republic of Nigeria provides a constitutional framework for Nigeria to "Protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria."

In 1991, Nigeria published its first National Policy on the Environment, which was revised in 2016. The Policy detailed the framework for managing the environment and natural resources for sustainable development.

Under Paragraph 9.2, the Policy emphasised the need for the involvement of the private sector, the public sector, civil society organisations, local communities and individuals in its implementation. Federal regulatory bodies with responsibilities for achieving the objectives of the National Policy on Environment are the Federal Ministry of Environment and the National Environmental Standards and Regulations Enforcement Agency (NESREA), amongst others.

1.7.2 The Federal Ministry of Environment (FMEnv)

Established in 1999 via a Presidential Proclamation, the FMEnv is the federal body in charge of matters concerning the Nigerian environment. The ministry morphed from the defunct Federal Environmental Protection Agency (FEPA), established by Decree No. 58 of 1988 and 59 (Amended) of 1992, which had responsibility for environmental protection. Following its establishment, the FMEnv, through its Environmental Assessment Department (EAD), is responsible for ensuring that all developmental projects comply with relevant environmental laws and regulations to ensure environmental sustainability.

To help deliver her mandates, the FMEnv has several departments, such as Environmental Assessment and Climate Change, as well as parastatals, including the National Environmental Standards Regulatory and Enforcement Agency (NESREA), the federal agency responsible for the enforcement of environmental standards, regulations, rules, laws, policies and guidelines.

1.7.3 EIA Act and FMEnv Guidelines and Standards

1.7.3.1 Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004

The EIA Act Cap E12 LFN 2004, first enacted as the EIA Decree 86 of 1992, sets out general principles, procedures and methods to consider EIA of qualifying public and private projects. The Act's objective is to promote the implementation of appropriate policies consistent with all the laws and decision-making processes to achieve its goals and objectives. The Act also encourages the development of procedures for information exchange, notification and consultation between the organs and persons when proposed projects or activities are likely to have significant environmental effects on boundary or trans-state or the environment bordering towns and villages.

1.7.3.2 EIA Procedural Guidelines

In response to the promulgation of the EIA Act of 1992, the FMEnv developed a National EIA Procedure in 1995, updated to EIA Procedural Guidelines 2017. The procedural guidelines provide a step-by-step process, from project conception to commissioning stages, to ensure that a qualifying project is implemented with maximum consideration for the environment.

The procedure is generally characterised by certain technical activities, as depicted in Figure 1.3. It also identifies three categories of projects that qualify for EIA studies. The location of a project in environmentally sensitive areas (ESAs) is an important criterion in the project categorisation. The areas categorised as ESAs include coral reefs, mangrove swamps, small islands, tropical rain forests, areas with erosion-prone soils and natural conservation areas.

The three categories of projects include:

1. **Category I**: Projects are subject to full-scale EIA, and they consist of petroleum projects such as oil and gas fields' development, construction of offshore pipelines over 50 kilometres in length, construction of oil and gas separation, processing, handling and storage facilities, and large-scale construction of depots for storage of petroleum products, and others. The SAPZ programme falls under this category.
2. **Category II:** A project in this category may not require a full-scale EIA except when located in an ESA. In that case, the project will be assigned to Category I. The requirement for Category II projects is a partial EIA. Also, mitigation measures or changes in project design (depending on the nature and magnitude of the environmental impacts), and further actions, may be required from the proponent.
3. **Category III:** This includes projects expected to have beneficial impacts on the environment. For projects in this category, the Ministry will issue EIS. This category includes family planning programmes, institutional development, environmental awareness projects, and others.

1.7.3.3 National Guidelines for Decommissioning of Facilities in Nigeria

This guideline outlines how to safely and sustainably decommission facilities that are either past their shelf life or have been abandoned for at least three years in the case of BTS infrastructure. It provides a step-by-step process to ensure the land is suitable for future use. Chapter 6 of this report explains the decommissioning process in detail.

1.7.3.4 National Interim Guidelines and Standards for Industrial Effluent, Gaseous Emissions and Noise Limitations 1991

Published by FEPA in 1991, the 253-page document aimed to support the implementation of the National Policy on the Environment and the environmental pollution abatement strategy by prescribing guidelines and limitations on discharging pollutants into the Nigerian environment.

The guidelines and standards outlined in the document relate to six areas of environmental pollution control:

i. Effluent limitations
ii. Water quality for industrial water uses at the point of intake
iii. Industrial emission limitations

iv. Noise exposure limitations
v. Management of solid and hazardous wastes
vi. Pollution abatement in industries

1.7.3.5 Management of Hazardous and Solid Wastes Regulation

The Management of Hazardous and Solid Waste Regulation, S.1.15 of 1991 (No.102, Vol. 78, August 1991) defines the requirements for groundwater protection, surface impoundment, land treatment, waste piles, landfills, incinerators, and others. It states the procedure for inspection, enforcement and penalty.

1.7.4 National Environmental Standards and Regulations Enforcement Agency (NESREA)

ACT No. 25 2007 (As Amended, 2018) established the National Environmental Standards and Regulations Enforcement Agency (NESREA). The agency is "charged with the responsibility for the protection and development of the environment in Nigeria; and related matters."

In addition to ensuring the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria 's natural resources, NESREA has the mandate to coordinate and liaison with relevant stakeholders within and outside Nigeria on matters of enforcement of environmental standards, regulations, rules, laws, policies and guidelines.

Part II (7) of the NESREA Act enumerates the specific powers of enforcement granted to the Agency, including but not limited to:

- Enforcement of compliance with laws, guidelines, policies and standards on environmental matters;
- Enforcement of compliance with policies, standards, legislation and guidelines on water quality, environmental health and sanitation, including pollution abatement;
- Enforcement of compliance with guidelines and legislation on sustainable management of the ecosystem, biodiversity conservation and the development of Nigeria 's natural resources;
- Enforcement of compliance with any legislation on sound chemical management, safe use of pesticides and disposal of spent packages thereof;
- Enforcement through compliance monitoring, the environmental regulations and standards on noise, air, land, seas, oceans and other water bodies other than in the oil and gas sector;
- Conduction of environmental audit and establish data bank on regulatory and enforcement mechanisms of environmental standards other than in the oil and gas sector;
- Creation of public awareness and provide environmental education on sustainable environmental management, and
- Carrying out such activities as are necessary or expedient for the performance of its functions.

1.7.5 NESREA Regulations

1.7.5.1 National Environmental (Noise Standards and Control) Regulations 2009

These regulations aim to ensure the maintenance of a healthy environment for all people in Nigeria and the tranquillity of their surroundings and psychological well-being by regulating noise levels and elevating their standard of living. It prescribes the maximum permissible noise levels of a facility or activity to which a person may be exposed. It also provides for the control of noise and mitigating measures to reduce noise.

1.7.5.2 Pollution Abatement in Facilities Generating Wastes Regulation

The Pollution Abatement Regulation, S.1.9 of 2004, restricts the release of toxic substances into the environment and stipulates requirements for pollution monitoring units, machinery for combating pollution and contingency plans by industries. No facility shall release hazardous or toxic substances into the air, water or land of Nigeria's ecosystems beyond limits approved by the Federal Environmental Protection Agency. The Regulation also provides for the protection of workers, safety requirements, environmental audit (or environmental impact assessment for new industries) and penalty for contravention.

1.7.5.3 National Environmental (Air Quality Control) Regulations 2014

The objective of the National Environmental (Air Quality Control) Regulations 2014 is for improved control of Nigeria's air quality for enhancement of flora and fauna, human health and other resources affected by air quality deterioration. The Regulations also reaffirm citizens' right to clean air, sustainable management of natural resources and access to information concerning the nature and extent of potential hazards that may result in the accidental or deliberate release of harmful or hazardous substances into the atmosphere. Activities with the potential to emit pollutants require permits for air quality control under the Regulations.

The Air Quality Control Regulations also set permissible limits for emissions for groups of pollutants such as heavy metals, hydrocarbons (HCs), hydrogen sulphide (H_2S), oxides of nitrogen (NOx), particulate matter, and more. These limits account for the source of the emissions, for example, stacks, mobile sources, and others. Failure to comply with the emission standards incurs fines.

1.7.5.4 National Environmental (Food, Beverages and Tobacco Sector) Regulations 2009

These Regulations were established "to prevent and minimise pollution from all operations and ancillary activities of Food, Beverages and Tobacco Companies to the Nigerian environment." The Regulations require companies to employ cost-effective cleaner technologies to minimise pollution, meet the limitations set by the National Standards on emission, minimise pollution at source and reduce the amount of packaging it uses.

1.7.5.5 Nigerian Safety and Security of Radioactive Sources Regulations of 2006

The Regulations serve to ensure the following, amongst others:

- Regulate the possession and application of radioactive substances and devices emitting ionising radiation;
- Ensure protection of life, health, property, and the environment from the harmful effects of ionising radiation while allowing beneficial practices involving exposure to ionising radiation; and
- Regulate the introduction of radioactive sources, equipment and practices involving workers and the general public exposure to ionising radiation.

1.7.5.6 National Environmental (Control of Vehicular Emissions) 2011

The National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations 2009 aims to "restore, preserve and improve the quality of air." Schedules II and VIII of the Regulations specify the emission limits for carbon monoxide, hydrocarbons (HCs), nitrogen oxides (NOx) and combined masses of HCs and NOx for petrol and diesel engines. The limits aim to protect citizens' right to clean air, reduce and prevent air pollution and improve the health of Nigerians. The Regulations, which became enforceable on 28th April 2011, also specify fines for violating the standard.

1.7.5.7 National Environmental (Surface and Groundwater Quality) Control Regulation 2011

To restore, enhance and preserve the integrity of Nigeria's surface water, maintain existing water uses and control pollution of water bodies. The Regulations also set the standard for water quality and prohibit discharges that could result in the deterioration of water quality without approval granted under the Regulations.

1.7.5.8 National Environmental (Sanitation and Wastes Control) Regulations 2009

To minimise pollution and promote the adoption of sustainable and environment-friendly practices in environmental sanitation and waste management. These Regulations make adequate provisions for waste control and environmental sanitation, including punishments in cases of malfeasance.

1.7.5.9 National Environmental (Ozone Layer Protection) Regulations 2009

The Regulations prohibit the importation or manufacture, either in part or whole, of facilities that produce any ozone-depleting substance. The Regulations also prohibit the release of any ozone-depleting substance into the atmosphere from any equipment, part of equipment or fire extinguishing equipment, except during firefighting.

1.7.5.10 National Guidelines on Environmental Audit in Nigeria, 1999 (Revised in 2011)

The National Guidelines on Environmental Audit in Nigeria was first published in 1999 by the then FEPA. NESREA published an updated version of the guidelines in 2011 due to emerging trends and issues relating to the environment. The revised document also placed NESREA in better stead to oversee and regulate environmental audits of the regulated Community.

1.7.6 Agricultural Framework

1.7.6.1 Agricultural (Control of Importation) Act Cap A13 LFN 2004

The Agricultural (Control of Importation) Act regulates the import of agricultural items to prevent the spread of plant diseases and pests. This is done by controlling the import of plants, seeds, soil, and other agrarian materials that could be contaminated. The Act helps protect local agriculture and biodiversity.

1.7.6.2 The National Agricultural Seeds Council Act 2019

The Act regulates the seed industry in Nigeria. It aims to ensure high-quality seeds are available to farmers by promoting seed production, controlling seed registration, and preventing the sale of poor-quality seeds. This Act is important for the project because it guarantees the use of certified seeds that will improve agricultural productivity and overall project success.

1.7.6.3 Agriculture Promotion Policy 2016

Also known as the Green Alternative, the Agriculture Promotion Policy (APP) was launched in 2016 to guide Nigeria's agricultural development from 2016 to 2020. The policy focuses on achieving food security, diversifying the economy through agriculture, developing agricultural value chains, and creating jobs, especially for youth and women. It emphasises private sector involvement and improving access to finance, technology, and market infrastructure to boost productivity and reduce reliance on food imports.

1.7.6.4 The Agricultural Sector Food Security and Nutrition Strategy (AFSNS) 2016

- The AFSNS is a strategy to improve food security and nutrition for all citizens. It recognises that agriculture is critical for many Nigerians, but food production hasn't kept up with population growth. The AFSNS objective includes to:
- Increase food security at all levels (national, community, household)
- Reduce malnutrition, especially in children and women
- Prevent diet-related diseases
- Improve people's knowledge of nutrition
- Build stronger food and nutrition systems
- Integrate food security into government agricultural plans

Aligning with the strategy will ensure that the Anambra State SAPZ project achieves positive outcomes by enhancing food security, improved nutrition, sustainable practices, and empowerment for women and vulnerable groups.

1.7.6.5 National Livestock Transformation Plan (NLTP) 2019-2028

The NLTP is a 10-year strategy to modernise Nigeria's livestock industry and reduce conflict between herders and farmers. It focuses on creating permanent ranches with improved technology to boost production and sustainability. The NLTP also has a social development aspect, addressing the needs of herders and farmers impacted by the changes. Following the NLTP, the Anambra State SAPZ project can ensure its livestock development aligns with national goals and promotes peaceful coexistence.

1.7.7 Other Relevant Statutory and Policy Documents

1.7.7.1 Land use Act Cap L5, LFN 2004

The Land Use Act (LFN 2004) establishes a framework for land management in Nigeria. It designates all land ownership to the state governor, who acts as a trustee managing the land to benefit all citizens. The Act outlines a process for allocating land rights for various uses, including commercial and agricultural purposes, through a system of statutory and customary rights of occupancy. Following this Act ensures your project adheres to legal land acquisition procedures, safeguards existing land rights, and promotes responsible land use practices.

1.7.7.2 Nigerian Urban and Regional Planning Act Cap N138, LFN 2004

The NURPA sets the rules for planning and development in Nigeria. This includes creating national physical development plans (Section 13) and regional, rural, and specific subject plans (Sections 25 & 26). These plans establish zoning regulations for different areas. By following NURPA, the Anambra State SAPZ project can ensure its development aligns with national guidelines, promoting sustainable growth and considering environmental and social factors.

1.7.7.3 National Building Code Act 2005

The National Building Code Act 2005 prescribed a set of rules that specify the standards for constructed objects such as buildings and non-building structures. Buildings/structures must conform to the code to obtain planning permission. The main purpose of building codes is to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures. This project complies with the National Building Code Act 2005.

1.7.7.4 The Fire Service Act Cap F29, LFN 2004

The key objectives of the Act are:

- To prevent uncontrolled fires in our environment, especially our markets, public and private buildings and structures and reduce the incidence of loss of lives and property;
- Enhance response capabilities of the Fire Services and strengthen the regulatory and revenue generation potentials of government as it relates to the distribution and maintenance of fire protection equipment; and
- Promote inter-agency collaboration in distributing and maintaining fire protection equipment to minimise fire incidences.

1.7.7.5 The Harmful Waste Act (1988)

The Harmful Waste Act (1988) strictly prohibits the illegal dumping or disposal of harmful waste in Nigeria. It mandates proper handling, treatment, and disposal of any waste generated during the project, including construction waste and transformer oils. Following this Act safeguards the environment and avoids hefty fines or penalties.

1.7.7.6 Natural Resources Conservation Act Cap 286 LFN 1990

The Natural Resources Conservation Act Cap 268 LFN 1990 is the most direct extant piece of legislation on natural resource conservation in Nigeria. The Act establishes the Natural Resources Conservation Council, empowered to address soil, water, forestry, fisheries and wildlife conservation by formulating and implementing policies, programmes and projects to conserve the country's natural resources.

1.7.7.7 The Endangered Species Act Cap E9 LFN 2004

This Act focuses on protecting and managing Nigeria's wildlife, including those in danger of extinction due to overexploitation.

The following sections are noteworthy:

- Section 1 prohibits, except under a valid licence, the hunting, capture or trade of animal species, either presently or likely to be in danger of extinction;
- Section 5 defines the liability of any offender under this Act; and
- Section 7 provides for regulations to be made necessary for environmental prevention and control as it concerns the purposes of the Act.

1.7.7.8 Forestry Law CAP 51 LFN 1994

The Forestry Law prohibits any act that may lead to the destruction of or cause injury to forest products, forest growth or forestry property in Nigeria. The law prescribes the administrative framework for the management, utilisation and protection of forestry resources in Nigeria. The Act aims to protect and conserve Nigeria's forests while ensuring their sustainable use.

1.7.7.9 Labour Act Cap L1 LFN 2004

The Labour Act provides comprehensive legislation on conditions of work and employment.

- Part I sets out general provisions relating to wages, contracts and terms of employment. Employers shall not advance more than one month's wages to an employee (Section 4). Section 8 requires medical examination of workers entering a contract at the employer's expense. Section 20 governs redundancy;
- Part II regulates recruiting, including the licensing of recruiters (Section. 25), and the right to be accompanied by family (not exceeding two wives) (Section 34);
- Part III relates to special classes of workers, including apprentices (Sections 49-53), women (Sections 54-58) and young persons (Sections 59-64). In general, women and young persons are prohibited from performing underground and night work. Section 73 prohibits forced labour; and
- Part IV contains supplemental provisions relating to the administration and the settlement of disputes. Section 90 repeals the Labour Code Act.

1.7.7.10 National Policy on Occupational Safety and Health 2006 (Revised 2020)

The National Policy on Occupational Safety and Health derived its main ground from the 1999 constitution, which in section 17 (3c) prescribes that the Nigerian State shall make laws and bye-laws to preserve the health and well-being of workers in workplaces. The goal of the National Policy on Occupational Safety and Health 2020 is to facilitate the improvement of occupational safety and health performance in all sectors of the economy and ensure the harmonisation of workers' rights protection with regional and international standards.

1.7.7.11 Employee Compensation Act of 2010

An Act to provide compensation for injuries and death suffered by workers in the course of their employment. This legislation, the first of its kind in Nigeria, sought to incorporate international standards as they relate to worker's compensation. It caters to the welfare of injured workers.

The Act makes the following mandatory for employers:

- Pay compensation to any of their employees who suffers injury from any accident arising out of and in the course of his employment; and
- Pay compensation to the person or persons entitled to the estate of any of his employees who dies from an accident arising out of and in the course of his employment.

1.7.7.12 Factories Act CAP F1 LFN, 2004

The Factories Act (1987) governs health and safety in Nigerian workplaces. It protects workers from occupational hazards by setting health and safety standards in factories and likely construction sites. The Act is enforced by the Director of Factories and includes provisions for inspectors to address safety hazards. Ensuring compliance with this Act is vital for creating a safe work environment for personnel and others on the site.

1.7.7.13 The Nigeria National Health Act 2014

The Act aims to establish a national framework for the regulation, development and management of a national health system and set standards for rendering health services in Nigeria. Other key provisions include:

- The establishment of the National Health Systems;
- An exemption from payment for health services in public health establishments; and
- The establishment of the Basic Health Care Provision Fund

1.7.7.14 National Environmental Health Practice Regulation Act 27, 2016

The purpose of the Act is to:

- Provide a guideline for the enforcement of the regulatory powers in the Act;
- Prevent and abate nuisances;
- Protect, preserve and promote the physical and social well-being of the public;

- Prevent and control the incidence of communicable diseases through environmental health intervention;
- Reduce environmental hazards to health;
- Safeguard and maintain the aesthetic value of the environment;
- Promote the general welfare of the public by regulating the sanitary construction and sanitation of all premises; and
- Regulate private and public sector collaborations for purposes of maintaining adequate sanitation and promoting public health and safety.

1.7.7.15 Public Health Laws

Several countries, such as Canada, New Zealand, Australia, and England and Wales, have legislation establishing the administrative and legal framework for conducting health impact assessments (HIA) in development projects, either within an environmental impact assessment (EIA) or as standalone studies. Additionally, international agencies like the World Bank, the Asian Development Bank, and the World Health Organisation have endorsed integrating HIA into development activities.

In Nigeria, there is no single comprehensive public health law that governs all aspects of public health and safety. Instead, a range of federal and state-level laws, regulations, and policies address different aspects of public health management.

For the SAPZ II ESIA project, key legal instruments regulating public health and safety include environmental regulations and policies aimed at protecting air, water, and land, as well as waste management, sanitation, occupational health and safety, and specific health-related laws, all of which are discussed in this chapter.

1.7.7.16 The National Gender Policy 2006

The National Gender Policy 2006 is a critical framework that seeks to improve the lives of Nigerian women and children across all sectors. By aligning with this policy's goals of empowerment, shared responsibility, women's leadership, fair labour practices, and gender mainstreaming, the Anambra State SAPZ project can help create a more equitable and inclusive environment in line with the 1999 Constitution of the Federal Republic of Nigeria, which prohibits discrimination based on places of origin, sex, religion, status, ethnic or linguistic association.

1.7.7.8 Climate Change Act 2021

The Climate Change Act 2021 provides a framework to help Nigeria achieve low levels of greenhouse gas emissions, ultimately contributing to achieving the ETP net-zero carbon target by 2060.

- Part II of the Act establishes the National Council on Climate Change with powers to "make policies and decisions on all matters concerning climate change in Nigeria." Part V of the Act deals with setting a carbon budget and climate change action plan to be overseen by the FMEnv and the Federal Ministry responsible for National Planning
- Part VI of the Act articulates the obligations of Ministries, Departments and Agencies (MDAs) and public and private entities, the need to partner with Civil Society

Organisations (CSOs) to achieve carbon targets and the need to integrate climate change education into all subjects and levels of Nigeria's educational curriculum.

1.7.7.19 National Energy Policy (2003) and the Energy Transition Plan (2021)

The National Energy Policy (NEP) establishes guidelines for the protection of the environment in the exploitation of Nigeria's fossil fuels. The policy also emphasises the exploration of renewable and alternative energy sources, primarily solar, wind and biomass. It was projected that renewable electricity would contribute about 20% of the total national electricity supply mix by 2030 while observing energy efficiency and conservation best practices.

In 2015, the Federal government approved the National Renewable Energy and Energy Efficiency Policy (NREEP). The policy seeks to establish a policy framework for developing Nigeria's abundant renewable energy sources and efficiency in energy services and supply. The NREEP outlines a blueprint for the development, supply, and utilisation of renewable energy resources within the economy and comprising of both on-grid and off-grid energy solutions.

In 2021, President Muhammadu Buhari announced during the 26th Conference of Parties (COP 26), a detailed energy transition plan (ETP)[2] that would see Nigeria become carbon neutral by 2060, end energy poverty and lift 100 million people out of poverty. The plan, which replaces the 2003 NEP hinged on the development of the local natural gas sector, which would support the energy sector until 2040, without detracting from the goals of the Paris Agreement on climate change. However, there is an inclusion of adding 30 gigawatts (GW) by 2030 with 30% renewable energy. The Nigerian government formally launched the plan on 24 August 2022 demonstrating the government's commitment to a clean and sustainable future. According to the government, an annual investment of US$10 billion in the energy sector is required to achieve the plan's objectives

1.7.7.20 National Policy on Waste Battery Management 2022

This policy recognises that batteries used to power automobiles, industrial equipment and alternative energy systems may contain lead, lead alloys, lead and lithium compounds and dilute sulphuric acid, which if not correctly managed in an environmentally sound manner, can contaminate the environment and pose health risks to the people. The policy identifies the proper management of waste batteries as a priority issue, taking into consideration the objectives of the National Policy on Environment, the Harmful Waste Act Cap HI LFN 2004 and the United Nations Basel and Bamako Conventions, of which Nigeria is a signatory. The specific objectives of the policy include the provision of standard guidelines regulating waste batteries management and strengthening institutions and human capacities for effective implementation of waste batteries policy in Nigeria, amongst others.

1.7.7.21 Nigeria Cultural Policy 1988

Introduced in September 1988, the Nigeria Cultural Policy document defines culture as "the totality of the way of life evolved by a people in their attempt to meet the challenges in their

[2] Energy Transition Plan Website

environment which gives order and meaning to their social, political, economic, aesthetic and religious norms and modes of an organisation; thus, distinguishing a people from their neighbour."

The Policy notes the need to understand the nation's cultural conditions, needs, aspirations and goals, and based on that understanding, to develop the means to achieving set goals. The Policy sets the following objectives:

- To mobilise and motivate the people by disseminating and propagating ideas which promote national pride, solidarity and consciousness;
- To evolve from our plurality, a national culture, the stamp of which will be reflected in African and world affairs;
- To promote an educational system that motivates and stimulates creativity and draws largely on our tradition and values, namely: respect for humanity and human dignity, for legitimate authority and the dignity of labour, and respect for positive Nigerian moral and religious values;
- To promote creativity in the fields of arts, science and technology;
- To ensure the continuity of traditional skills and sports and their progressive updating to serve modern development needs as our contribution to a world growth of culture and ideas;
- To establish a code of behaviour compatible with our tradition of humanism and a disciplined moral society;
- To sustain environmental and social conditions which enhance the quality of life, produce responsible citizenship and an ordered society;
- To seek to enhance the efficient management of national resources through the transformation of the indigenous technology, design resources and skills; and
- To enhance national self-reliance and self-sufficiency, and reflect our cultural heritage and national aspiration in the process of industrialisation.

1.7.7.22 Criminal Code Act Cap C38 LFN, 2004

The Nigerian Criminal Code makes it an offence punishable with up to 6 month's 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 neighbourhood, 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 animal.

1.7.8 State Ministries/Environmental Protection Agencies

Section 25 of the FEPA Act 1992 encourages States and local government councils to set up their environmental protection bodies to maintain good environmental quality in the areas of related pollutants under their control. The functions of state environmental protection agencies (SEPAs) include:

Some of the functions of the state ministries of environment include:

- Co-operating with FMEnv and other Agencies in the performance of environmental functions, including environmental education/awareness to the citizenry;
- Monitoring waste management standards;
- Liaising with the FMEnv to achieve healthy and better management of the environment via the implementation of the National Policy on Environment; and
- Monitoring the implementation of EIA studies and other environmental studies for all development projects in the State.

1.7.8.1 Anambra State Ministry of Agriculture

The Ministry is saddled with the responsibility of implementing and monitoring other agricultural Programmes, policies and regulations. The Ministry oversees the implementation of SAPZ in the state.

1.7.8.2 Anambra State Ministry of Environment

The Anambra State Ministry of Environment is the supervisory ministry for environmental affairs in Anambra State. The ministry is responsible for formulating environmental protection policies and management in the state. It works closely with agencies under it and with FMEnv, NESREA and other relevant federal agencies to ensure that the state environmental laws accord with federal laws and regulations.

1.7.8.3 Anambra State Environmental Management, Protection, and Administration Law of 2024

This state-specific law establishes guidelines for environmental protection within Anambra State. It addresses issues such as waste management, pollution control, land use, water conservation, and biodiversity protection, and ensures sustainable development at the state level.

1.7.8.4 Anambra State Environmental Protection Agency (ANSEPA)

The Anambra State Environmental Protection Agency (ANSEPA) is an agency under the Anambra State Ministry of Environment.

The Anambra State Environmental Protection Agency (ANSEPA) is the state Agency taxed with implementing environmental management in the state. This agency is saddled with the mandate to protect, manage and develop the Anambra State environment. It is under the supervision of the Anambra Ministry of Environment, which formulates environmental policies guiding the implementation of environmental laws in the state. Its operation activities cover solid waste management, ecological/erosion control, pollution control and environmental health.

The ANSEPA derives its mandate from the ANSEPA edict of 1998 as specified in sections 7, 8, 9, 13 and 47 of the edicts, which gives the Agency the responsibility to protect and develop the environment in the state without prejudice to such guidelines as may be laid down by the FEPA, now FMEnv). The edict also empowers the ANSEPA to implement and enforce the provision of the Act and the regulations made under it to national standards as it regards environmental protection and maintenance in the state.

1.7.8.5 Anambra State Waste Management Authority (ANWAMA) 2015

The Anambra State Waste Management Authority (ASWAMA) Law 2015 repeals the ASWAMA Law 2011. Among the many objectives of the law is the need to incorporate sustainable development in the field of waste management. Thus, the law includes the concept of waste treatment, processing and recycling that were absent in the 2011 law.

Section 6 of the ASMAWA law lists the functions of the ASWAMA, such as:

- The collection, removal, processing, treatment and safe disposal of domestic, hospital, commercial, institutional and industrial wastes;
- Waste recycling;
- Making recommendations to the State Ministry of Environment for improvements in collection, removal, processing, treatment and safe disposal of waste;
- The promotion, encouragement and fostering of the maintenance of a clean and healthy environment in the State; and
- The designing, operating and maintaining of waste disposal facilities, amongst other functions.

The ANWAMA Law also empowers the body to license private waste collectors to collect and manage wastes generated in the state.

1.7.8.6 Anambra State Physical Planning Board (ANSPPB)

The Anambra State Physical Planning Board (ANSPPB) derives its power via the Anambra State Physical Planning Law No. 9 of 2013 and the Anambra State Building Regulation 2015. The Board is the Anambra State implementing agency in projects related to physical and environmental planning. It also has the power to monitor projects to ensure they adhere to the approved plan and enforce the provisions of the law where necessary, including serving notices and demolitions in extreme cases.

1.7.8.7 Local Government Area By-Laws

Local government bylaws typically regulate smaller-scale environmental and public health issues within a community. This may include waste collection and disposal, noise pollution control, sanitation, local zoning rules, and land use regulations that align with broader state and national laws. These laws and regulations provide a framework for ensuring the health, safety, and environmental sustainability of the affected regions.

1.7.9 International Conventions, Protocols and Agreements

Nigeria is a signatory to multiple International Conventions, Agreements and Protocols. The following sections discuss some relevant ones.

1.7.9.1 United Nations Conferences, Conventions and Agreements on the Environment

1.7.9.2 Stockholm 1972

Held in 1972 in Stockholm, Sweden, United Nations Conference on Environment and Development (UNCED) was the first global conference to bring environmental issues to the world stage, giving rise to the Stockholm Declaration and Action Plan for the Human

Environment and several resolutions. The Stockholm Declaration contained 26 principles[3] that marked the start of the conversation to solve environmental issues. Highlighted below are some of the Principles of the Stockholm Declarations grouped under the following themes:

- **Human-centric (Principles 1 and 15):** Establishing rights and responsibility to protect the environment and the right to planned settlements and urbanisation.
- **Sustainable development (Principles 2, 3, 4, 5, 13 and 14):** Warns of duty to protect natural resources, preserve renewable resources, conserve wildlife, preserve non-renewable resources, manage resources rationally and rationally implement development activities;
- **Preventive actions (Principles 6, 7, 8 and 18):** Principles 6 and 7 address the management of environmental pollution and the management of sea pollution, respectively, while Principle 8, Social and Economic Development, recognises that improvement in social and economic wellbeing should not be achieved at the expense of the environment. On the other hand, Principle 18, Application of Science, stresses the indispensability of science and technology in identifying and controlling environmental risks as well as finding solutions for environmental issues; and
- **Cooperation (Principles 24 and 25):** These Principles emphasise the importance of cooperation and coordination among nations to achieve holistic global environmental targets through multilateral and bilateral agreements to control, prevent, and reduce environmental risks. They also recognise each State's right to legislate on internal matters.

In June 2022, the global Community came together again for the Stockholm +50 Conference to take stock of the state of the environment. At the end of the convention, the following ten (10) actionable recommendations[4] "for accelerating action toward a healthy planet for the prosperity of all" were agreed on:

- Place human well-being at the centre of a healthy planet and prosperity for all;
- Recognise and implement the right to a clean, healthy, and sustainable environment;
- Adopt system-wide change in the way our current economic system works to contribute to a healthy planet;
- Strengthen national implementation of existing commitments for a healthy planet;
- Align public and private financial flows with environmental, climate, and sustainable development commitments;
- Accelerate system-wide transformations of high-impact sectors, such as food, energy, water, buildings and construction, manufacturing, and mobility;
- Rebuild relationships of trust for strengthened cooperation and solidarity, though, inter alia, enabling the meaningful participation of all relevant stakeholders, including youth, women, rural communities, Indigenous Peoples, interfaith groups, and local communities, in policy formulation and implementation at the national and international levels;
- Reinforce and reinvigorate the multilateral system, including by ensuring "a fair and effective multilateralism" and strengthening the environmental rule of law;

[3] Available on UNEP's website
[4] Full text is available on the Stockholm +50 website

- Recognise intergenerational responsibility as a cornerstone of sound policymaking; and
- Take forward the Stockholm+50 outcomes by reinforcing and re-energising the ongoing international processes.

1.7.9.3 UN Conference on Environment and Development (UNCED), Rio 1992

Popularly called the Earth Summit, this conference held in Rio de Janeiro, Brazil, produced the signing of two important treaties:

- The Convention on Biological Diversity (CBD): Requires nations to take inventories of their faunal and floral communities and protect their endangered species; and
- The United Nations Framework Convention on Climate Change (UNFCCC): Also known as the Global Warming Convention (GWC): Requires nations to reduce their emissions of greenhouse gases such as carbon dioxide, methane, and others.

Other important outcomes of the Rio Summit include:

- The Statement of Principles on Forests to reserve the world's rapidly vanishing tropical rainforests. The statement is non-binding and recommends that nations monitor and assess the impact of development on their forest resources and take steps to limit the damage done to them.
- Agenda 21[5] outlined global strategies for cleaning up the environment and encouraging environmentally sound development.
- The Declaration on Environment and Development, also known as the Rio Declaration[6], is made up of 27 broad, nonbinding principles for environmentally sound development.

1.7.9.4 Kyoto Protocol and The Paris Agreement

The Paris Agreement sets out a global framework to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. Over 190 countries adopted the Agreement made at the Conference of the Parties (COP) 21 held in Paris, France, in December 2015. The Agreement aims to strengthen countries' ability to deal with the impacts of climate change and support them in their efforts. It builds on the 1997 Kyoto Protocol, which operationalises the UNFCCC by committing industrialised countries and economies in transition to limit and reduce greenhouse gas (GHG) emissions per agreed individual targets. The Agreement, which came into force on 4 November 2016, differs from the Kyoto Protocol by being binding to all countries, including developing countries. Also, while the Kyoto Protocol focused on reducing GHG emissions, the Paris Agreement focuses on preventing global average temperature rise due to GHG and does not target specific greenhouse gases. The first phase of the Kyoto Protocol was also to be completed by 2012, whereas the Paris Agreement timeline varies, with most nations intending to accomplish their target goals by 2025-2030.

Nigeria ratified the Kyoto Protocol on 10 December 2004 and signed and ratified the Paris Agreement on 22 September 2016 and 16 May 2017, respectively. In May 2017, the country

[5] Agenda 21
[6] Rio Declarations

submitted its nationally determined contribution (NDC), targeting a 20% emissions reduction against 2030 business-as-usual (BAU) projections. In July 2021, Nigeria announced an updated NDC target[7] of 20% unconditional or 45% conditional reduction. In the updated NDC, Nigeria proposes to mitigate four greenhouse gases, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and hydrofluorocarbons (HFCs), as against the three GHG (CO_2, CH_4 and N_2O) proposed in the initial NDC submitted.

1.7.9.5 Agenda 2030 for Sustainable Development Goals (SDGs)

Agreed upon by the United General Assembly in 2015[8]. The Sustainable Development Goals (SDGs) consist of seventeen (17) goals designed to provide "a shared blueprint for peace and prosperity for people and the planet, now and into the future". While the 17 Goals are inter-related, SDG-6 (Clean water and sanitation), SDG-7 (Affordable and clean energy), SDG-11 (Sustainable Cities and Communities), SDG-12 (Responsible Consumption and Production), SDG-13 (Climate Action), 14 (Life below Water) and SDG-15 (Life on Land) directly address environmental sustainability. SDG-16 (Peace, Justice and Strong Institutions) and SDG-17 (Strong partnership) are critical for devising, collaborating, implementing and assigning accountability for the realisation of the Goals. The SDGs build directly from the 27 goals set by Agenda 21 and re-assert them as the basis for sustainable development on the concept of people, planet, prosperity, peace, and partnership.

Furthermore, the 2030 Agenda for Sustainable Development encourages member states to "conduct regular and inclusive reviews of progress at the national and sub-national levels, which are country-led and country-driven." The reviews, called voluntary national reviews (VNRs) are voluntary and "aim to facilitate the sharing of experiences, including successes, challenges and lessons learned to accelerate the implementation of the 2030 Agenda." The VNRs also seek to strengthen policies and government institutions and mobilise multi-stakeholder support and partnerships for SDGs implementation.

In 2017, Nigeria submitted its first VNR[9] outlining the institutional dimensions for creating an enabling policy environment for SDGs implementation through its Economic and Recovery Growth Plan (ERGP) (2017-2020). The ERGPs focus on economic, social and environmental dimensions of development, making them consistent with the aspirations of the SDGs. Nigeria also submitted a second VNR in 2020 with a focus on Poverty (SDG-1), Inclusive Economy (SDG-8), Health and Well-being (SDG-3), Education (SDG-4), Gender equality (SDG-5), enabling an environment of Peace and Security (SDG-16) and Partnerships (SDG-17). This focus is based on Nigeria's current development priorities and development objectives. It is instructive that the updated VNR was developed during the COVID-19 pandemic amidst falling oil prices, which accounted for 86% of public revenue from oil and gas.

1.7.9.6 Other International Agreements

These include:

1. Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention) (1968) - (Signatory only)

[7] Nigeria's updated NDC target
[8] UN General Assembly Resolution on SDGs
[9] Nigeria's Voluntary National Review

2. African Convention on the Conservation of Nature and Nature Resource (1968)
3. Convention to Regulate international trade in Endangered species of Fauna and Flora (CITES) (1973)
4. Convention on the Protection of the World Cultural and Natural Heritage (World Heritage Convention), Paris (1975)
5. Convention on Conservation of Migratory Species of Wild Animals (1979)
6. Occupational Safety and Health Convention (C155) (1981)
7. Occupational Safety and Health Recommendation (R164) (1981)
8. Vienna Convention on the Ozone Layer (1985)
9. Montreal Protocol on Substances that Deplete the Ozone Layer (1987)
10. Basel Convention on the Control of Tran boundary Movements of Hazardous Wastes and their Disposal (1989)
11. United Nations Framework Convention on Climate Change (UNFCCC) (1992)

The African Development Bank's (AfDB) Integrated Safeguards System (ISS) is indeed fundamental to ensuring that the Bank's projects promote environmental and social sustainability. The ISS aims to mitigate any potentially negative impacts of projects and ensure that the outcomes are beneficial and inclusive.

1.7.10 The African Development Bank (AfDB)

The African Development Bank's (AfDB) Integrated Safeguards System (ISS) is fundamental to ensuring that the Bank's projects promote environmental and social sustainability. The ISS aims to mitigate any potentially negative impacts of projects and ensure that the outcomes are beneficial and inclusive.

The ISS comprises four interrelated components, which can be summarised as follows:

1. Integrated Safeguards Policy Statement: This outlines the AfDB's commitment to environmental and social sustainability and serves as a foundational policy that guides all of the Bank's operations.
2. Operational Safeguards (OS): These are specific requirements that borrowers or clients must meet to comply with the ISS. They cover key areas such as environmental assessment, involuntary resettlement, biodiversity conservation, pollution prevention, and labour conditions.
3. Environmental and Social Assessment Procedures (ESAP): These procedures provide a framework for identifying, assessing, and managing the environmental and social risks and impacts associated with the Bank's projects. They ensure that projects are screened, categorised, and subjected to appropriate levels of assessment.
4. Technical Guidance Notes (TGN): These notes offer detailed guidance on implementing the Operational Safeguards. They provide practical advice and examples to help borrowers and clients understand and apply the safeguards effectively.

These components work together to ensure that AfDB-funded projects are environmentally sustainable and socially inclusive, protecting both people and the environment from adverse impacts.

1.7.10.1 The Integrated Safeguards Policy Statement

The AfDB's Integrated Safeguards Policy Statement describes the common objectives of the Bank's safeguards and establishes policy principles to be applied across current and future lending modalities. It considers the various capacities and needs of regional member countries in both the public and private sectors. This policy statement sets out the Bank's commitments and responsibilities to ensure the systematic assessment of environmental and social (E&S) impacts and risks.

1.7.10.2 Operational Safeguards (OSs)

The Operational Safeguards are a set of ten specific safeguard requirements that Bank clients must meet when addressing social and environmental impacts and risks. Bank staff employ due diligence, review, and supervision to ensure compliance with these requirements during project preparation and implementation. The Bank may, over time, adopt additional safeguards or update existing ones to enhance effectiveness, respond to changing needs, and reflect evolving best practices.

The ten Operational Safeguards are:

1. OS 1: Assessment and Management of Environmental and Social Risks and Impacts
2. OS 2: Labour and Working Conditions
3. OS 3: Resources Efficiency and Pollution, Prevention and Management
4. OS 4: Community Health, Safety, and Security
5. OS 5: Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement
6. OS 6: Habitat and Biodiversity Conservation, and Sustainable Management of Living Natural Resources
7. OS 7: Vulnerable Groups
8. OS 8: Cultural Heritage
9. OS 9: Financial Intermediaries
10. OS 10: Stakeholder Engagement and Information Disclosure.

The AfDB's safeguards are designed to:

- Better integrate considerations of E&S impacts into Bank operations.
- Promote sustainability and long-term development in Africa.
- Prevent adverse effects on the environment and local communities, or where prevention is not possible, minimise, mitigate, and/or compensate for such effects.
- Maximise development benefits.

- Ensure systematic consideration of climate change impacts on project sustainability and contribution to global greenhouse gas emissions.
- Clearly define the roles and responsibilities of the Bank and its borrowers or clients.
- Enhance local participation.
- Strengthen the safeguard systems and capacities of regional member countries and borrowers/clients to manage E&S risks.

Table 1.2 below summarises the ten OSs that form a critical component of the Bank's ISS, designed to ensure that projects funded by the AfDB are environmentally sustainable and socially inclusive. Each safeguard outlines specific requirements that Bank clients must meet to address potential E&S impacts and risks. The table includes a description of each OS, indicates whether it is triggered for the proposed project, and explains its applicability to the project activities.

Table 1.2: Applicability of AfDB Operational Safeguards to the Anambra State SAPZ Project

Operational Safeguards	Description	Triggered/Not Triggered	Applicability to Proposed Project
OS 1: Assessment and Management of Environmental and Social Risks and Impacts	This safeguard is the foundation for identifying the environmental and social risks associated with a project based on its category. The identified risks are then managed through mitigation measures outlined in project-specific ESMPs.	Triggered	Developing and rehabilitating agricultural infrastructure can have environmental and social risks. The Anambra State SAPZ project will manage these risks by implementing mitigation measures outlined in the site-specific ESMPs.
OS 2: Labour and Working Conditions	This safeguard establishes the Bank's requirements for worker conditions, rights, and protection from abuse or exploitation. It also ensures alignment with most international labour standards.	Triggered	The project contractor must comply with Nigerian labour laws and best practices for occupational health and safety.
OS 3: Resources Efficiency and Pollution, Prevention and Management	This safeguard addresses a range of environmental impacts related to pollution, waste, and hazardous materials. It considers international conventions and industry-specific standards for managing these issues, including greenhouse gas accounting practices followed by other development banks.	Triggered	Agricultural development activities often involve using fertilizers and agrochemicals, which can lead to pollution. The project will manage these aspects through measures outlined in the ESMP.

OS 4: Community Health, Safety, and Security	This OS ensures that project activities avoid or minimise health and safety risks to local communities, particularly vulnerable groups and workers. It emphasises safe project design, emergency preparedness, and responsible security measures while preventing exposure to hazards such as diseases, road accidents, and harmful materials. This safeguard applies throughout the project's lifecycle to ensure community well-being.	Triggered	The SAPZ II project can introduce health and safety risks such as increased traffic, exposure to chemicals and accidents. This OS ensures that a comprehensive risk assessment is performed to identify and mitigate these risks ensuring the project is carried out responsibly with respect to health and safety standards.
OS 5: Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement	This safeguard addresses the adverse impacts of project-related land acquisition and restrictions on land use. It aims to avoid involuntary resettlement where feasible and minimize it when unavoidable. Key objectives include providing timely compensation for lost assets, supporting displaced persons in restoring their livelihoods, improving living conditions for vulnerable populations, and ensuring that resettlement activities are guided by social assessments and involve meaningful consultation with affected communities.	Triggered	The Anambra SAPZ II project necessitates land acquisition for agro-processing facilities, which may lead to economic displacement issues such as loss of access to livelihood sources for farmers. A Resettlement Action Plan (RAP) will be prepared to outline strategies addressing economic displacement, ensuring compliance with the AfDB's ISS.
OS 6: Habitat and Biodiversity Conservation, and Sustainable Management of Living Natural Resources	This safeguard aims to protect biodiversity and promote sustainable use of natural resources. It also translates the Bank's policy on integrated water resources management into practical requirements.	Triggered	The proposed interventions will involve using natural resources such as water, soil, and commercial harvesting of agricultural products. These activities must be managed sustainably.

OS 7: Vulnerable Groups	This safeguard focuses on protecting the rights and interests of vulnerable groups, especially highly vulnerable rural minorities (HVRM). It ensures these groups are identified, consulted, and benefit from projects in a way that respects their cultural identities, protects their land and natural resources, and promotes their well-being.	Triggered	The Anambra SAPZ II project is located in rural areas where vulnerable groups, especially those reliant on natural resources, face significant risks. The OS 7 ensures these communities are identified, consulted, and involved throughout the project, protecting their cultural identities and promoting their well-being.
OS 8: Cultural Heritage	This safeguard protects tangible and intangible cultural heritage from adverse project impacts. It requires identifying and consulting with stakeholders, ensuring projects respect and preserve cultural heritage while promoting equitable benefit-sharing.	Triggered	Rural communities are often custodians of rich cultural heritage. This OS ensures these communities are engaged and consulted, promoting the respect and preservation of their cultural heritage.
OS 9: Financial Intermediaries	This safeguard ensures that financial intermediaries (FIs) receiving support from the African Development Bank (AfDB) manage environmental and social (E&S) risks responsibly. It mandates FIs to develop and maintain an Environmental and Social Management System (ESMS) to identify, assess, and monitor E&S risks and impacts associated with their portfolios and subprojects.	Not Triggered	Since the AfDB is funding the project directly without intermediaries, OS9 does not apply.
OS 10: Stakeholder Engagement and Information Disclosure.	This safeguard emphasises the need for open and transparent communication between the Borrower and all stakeholders throughout the project. It aims to identify and engage with those affected by the project, ensuring their concerns and inputs are considered in decision-making. It promotes	Triggered	The Anambra SAPZ II project will significantly impact local communities, necessitating transparent and inclusive engagement. The OS10 ensures that affected communities are identified, informed, and meaningfully involved in decision-making. This promotes transparency,

	inclusive participation, timely information sharing, and effective grievance management, enhancing project sustainability and acceptance.		and inclusivity, and ensures that project benefits are distributed equitably, aligning perfectly with the goals of the SAPZ II project.

1.7.10.3 Environmental and Social Assessment Procedures (ESAPs)

The African Development Bank's (AfDB) Environmental and Social Assessment Procedures (ESAPs) provide detailed guidelines for the Bank and its borrowers or clients to ensure compliance with the OSs throughout the Bank's project cycle. The ESAPs enhance the E&S performance of the Bank's operations, ultimately improving project outcomes. By adhering to these procedures, the ESAPs facilitate better decision-making and project results, ensuring that Bank-financed operations conform to the requirements of the OSs and are sustainable.

1.7.10.4 Environmental and Social Assessment of Nigerian Policies and Legislations and AfDB Safeguard Systems

The Nigerian EIA Procedural Guidelines address most of the key elements required for projects involving multiple subprojects, including the differentiated treatment of vulnerable groups, which are adequately covered by the AfDB safeguard systems. Despite this alignment, challenges remain, particularly due to the overlapping functions of different agencies responsible for enforcing these policies, guidelines, regulations, and legislative provisions.

To ensure effective E&S safeguarding during project implementation, both the Nigerian and AfDB E&S safeguard systems will be employed. However, where divergences or gaps exist between the two regulations, the AfDB safeguard system with the more stringent requirements will take precedence, as outlined in Table 1.3. The table compares the E&S safeguard requirements between Nigerian provisions and the African Development Bank's ISS in the context of the Anambra SAPZ project. The final column indicates the provision to be adopted by the project. This approach ensures the highest standards of environmental and social protection are maintained throughout the project lifecycle.

Table 1.3: Comparison of Nigerian E&S Safeguards with AfDB's ISS

Key Element	Nigerian Provisions	AfDB Integrated Safeguard System	Provision to be Adopted by Anambra SAPZ
ESMF for Projects Involving Multiple Subprojects	Not a national requirement	OS1: Environmental and Social Assessment	AfDB OS1
Screening	EIA Act Cap E12 LFN 2004	OS1: Environmental and Social Assessment	Follow both the Nigerian EIA Act and AfDB OS1
Scoping	EIA Act Cap E12 LFN 2004	OS1: Environmental and Social Assessment	Follow both the Nigerian EIA Act and AfDB OS1
Environmental and Social Impact Assessment (ESIA)	EIA Act Cap E12 LFN 2004, EIA Procedural Guidelines, 1995, Sectoral Guidelines (e.g., Power Sector, 2013)	OS1: Environmental and Social Assessment, ESIA Guidance Notes	Conduct a comprehensive ESIA following both Nigerian guidelines and AfDB ESIA Guidance Notes.
Environmental Categorisation	EIA Procedural Guidelines, 1995 (Categories I, II, III)	OS 1 (Categories 1, 2, 3 & FI)	Follow stricter AfDB categorisation including Financial Intermediary (FI) requirements.
Environmental and Social Management Plan (ESMP)	EIA Act Cap E12 LFN 2004	OS1: Environmental and Social Assessment	Develop an ESMP that meets both Nigerian EIA Act requirements and AfDB OS1.
Consultation and Participation	EIA Act Cap E12 LFN 2004	OS1 (include provisions of IESIA Guidance Notes on consultation)	Follow the Nigerian EIA Act and incorporate AfDB IESIA Guidance Notes on consultation
Involuntary Resettlement Compensation	Land Use Act CAP L5 LFN 2004, Acquisition of Land Access Rights for Electricity Projects Regulations, 2012 (cash compensation based on market value)	OS 4: Affected Persons are compensated at full replacement cost with options for resettlement assistance & livelihood improvement	Adopt AfDB OS4 requiring full replacement cost compensation and a wider range of support options.
Pollution Prevention and Control	National Environmental Protection Regulations (1991)	Operational Safeguard 3	Adopt AfDB Operational Safeguard 3 for a more comprehensive approach

Greenhouse Gases (GHGs)	National Environmental Protection Regulations (1991)	Operational Safeguard 3 (special screening for GHGs under OS1)	Consider both Nigerian regulations and conduct GHG screening following AfDB OS1
Waste and Hazardous Materials	National Environmental Protection Regulations (1991), Harmful Wastes Act (2004)	Operational Safeguard 3	Adopt AfDB Operational Safeguard 3 for a more comprehensive approach
Resources and Conservation	Natural Resources Conservation Act (1990)	Operational Safeguard 6	Adopt AfDB Operational Safeguard 6 for a more comprehensive approach
Labour Conditions	Employee Compensation Act (2010), Labour Act (2004)	Operational Safeguard 2	Adopt AfDB Operational Safeguard 2 for a more comprehensive approach
Health and Safety	Factories Act (2004)	Operational Safeguard 4	Adopt AfDB Operational Safeguard 4 for a more comprehensive approach
Natural Habitat and Biodiversity	Forestry Law (1994), Endangered Species Act (2004), Natural Resources Conservation Act (1990)	Operational Safeguard 6	Adopt AfDB Operational Safeguard 6 for a more comprehensive approach
Gender	National Gender Policy (2010)	Special consideration for women's needs & rights. The project must design a Gender Action Plan considering the AfDB Gender Marker System.	Integrate the AfDB Gender Marker System into project design and develop a Gender Action Plan
Vulnerable Groups	Limited provisions (Gender Policy, Child Rights)	OS7: Special attention to vulnerable groups	Follow AfDB OS7 requiring special attention to vulnerable groups during the ESIA.
Differentiated Measures for Vulnerable Groups	No specific provisions	Provision for differentiated measures for inclusion	Adopt the AfDB requirement to include differentiated measures for vulnerable groups in the ESIA
Environmental Monitoring	EIA Act Cap E12 LFN 2004	ESAP	EASP
Disclosure and Access to Information	EIA Act Cap E12 LFN 2004	OS 10: Environmental and social assessment	OS10: Environmental and social assessment

1.7.11 Institutional and Administrative Framework

The implementation of the ESMP for the Anambra State Special Agro Processing Zone (SAPZ) project will be overseen by the African Development Bank (AfDB) in collaboration with relevant stakeholders through the Project Implementing Unit (PIU). Identified stakeholders are discussed in the following subsections.

1.7.11.1 The Federal Government of Nigeria

The Nigerian Constitution mandates the government to protect the environment, linking this responsibility to fundamental human rights. The executive council is responsible for approving national policies, including the National Policy on Environment.

1.7.11.2 Federal Ministry of Agriculture and Food Security (FMAFS)

FMAFS regulates agricultural research and practices across Nigeria, managing agencies that oversee fisheries and livestock.

1.7.11.3 Federal Ministry of Environment

The Federal Ministry of Environment oversees the country's environmental policy, including site verification, ESIA report review, project phase approval, monitoring impact mitigation, and waste management compliance throughout the project lifecycle.

1.7.11.3.1 The National Environmental Standards and Regulations Enforcement Agency (NESREA)

Established by ACT No. 25 of 2007 and amended in 2018, NESREA is responsible for protecting Nigeria's environment and promoting sustainable resource management. It enforces compliance with environmental laws, coordinates with stakeholders, and conducts audits while fostering public awareness of environmental issues.

1.7.11.4 National Agricultural Land Development Authority Act

Established in 1992, this Act provides public support for land development, essential for agricultural projects.

1.7.11.5 Federal Ministry of Health

1.7.11.5.1 National Agency for Food and Drug Administration and Control (NAFDAC)

NAFDAC ensures compliance with safety standards for food, drugs, and chemicals, preventing substandard products from entering the market and enforcing food safety regulations.

1.7.11.6 Project Implementation Unit (PIU)

The PIU, established by the Anambra State government, is responsible for the comprehensive delivery of AfDB-funded projects. Its key responsibilities include conducting ESIA studies, implementing the ESMP, supervising contractors, managing resettlement processes, and producing compliance monitoring reports throughout the project lifecycle.

1.8 Reporting

ESIA Report Structure

The structure of this ESIA report as presented below will be preceded by an Executive Summary.

- **Chapter 1:** Introduction. This Chapter provides a background to the proposed Project and the ESIA. It provides information about the project proponent and also includes the Institutional and Legal Framework within which the ESIA was undertaken. This includes environmental legislation, standards and guidelines applicable to the Project.
- **Chapter 2:** Project Justification. This chapter discusses the project justification, need/value and its envisaged sustainability as well as the project development and options considered.
- **Chapter 3:** Project Description. This chapter describes the project in detail, including information regarding the project phases and schedule as well as the waste management policies and procedures that will adopted.
- **Chapter 4:** Biophysical and Socioeconomic Baseline. The chapter defines the areas of direct and indirect influence of the Project. It describes the biophysical and socio-economic baseline of the Project's areas of influence and presents the public participation process in the ESIA.
- **Chapter 5:** Impact Assessment. The chapter presents the approach and methodology for the ESIA process. It identifies and assesses potential Project impacts (biophysical and socioeconomic impacts).
- **Chapter 6:** Mitigation Measures. This chapter defines relevant mitigation measures to avoid, reduce, compensate or enhance Project impacts (as applicable).
- **Chapter 7:** Environmental and Social Management Plan (ESMP). It presents the Project ESMP, organising all mitigation, management and monitoring requirements and management programs.
- **Chapter 8:** Stakeholders Consultation
- **Chapter 9:** Conclusion and Recommendation
- **References**
- **Appendices**

CHAPTER 2 PROJECT JUSTIFICATION

This chapter presents project justification, benefits, sustainability, options and alternatives that were considered in this study. Anambra State is blessed with several socio-economic capabilities that are yet to be fully harnessed. The Anambra State Government (ANSG) aims to transform the state from a dominantly informal commercial state to a formal, productive, and competitive economy underpinned by rapid industrialisation, agriculture, commerce, entertainment/leisure the creative industry, technology and innovation, solid minerals, and oil and gas.

2.1 Rationale for the Project

Development Objectives

The SAPZ project in Anambra State aims to transform the agricultural sector by enhancing the efficiency and competitiveness of agro-industries. By establishing processing zones close to production areas, the project seeks to reduce post-harvest losses, improve access to markets, and create employment opportunities, thereby contributing to poverty reduction and economic growth. The project will also promote the establishment of modern, climate-resilient farming practices and improve access to quality inputs and technology, helping to boost agricultural productivity.

Strategic Importance

This project is strategically important for Nigeria's economic diversification efforts. It supports the government's agenda of developing value-added industries, increasing exports of processed agricultural goods, and reducing food imports. In Anambra, where agriculture faces significant challenges due to outdated practices and poor infrastructure, the SAPZ project will play a critical role in fostering inclusive economic development. It will attract private sector investment into rural areas and create a sustainable, market-based agricultural value chain.

Socioeconomic Benefits

The SAPZ project is expected to generate significant socioeconomic benefits, including the creation of thousands of jobs in agriculture, processing, and related services. It will enhance local skills through training programs, increase incomes for smallholder farmers, and improve food security by boosting the production and processing of staple crops. Additionally, by reducing dependence on food imports and strengthening the local economy, the project will contribute to poverty reduction and improved livelihoods in Anambra State.

2.2 Need for the Project

Anambra State faces significant socioeconomic challenges, including high population density (ANSG, 2024) and persistent poverty, particularly in rural areas where agriculture is a key livelihood. According to the National Bureau of Statistics (NBS) (2022), approximately 26% of people in Anambra Central, 31% in Anambra North, and 38% in Anambra South are classified as poor. Furthermore, 96% of the poorest individuals reside in rural areas (Aronu and Okafor, 2024). These statistics illustrate the urgent need for targeted interventions to address the uneven distribution of resources and opportunities.

Compounding these challenges, the agricultural sector, which is the primary source of livelihood for many in rural regions, suffers from low productivity, inadequate infrastructure, and limited market access. As a result, smallholder farmers find it difficult to scale their operations and meet the growing domestic and international food demand. Additionally, the Anambra State Government is driving a transition from a largely informal commercial economy to a formal, industrialised, and technology-driven one (ANSG, 2024). However, this transition poses significant challenges, as many farmers lack access to the necessary resources, training, and facilities to adapt effectively.

Addressing these challenges requires substantial investment in agricultural infrastructure development and capacity building. Such investment will help stabilise economic benefits for farmers, reduce post-harvest losses, create market opportunities, and stimulate economic growth. Without these targeted interventions, Anambra risks ongoing food insecurity and dependency on external sources, which makes it vulnerable to price and supply fluctuations and hinders its contribution to national food security.

The SAPZ II project will directly address these needs by establishing an Agro-Industrial Hub (AIH) within the Anambra Mixed Industrial City and three Agricultural Transformation Centres (ATCs). These facilities will not only provide agricultural processing and capacity building but also connect farmers with buyers. Additionally, the project will establish a research centre focused on developing sustainable and climate-resilient agricultural practices, complemented by a demonstration farm to provide practical experience for farmers.

The SAPZ project will address these needs by establishing an Agro-Industrial Hub (AIH) within the Anambra Mixed Industrial City and three Agricultural Transformation Centres (ATCs). These facilities will provide agricultural processing and capacity building and connect farmers with buyers. Additionally, the project will establish a research centre focused on developing sustainable and climate-resilient agricultural practices, complemented by a demonstration farm to provide practical experience for farmers.

The project will also procure and distribute one million high-yielding palm seedlings annually to 100,000 farmers/households, with each household receiving at least 40 seedlings over four years. Farmers/households will be selected through an inclusive process, prioritising smallholder farmers based on factors such as farm size, willingness to cultivate palm seedlings, and economic need. Seedlings will be sourced from reputable nurseries and suppliers with a proven track record of producing high-quality, high-yielding palm seedlings that can start fruiting within 2-4 years, thereby enhancing productivity and income for beneficiary households. This initiative is aimed at lifting households out of poverty while creating jobs in the oil palm processing industry.

Furthermore, the SAPZ project will create thousands of jobs in the agricultural sector during both the construction and operational phases of the AIH and ATCs. This includes roles in micro, small, and medium enterprises (MSMEs) along the agricultural value chain and operating within the SAPZ facilities. By leveraging competitive industrial, environmental, physical, and social infrastructure, the project seeks to foster balanced development in Anambra State and the Southeast region, driving economic and social progress.

Expected benefits include:

- Improvement in crop production
- Capacity building for local farmers
- Increased employment opportunities
- Enhanced livelihoods for adjoining communities
- Revenue generation for the government at all levels
- The project will engender mass-scale economic activities in Anambra State by way of upping activities of small-scale commercial entrepreneurs at both the construction and operational phases.
- Increase and expose to the wider world, values, and potentials of economic and social mobility including opportunities that abound in the Agro-sector of Nigeria.
- Attracting Foreign Direct Investment (FDI), and supporting the development of local content.

2.3 Envisaged sustainability

The proposed project will comply with existing principles and tenets of the regulations and operational guidelines of the project. Sustainable designs, construction and installation of equipment, and installation of other ancillary facilities will form the proposed project's bedrock to mitigate environmental impact. The general sustainability principles (technical, economic, environmental and social) that shall guide the project are discussed below.

2.3.1 Technical Sustainability

The proponent will set up a highly technical multi-disciplinary project team which includes civil and structural engineers, electrical engineers, mechanical engineers, environmentalists, agronomists and geologists amongst others to prepare the engineering design of the proposed project construction and implementation in an environmentally friendly manner. The equipment and machinery proposed for this project are those whose operation will have minimal adverse effects on the environment in terms of noxious gas emissions, noise, and vibration which are mitigable. Installation of any equipment will be undertaken with a firm understanding of the implications of its impact on process mass balance, electrical capacity, and other process services.

The proposed project is technically feasible because, it is professionally designed, and the technology employed is readily available, such as the installation of solar farms to supplement electricity from the national and increase the capacity to deliver quality transmission; as well as recycling wastewater to achieve a high degree of efficiency in resource use and conservation. These technologies are rooted in BATNEEC (Best Available Technology Not Entailing Excessive Costs), considering both the initial capital and overtime cost savings.

2.3.2 Economic Sustainability

The economic sustainability of the Anambra SAPZ project is anchored in its potential to significantly enhance the economic landscape of Anambra State and Nigeria as a whole. The project aims to transform the agricultural sector by improving productivity, creating jobs, and boosting income levels, thereby fostering economic growth and stability in the state.

Key areas of focus for ensuring the project's economic sustainability include:

- **Job Creation and Income Generation:** The project is expected to create thousands of jobs, both skilled and unskilled, during the construction and operational phases. By employing local labour and engaging local partners, the project will stimulate economic activity in the surrounding communities, leading to increased household incomes and improved living standards.

- **Market Expansion and Profit Maximisation:** With the high demand for agricultural products like cassava, maize, rice, and palm oil, as well as processed cereals for livestock feeds, the SAPZ project will tap into these lucrative markets. The project aims to maximise profits through the production and processing of these high-demand products, ensuring a steady return on investment. The expansion of local and regional markets will contribute to the economic resilience of the state.

- **Value Addition and Industrial Growth:** By integrating advanced agro-processing technologies and best industrial practices, the project will add significant value to raw agricultural products. This value addition will not only increase the profitability of local farmers but also contribute to the industrial growth of Anambra State, positioning it as a key player in Nigeria's agricultural economy.

- **Support for Local Businesses and Education:** The project will support the development of local businesses and vocational education programmes, ensuring that the local workforce is equipped with the necessary skills to sustain and grow the agro-industrial sector. This investment in human capital will have long-term economic benefits, fostering entrepreneurship and innovation within the state.

- **Economic Multiplier Effects:** The project is expected to generate positive multiplier effects, such as increased demand for goods and services in the local economy. This will lead to the growth of ancillary industries, further enhancing the economic situation in Anambra State.

In measurable terms, the project's success will be reflected in increased agricultural output, higher employment rates, improved income levels, and enhanced economic resilience. These outcomes will contribute to the long-term economic development of Anambra State, ensuring that the benefits of the project are widely felt across the region.

2.3.3. Environmental Sustainability

The project site has been carefully selected by considering sensitive ecosystems and avoiding built-up areas as much as possible. In addition, practical mitigation measures have been proffered for the identified environmental impacts of the Agro-processing project and Anambra SAPZ is fully committed to complying with the relevant applicable national environmental laws, applicable international conventions and AfDB environmental and social safeguard requirements. Furthermore, Anambra SAPZ is also committed to implementing the ESMP developed to further guarantee environmental sustainability. Furthermore, the ESMP (Chapter 7) recommended the establishment of a competent Environmental and Social (E&S) Safeguard unit to manage issues related to environmental and social sustainability or approve the secondment of trained staff from other departments to take up the responsibility.

The implementation of the findings and recommendations of the ESIA in the project design shall ensure the environmental sustainability of the project. The application of standard industrial practice during construction and implementation of the project shall also ensure the environmental sustainability of the project. The implementation of the standalone ESMP shall ensure continuous safeguarding of the Environmental and Social components for ensured sustainability in line with the AfDB's policy.

2.3.4 Social Sustainability

One of the benefits of this project is to enhance the socio-economic activities of the people and also to create job opportunities for unemployed indigenes. Although exact figures are yet to be finalised, it is expected that a significant percentage, possibly ranging between 70% to 85%, of unskilled labour will be drawn directly from host communities. This approach ensures that the economic benefits of the project are closely aligned with the local population, leading to an improvement in their overall quality of life and fostering social sustainability.

Moreover, Anambra SAPZ is committed to effective and continuous stakeholder engagements and consultations. Consultation so far carried out at the planning stage showed that the host communities are happy with the project and are willing to support the implementation of the project to its logical conclusion. Anambra State SAPZ is committed to complying with applicable national social laws, relevant international conventions and AfDB safeguard requirements. The AfDB's commitment to training and re-training the State Project Implementation Unit (SPIU) team members on environmental and social management risks underscores the project's dedication to social sustainability. The continuous implementation of the Bank's Environmental and Social safeguards policies throughout the various phases of the project will further ensure that the social impacts are managed effectively, further securing its social sustainability.

2.4. Project Alternatives and Options

The selection of the most suitable options and alternatives is a critical phase in the development of the SAPZ project. This involves evaluating a range of possibilities across various dimensions, including projects, locations, technology, waste management and product sourcing. Each alternative presents its own set of benefits and challenges, requiring a careful assessment of economic viability, environmental sustainability, logistical efficiency, and social impact. By exploring these alternatives, the project aims to optimise its overall design, ensuring that it not only meets its immediate objectives but also aligns with broader goals of long-term sustainability and community development. The following sections detail the key alternatives considered and the rationale behind the chosen actions.

2.4.1 Project Options

2.4.1.1 Option One: No Project Option

The "No Project" option involves not proceeding with the proposed development of the Special Agro-Industrial Processing Zone (SAPZ) in Anambra State. This option may be considered if there are significant economic, technical, or regulatory barriers that make the project unfeasible. It could also be chosen if the Anambra State Government or key stakeholders are unwilling to commit to the project or if essential resources, such as suitable land or infrastructure, are not available. However, opting for the "No Project" alternative would result in the loss of numerous potential benefits that the SAPZ could bring to the state and the region, such as:

- Missed opportunities for boosting agricultural productivity and value-added processing;
- Missed opportunities for job creation and economic development.
- Persistent poverty, especially in rural areas
- Loss of potential increases in state and local government revenue through taxes and fees;
- Failure to enhance food security and reduce post-harvest losses;
- Delayed progress towards achieving state and national agricultural transformation goals and rural development.

2.4.1.2 Option Two: Delayed Project Option

The "Delayed Project" option suggests postponing the development of the SAPZ to a future date. This option may be considered if current conditions, such as political instability, community opposition, or unfavourable economic circumstances, make immediate project implementation challenging. However, in the case of the Anambra SAPZ, the political, social, and economic environments are conducive to moving forward with the project. Delaying the project would lead to the disbandment of already mobilized resources, such as contractors, technical teams, and procurement processes. This would not only increase project costs but also delay the expected benefits to the local economy and agricultural sector. Given these drawbacks, adopting the "Delayed Project" option is neither advisable nor necessary.

2.4.1.3 Option Three: Go-Ahead Project Option

The "Go-Ahead" option is the preferred choice, deemed the most economically, technically, socially, and environmentally sustainable for the SAPZ project. This option has been selected based on thorough assessments and the use of efficient, cost-effective, and environmentally friendly technologies. Moving forward with the SAPZ will accelerate the realisation of its numerous benefits, some of which include:

- Creation of jobs and income-generating opportunities for local communities;
- Enhancement of agricultural productivity and food security through advanced processing and value addition;
- Strengthening of local and state economies by attracting private investment and increasing tax revenues;
- Improvement of infrastructure, such as roads, electricity, and water supply, in rural areas;
- Contribution to the national agenda for agricultural transformation and rural development;
- Promotion of sustainable environmental practices in agricultural processing.

2.4.2 Project Location Alternatives

2.4.2.1 Location Alternatives for AMIC

The ANSG considered two locations for the establishment of AMIC, which will host the SAPZ AIH. The locations evaluated were Ogboji and the Mamu Forest Reserve, with Ogboji emerging as the preferred site. Several factors with weighted scores (in brackets) were considered in determining the preferred location for AMIC establishment. These factors included land status (15%), connectivity (25%), physical features (10%), infrastructure availability (20%), environmental and social considerations (5%), and business considerations (15%).

Each location was evaluated against these factors, resulting in Ogboji scoring 70% and Mamu Forest Reserve 56%. Both sites received similar scores in some areas, such as land area (a sub-category under land status), where each site scored 4% out of 5%. However, Ogboji outperformed Mamu Forest Reserve in other areas. For example, in the subcategory "Challenges in Acquisition," Ogboji scored 7% out of 10%, while Mamu Forest Reserve scored 5%, as no part of the negotiation had been completed for the latter. Furthermore, in the subcategory Development Regulations and Restrictions under Environmental Factors, Mamu Forest Reserve scored 0% out of 4% due to its status as a protected area, restricting development. In contrast, Ogboji, with no such restrictions, scored 3%. The full list of factors is attached as Appendix 1.

2.4.2.1 Location Selection for ATCs

The selection of locations for the Agricultural Transformation Centres (ATCs) in the SAPZ project was a critical decision, heavily influenced by various constraints that directly impact the project's success. In many projects, location choices are restricted by specific requirements, such as the availability of natural resources or favourable environmental conditions (Glasson and Therivel, 2019). Similarly, the ATC locations were chosen based on both economic and logistical criteria, including the availability of infrastructure, proximity to raw material sources, and access to markets.

Beyond these practical considerations, the project also prioritized avoiding environmentally sensitive areas, ensuring that the chosen locations would not only support the project's goals but also adhere to sustainable environmental practices. After thorough evaluations, the towns of Ogbunka, Omor, and Ugbene were identified as the optimal sites for the ATCs. These locations best balanced existing constraints, optimising the economic and operational feasibility of the ATCs while minimising potential environmental impacts.

Further details on the selection criteria are provided below:

- **Effective Procurement Zone:** All three locations are within a 25 km radius of highly productive agricultural areas, ensuring a reliable supply of raw materials for the SAPZ, with competitive logistics and cost-effectiveness.
- **Logistics and Connectivity:** Each of these locations is well-connected by strong road networks to major industrial clusters like Onitsha and Nnewi. This connectivity minimises transportation costs and ensures the efficient movement of goods, which is vital for the seamless operation of the ATCs.
- **Agricultural Land:** The procurement zones encompass extensive agricultural and mixed cultivation lands that are dedicated to crop production for the SAPZ. There is also potential for crop diversification within these areas to meet varied processing needs, further enhancing the project's adaptability and sustainability.
- **Legal and Feasibility Considerations:** Strategically chosen within Anambra State, these sites avoid potential legal complications associated with cross-regional procurement. This foresight ensures smooth operations and long-term sustainability, addressing any legal challenges that could arise from sourcing raw materials from other jurisdictions.

These factors collectively make the selected sites ideal for supporting the SAPZ’s objectives, contributing to the long-term success and sustainability of the project.

2.4.3 Processing Technologies Alternatives

Evaluating alternative processing technologies and methods is crucial to determining the most effective approach for handling the diverse range of agricultural products handled at the facilities. This evaluation ensures that the chosen technologies align with the project’s goals of efficiency, sustainability and economic viability.

The Anambra State Government (ANSG) plays a pivotal role in this SAPZ project by developing essential infrastructure such as roads, electricity, water supply, and sewage treatment plants to support the operational efficiency of processing facilities. Additionally, through favourable policies and incentives, ANSG is fostering an enabling environment for private investors to establish agricultural processing facilities within the SAPZ AIH and the three ATCs. While ANSG provides the necessary infrastructure, the establishment of processing units remains the responsibility of private investors and operators, who will operate under the provisions of the ESMP to manage the environmental and social impacts of their operations.

2.4.3.1 Context of Technology Alternatives

The Anambra State SAPZ is designed to serve as a comprehensive hub for processing various agricultural products, including cereals (rice, maize), pulses (beans), oilseeds (oil palm, sesame seeds), timber, fruits, vegetables, and livestock products. Each product type requires specific processing technologies and methods to optimise yield and quality. The selection process considers several factors, including technological advancements, cost implications, environmental impact, and operational efficiency, discussed below.

2.4.3.1.1 Processing Technologies Alternatives

- **Traditional vs. Modern Equipment:** Traditional processing technologies, like stone grinders for milling cereals, offer proven reliability but may lack the efficiency of modern systems. Modern milling technologies provide higher processing speeds and improved product quality, although they may involve higher initial investment and operational costs.

- **Automation vs. Manual Processing:** High-capacity, automated oil extraction systems enhance efficiency and reduce labour costs, while manual oil extractors allow for greater flexibility in processing small batches but can be labour-intensive and less consistent.

2.4.3.1.2 Scale of Operations Alternatives

- **Small-Scale vs. Large-Scale Facilities:** Small-scale facilities, such as those currently operating in the location areas, offer flexibility and lower capital expenditures but may not achieve economies of scale.

- **Large-scale facilities:** Large-scale facilities, such as high-capacity cereal processing plants benefit from reduced per-unit costs but require significant investment and infrastructure.

2.4.3.1.3 Product Scope Alternatives

- **Specialised Processing:** Focuses on specific high-value products, which can enhance profitability but may limit the range of processed items. This approach is efficient but can increase risk due to market fluctuations.

- **Diversified Processing:** Processes a broader range of products, which can mitigate risk and capture multiple market segments. However, may complicate operations and logistics.

2.4.3.1.4 Justification for No Preferred Option

Given the diverse range of agricultural products and their varying processing requirements, no single alternative was identified as the outright preferred option. Instead, the selection process aims to balance efficiency, cost, and environmental impact by considering a combination of these alternatives. The facility operator will be responsible for making the final decision, taking into account a detailed evaluation of each alternative's implications for the SAPZ's operational goals and sustainability targets.

In summary, a combination of processing technologies and approaches will be necessary to meet the diverse needs of the SAPZ. With ANSG's infrastructure support, the project is well-positioned to implement a strategy that balances operational efficiency with environmental sustainability.

2.4.4 Energy Options

A reliable energy supply is a critical component for the successful operation of the SAPZ AIH and ATCs, especially given the high-tech processing units and support facilities planned within the AMIC. In evaluating energy options for the SAPZ project in Anambra State, it is essential to consider both existing infrastructure and potential renewable energy sources to ensure a reliable and sustainable energy supply. The following options have been identified, along with their advantages and disadvantages:

2.4.4.1 Integration with National Grid

The SAPZ will be integrated into both existing and proposed national grid infrastructure, ensuring a reliable and efficient energy supply. Currently, the project areas are served by low-tension (LT) power lines and the nearby Enugu Electricity Distribution Company (EEDC) Oko Injection Substation. These existing facilities will provide the initial power required for the SAPZ's operations. Within the AMIC itself, an additional 132/33 KV substation will distribute power, ensuring a robust energy supply for the SAPZ's high-tech processing units and support facilities. These installations are planned to be implemented as part of the first phase of the Light-up Anambra Project.

Advantages

- Reliable and stable energy supply
- Utilises existing infrastructure, reducing initial costs
- Supports high-tech processing units and large-scale operations

Disadvantages

- Dependence on the national grid, which experiences outages
- Potential delays in infrastructure upgrades
- Limited control over energy pricing and supply.

2.4.4.2 Onsite Renewable Energy

To minimise environmental impacts associated with the use of fossil fuel energy, the SAPZ project will incorporate rooftop solar photovoltaic (PV) panels. These panels will leverage the roof spaces available atop various buildings to generate power. This approach not only reduces the project's carbon footprint but also provides a sustainable and cost-effective energy source.

Advantages

- Reduces carbon footprint and environmental impact
- Provides a sustainable and renewable energy source
- Potentially lower long-term operational costs

Disadvantages

- High initial investment and installation costs
- Energy production is weather-dependent
- Requires maintenance and periodic upgrades

2.4.4.3 Diesel Generators

Diesel generators (DGs) are used commonly to supplement energy needs in Nigeria due to the unreliability of power supply from the national grid. This option is not considered a power source for the Anambra SAPZ project. However, it is conceivable that some facility operators may opt to use generators if the energy supply is unreliable, especially during peak demand periods or unforeseen disruptions.

Advantages

- Provides a reliable backup energy source
- Ensures continuous operations during power outages
- Can be quickly deployed and scaled as needed

Disadvantages

- High operational costs due to fuel consumption
- Environmental impact from emissions
- Noise pollution and maintenance requirements

2.4.4.4 Scaling of Energy with Need

The implementation of energy sources will be scaled with the development of the SAPZ project. Initially, the existing LT power lines and the EEDC Oko Injection Substation will provide the necessary power. As the project expands, the new 150 MVA substation in Onitsha and additional 132/33 KV substations within the AMIC will enhance power capacity and stability. Onsite renewable energy installations, such as rooftop solar PV panels, will be scaled up to meet increasing energy demands.

Advantages

- Reduces the risk of over- or under-investing in energy infrastructure
- Spreads out costs over time, allowing for more flexible budgeting

Disadvantages

- Requires complex planning and coordination

- May lead to higher overall expenditures compared to a one-time investment
- Risk of interim energy shortages that could disrupt operations if scaling is not well-timed

2.4.4.5 Preferred Energy Strategy

The preferred energy strategy for the SAPZ project involves a combination of integrating with the national grid and utilising onsite renewable energy technologies. This hybrid approach ensures a reliable, efficient, and sustainable energy supply, supporting the project's high-tech processing units and overall operations.

2.4.5 Water Sources Options

The availability of a fit-for-purpose water supply is vital for the sustainability of the Anambra SAPZ II project, particularly given the critical role water plays in various agro-processing activities such as irrigation, cooling, cleaning, and sanitation. The potential sources include municipal supply, surface water, groundwater, and rainwater. Each option presents unique advantages and challenges, which are discussed below to facilitate informed decision-making.

2.4.5.1 Municipal Water

Municipal water systems are managed by local authorities to provide potable water to residents and businesses through a network of pipes and treatment facilities.

Advantages

- Typically reliable, providing water that meets established quality standards.

Disadvantages

- Currently non-existent in the project area, making it an impractical option.

2.4.5.2 Surface Water

Surface water includes water bodies such as rivers, lakes, and reservoirs, replenished by rainfall and runoff.

Advantages

- The project area has several large rivers, such as Ezu, Ahommiri, and Otakpu, which can provide significant volumes of water.

Disadvantages

- Availability can fluctuate seasonally and is prone to contamination risks, necessitating treatment. Additionally, utilising surface water may require investment in connection infrastructure and careful management to avoid ecological impacts on surrounding ecosystems.

2.4.5.3 Groundwater

Groundwater is located beneath the earth's surface in aquifers and accessed through wells and boreholes, offering a more consistent supply than surface water.

Advantages

- Provides a consistent supply, especially during dry periods, and is less affected by evaporation.

Disadvantages

- Risks include depletion and potential contamination, necessitating regular testing and treatment. Monitoring groundwater levels is crucial to prevent over-extraction and ensure long-term sustainability.

2.4.5.4 Rainwater

Rainwater is natural water collected from precipitation, which can be harvested for various uses.

Advantages:

- It can be a cost-effective source of water, especially in areas with sufficient rainfall, and can supplement other sources, enhancing overall water security.

Disadvantages

- Availability is limited to the rainy season, requiring investment in adequate storage facilities to ensure a reliable supply throughout the year. Proper infrastructure is essential to capture and store rainwater effectively.

2.4.5.5 Preferred Approach

To ensure a sustainable and reliable water supply for the agro-processing activities at the Anambra SAPZ II project, a combination of surface water, groundwater, and rainwater is proposed. This integrated approach helps mitigate risks associated with each individual source and enhances resilience against supply fluctuations, promoting efficient resource use. Additionally, a cost and technical assessment will be conducted to evaluate the feasibility and implementation of each water source option, considering infrastructure needs, maintenance costs, and potential environmental impacts to ensure that the chosen strategies align with both economic and operational requirements.

2.4.6 Waste Management Alternatives

2.4.6.1 Option 1: Traditional Waste Management

Traditional waste management practices, such as municipal waste dumps or landfill sites, offer several advantages. Landfills provide a straightforward method for waste disposal and allow for the reuse of filled land for other community purposes. They are effective for managing non-recyclable waste and help prevent illegal dumping. However, landfills come with notable disadvantages. Over time, completed landfill areas can settle and require ongoing maintenance. Environmental issues include the release of gases such as ammonia and sulphides, which produce unpleasant odours, as well as methane and carbon dioxide, which contribute to climate change. Landfills can also lead to groundwater contamination and foster bacterial growth, posing significant environmental and health risks.

2.4.6.2 Option 2: Innovative Waste Management Practices

Innovative waste management approaches, such as composting plants and closed-loop waste management systems, offer opportunities for more sustainable waste handling. Composting improves soil quality and structure by producing fully organic fertilizer, which enhances agricultural yields. Similarly, converting cassava peels into animal feed not only provides additional revenue but also reduces feed costs and the amount of food diverted from human consumption. These methods support eco-friendly practices, contribute to better soil health, and increase food security. Despite these benefits, setting up composting and recycling plants involves substantial initial investment. Their effectiveness depends on the quantity and quality of available organic waste. Additionally, composting can attract pests such as rats, snakes, and insects, require significant space, and may produce unpleasant odours.

2.4.6.3 Preferred Waste Management Option

Given the environmental and economic benefits, innovative waste management practices are the preferred option. They offer substantial advantages in terms of reducing the environmental footprint of the SAPZ project and decreasing the amount of waste directed to landfills. By adopting these methods, the project can enhance sustainability while mitigating the negative impacts associated with traditional waste management approaches.

2.4.7 Supply Chain Alternatives

In evaluating supply chain alternatives for the SAPZ project, two primary strategies were considered: local sourcing and long-distance sourcing. Each approach offers distinct advantages and challenges that influence the overall efficiency and effectiveness of the project.

2.4.7.1. Option 1: Local sourcing

Local sourcing emphasises procuring raw materials from within each facility's procurement zone. This strategy supports regional economies by fostering partnerships with local farmers and businesses, thereby strengthening community ties. Additionally, local sourcing reduces transportation costs and logistical complexities, contributing to lower overall operational expenses. The proximity of suppliers also enables faster turnaround times and more reliable supply chains.

2.4.7.2 Option 2: Long-distance sourcing

On the other hand, long-distance sourcing involves procuring farm produce from regions further away from the SAPZ. This approach can be advantageous when local supply is insufficient or when specific materials are not readily available. Long-distance sourcing offers access to a wider variety of raw materials and may provide higher-quality options in some cases. However, this strategy entails higher transportation costs and potential risks related to supply chain disruptions. These additional logistical challenges can increase overall expenses and complicate the management of the supply chain.

2.4.7.3 Preferred Option: Local Sourcing

Option 1 is the preferred option as it aligns with the project's goal of integrating and supporting the local agricultural sector, enhancing economic development, and promoting sustainability. Despite the preference for local sourcing, it is recognised that some farmers located farther from the SAPZ facilities may still need to process their products, especially for the ATC facilities in Ogbunka and Ugbene, which are strategically situated near the borders with Enugu and Abia States. By allowing access to processing facilities in these locations, the SAPZ project ensures that farmers from adjacent states can also benefit from the infrastructure and services offered, thereby broadening the project's reach and impact.

2.5 Conclusion

The availability of infrastructure and proximity to raw material sources, along with the logistical advantages offered by access to markets, strongly influenced the selection of locations for the Agricultural Transformation Centres (ATCs) in the Anambra SAPZ project. These factors, combined with the potential for leveraging existing transportation networks and local resources, made the chosen locations optimal for supporting the project's objectives. The strategic combination of local sourcing, renewable energy adoption, innovative waste management techniques and an integrated energy mix underscores the project's commitment to sustainability and resilience. By carefully selecting these options, the project is well-positioned to maximize efficiency, reduce operational costs, and ensure the successful transformation of the agricultural sector in Anambra State.

CHAPTER 3 PROJECT DESCRIPTION

This chapter provides a detailed description of the proposed Anambra State SAPZ II Project, focusing on the design and implementation of the Agro-Industrial Hub (AIH) in Ogboji (Orumba South LGA) and the three Agricultural Transformation Centres (ATCs) located in Ugbene (Awka North LGA), Omor (Ayamelum LGA), and Ogbunka (Orumba South LGA).

It outlines the project components and project location descriptions, as well as the various project phases: Pre-construction, Construction, Operation and Maintenance, and Decommissioning. Each phase includes descriptions of the specific activities involved, enabling a clear understanding of the project's scope and extent, as well as all potential sources of biophysical and socio-economic impacts.

Additionally, this chapter presents the waste management strategy, detailing the various waste streams, types, and management strategies. A project schedule is also provided to offer a timeline for the implementation and completion of the project.

3.1 Project Components

The Anambra SAPZ project is designed to catalyse agricultural transformation through strategic infrastructure development and institutional support. The project includes four main components:

1. Development of Climate-Adapted Infrastructure for the Agro-Industrial Hub: This component involves creating zones with essential infrastructure such as roads, water supply, and power, as well as facilities like processing units, offices, and training centres. The infrastructure will be designed to withstand climate-related challenges, ensuring long-term sustainability and efficiency. Comprehensive environmental and social impact assessments will guide the development, ensuring responsible implementation and mitigation of potential adverse effects.

2. Agricultural Productivity and Production Boost: This component aims to enhance agricultural output by improving farm infrastructure near Agro-Industrial Hubs (AIHs). It includes developing irrigation systems, access roads, and Agricultural Technology Centres (ATCs) that connect farmers to necessary resources and markets. Additionally, the project will provide training in sustainable agricultural practices and digital tools to help farmers access inputs, financing, and market information, thereby promoting efficiency and competitiveness.

3. Policy & Institutional Development: This component focuses on establishing a conducive legal and regulatory framework to attract private sector investment in AIHs. It includes setting up one-stop shops for streamlined business registration processes and developing a communication strategy to highlight investment opportunities. Capacity-building initiatives will strengthen the institutions involved in the programme, ensuring they can support sustainable agricultural and industrial practices.

4. Program Coordination and Management: A dedicated team will oversee the programme's implementation, providing training for staff and conducting feasibility studies for future phases. This component will also support oversight structures at both federal and state

levels, ensuring that the programme's goals are met efficiently and transparently. Monitoring and evaluation systems will be established to track the environmental and social impacts, allowing for adaptive management strategies to address any negative outcomes.

These components align with Anambra State's vision for economic transformation through industrialisation and agriculture, contributing to broader national goals of food security, poverty alleviation, and economic diversification.

3.2 Project Location Descriptions

The proposed location of the Agro-Industrial Hub (AIH) in Ogboji and the three Agricultural Transformation Centres (ATCs) in Ogbunka, Omor and Ugbene are shown in Figure 3.1.

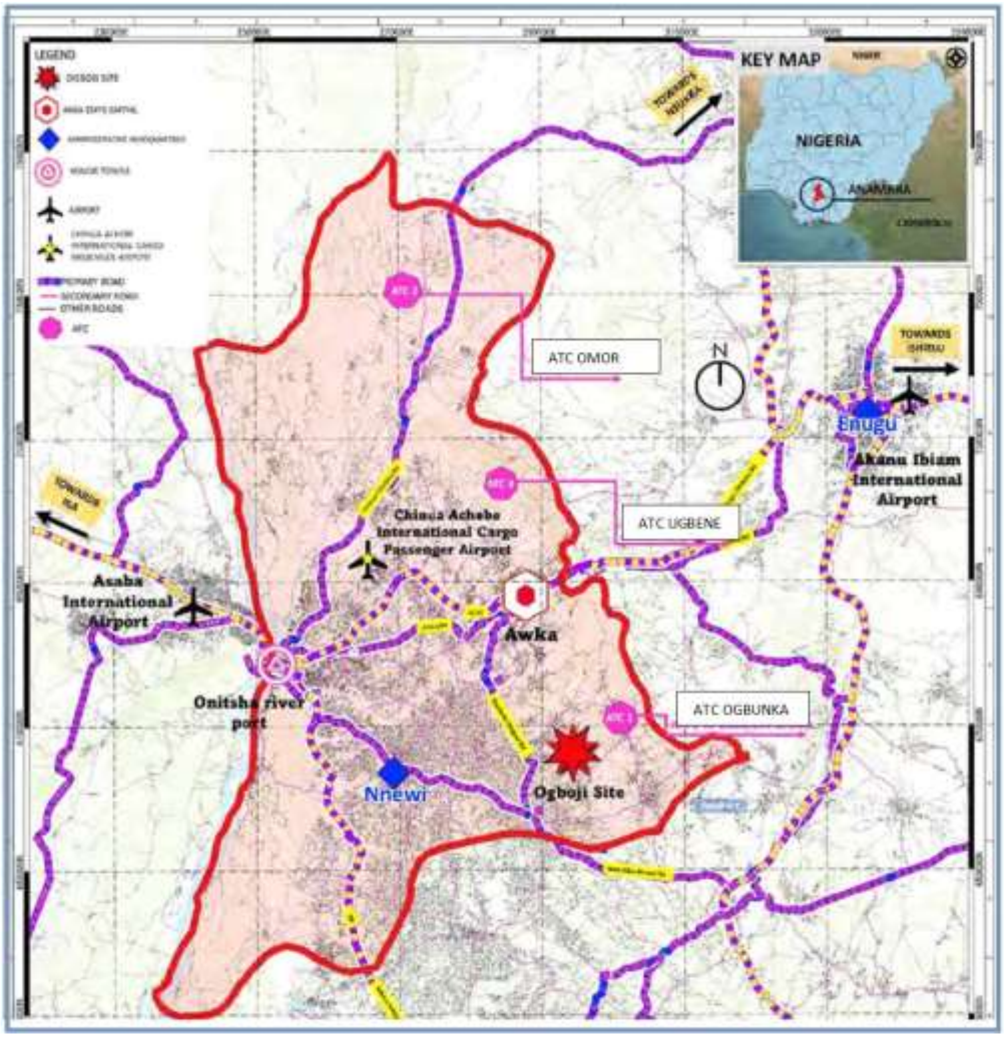


Figure 3.1: Map of Anambra State Showing the Location of SAPZ in Ogboji, Ogbunka, Omor and Ugbene

Source: ANSG (2024)

3.2.1 SAPZ Agro-Industrial Hub, Ogboji, Orumba South LGA

The coordinates of the Agro-Industrial Hub are 6.010337° N and 7.132317° E. They fall within the planned AMIC in Ogboji Town. The host community is Amangwu in Ogboji, Orumba South Local Government Area (LGA). The landmass is approximately 451 hectares of primary and secondary forests and farmlands, currently utilised for cultivating tubers like cassava and yam, legumes like melon and cereals like maize. The project site is shared with Aguluezechukwu in Aguata LGA, with the Aguluezechukwu-Ogboji-Ajalli Road providing the major access road. Ogboji Town is located about 1.5 km northeast of the site, while St Peter's Catholic University, Achina, Aguata LGA, is approximately 2 km to the southeast of the site.

The terrain is undulating with an average elevation of approximately 120 meters above sea level. The soil is predominantly reddish laterite. The Eso (or Eso Ogbo) stream, a tributary of River Otali, meanders through the thick forest within the site (Plate 3.1). Parts of the stream were hardly accessible. The local guides claimed it was derived from an unnamed rock. The stream is a tributary to River Otali.

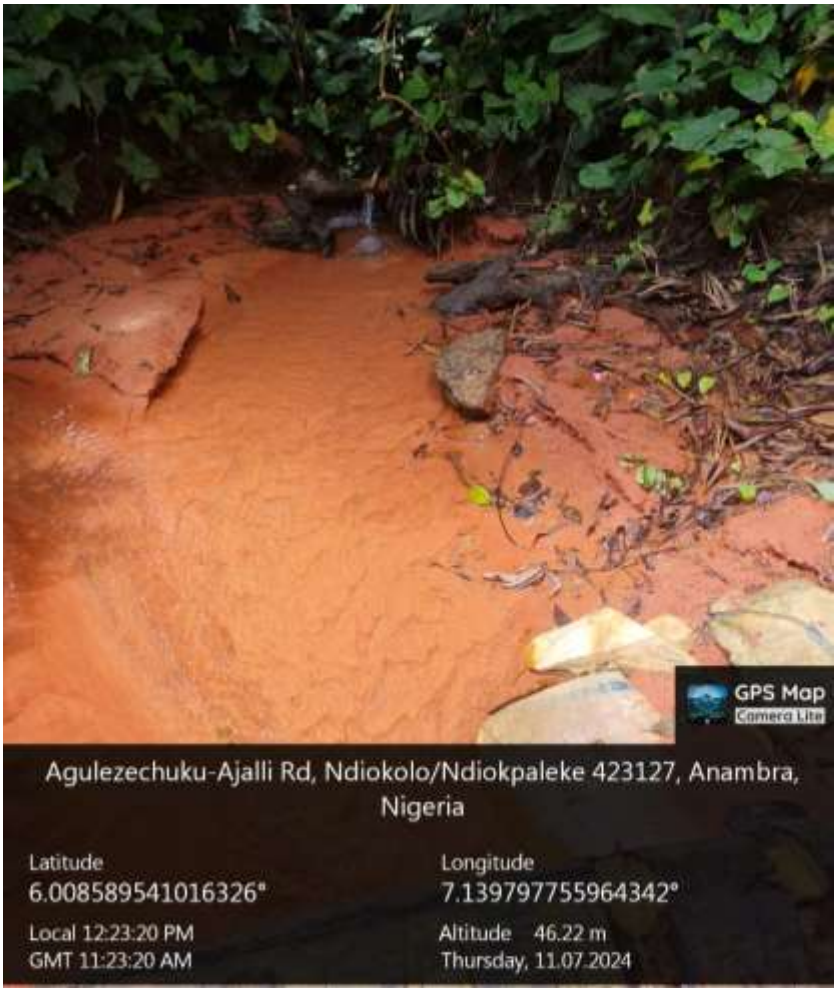


Plate 3.1: Upstream of Eso Stream within the forests of the proposed project site.

Sensitive Areas: The project site is located within primary and secondary forests and farmlands. The undulating terrain, the presence of forest cover, and the presence of the Eso stream indicate potential risks of soil erosion, habitat loss, disruption to ecosystem services and water pollution. The stream is a critical water resource for the local community, and its ecological integrity needs to be protected. Furthermore, impacts relating to displacement due to the conversion of farmland to industrial uses in the area require special consideration.

Plate 3.2: Farmland within the proposed project site. A dense forest is visible in the background

Source: AN SAPZ ESIA Field Data

3.2.2 Agricultural Transformation Centre, Ugbene, Awka North LGA

The Ugbene project site is located at coordinates 6.408411° N, 7.082986° E, within the isolated community-owned Nuke Farm, Ugbene, Awka North Local Government Area. The site is located about 45 km north of the Agro-Industrial Hub, Ogboji and approximately 2.8 km northwest of the palace of the Ugbene Traditional Ruler (Igwe Ugbene). It is accessible via the Amansiri-Ebenebe-Ugbenu-Ugbene-Awba Ofemili Road. It is also within 2k of Ogulogu Eziagu LGA, Enugu State. The nearest significant landmarks are the Tulugo Rice Processing Mill and the Ugbene Community Secondary School. The Awka North Secretariat, Achalla, is approximately 13.18 kilometres southwest of the site.

The topography of the land is relatively flat, while the average elevation is about 30 m ASL. The soil is alluvial and brownish in colour and the River Nnamuzu passes through the site and is a tributary to River Ezu. Other than the Rice Mill and Secondary School, there was no other observable infrastructure within the vicinity of the site.

Sensitive Areas: The project site is an agricultural wetland area characterised by its swampy nature and the presence of the River Nnamuzu. It is susceptible to flooding, waterlogging, and potential impacts on aquatic ecosystems. Proximity to the river poses risks of water pollution, disruption to the local water table, and impacts on rice cultivation practices in the Ugbene Community. The alluvial soil underscores the need for careful soil management to maintain the fertility of the area.

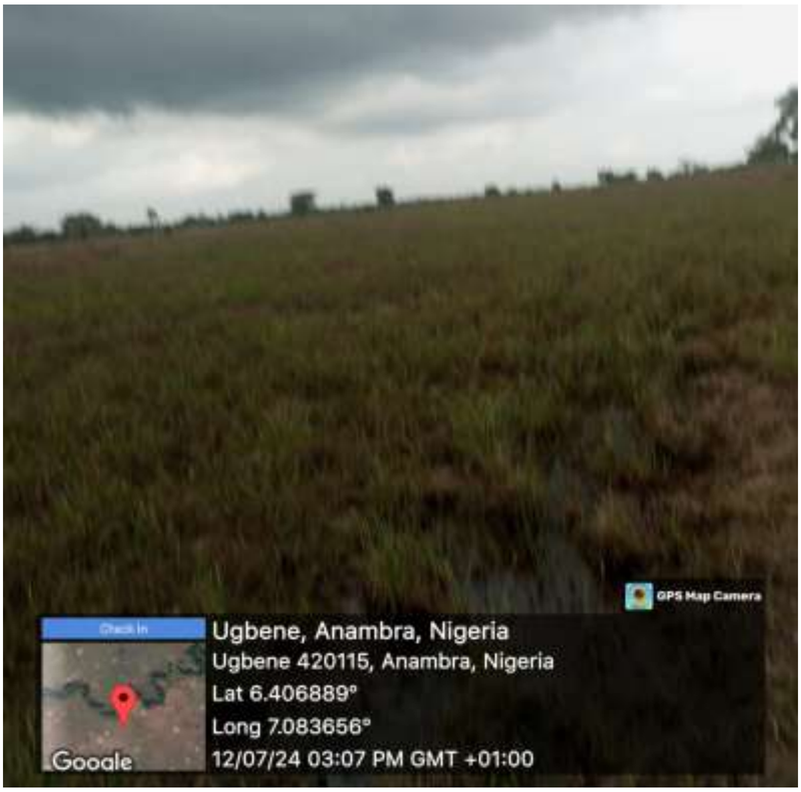


Plate 3.3: Proposed Project Location in Ugbene, Awka North LGA, Anambra State

Plate 3.4: Upstream of River Nnamuzu within the proposed project location in Ugbene.

3.2.3 Agricultural Transformation Centre, Omor, Ayamelum LGA

The geographical coordinates of the project location are 6.498969°N, 6.986988°E. It is located about 58 km north of the Agro-Industrial Hub, Ogboji. The host community is Isiokwe Orenja in Omor, Ayamelum LGA, Anambra State. The site is adjacent to the Fadama III Project site and the Rural Electrification Project in Omor. The primary access road is the Ezieke-Omor Road, branching off the Anaku-Adani/Nsugbe-Nsukka Road. The location is approximately 6.92 kilometres northeast of Ayamelum LGA headquarters, Anaku Town. Key developmental facilities, such as the Orenja Primary School and the Orenja Primary Health Post, are located about 1.43 km and 1.47 km from the proposed site, respectively. The site is also roughly 2 km from the Ajaani Forest, a significant cultural area housing the town's major deity, Ajaani Ukwu.

The topography of the land is relatively flat, with an average elevation of about 26 meters above sea level. The soil is alluvial and brownish in colour. Besides the Fadama III and the rural electrification project, there is no other observable infrastructure within the vicinity, making the site partly isolated from residential areas.

Sensitive Areas: Similar to Ugbene, the project site is an agricultural wetland characterised by its swampy nature, making it susceptible to flooding and waterlogging. The conversion of farmland to industrial use may impact rice cultivation practices in the Omor community, requiring special consideration. The alluvial soil highlights the need for careful soil management to maintain fertility. Additionally, the proximity of Ajaani Ukwu, a community deity located within 2 km of the project site in the Ajaani Forest, underscores the need for cultural sensitivity and careful planning to avoid disturbing this important community landmark.

Plate 3.5: Proposed Project Site in Omor, Ayamelum LGA, Anambra State

3.2.4 Agricultural Transformation Centre, Ogbunka, Orumba South LGA

The coordinates of the site are 5.994683°N, 7.278838° E in Isiokpu Community Farm, Isiokpu Village, Ogbunka Town, Orumba South LGA, Anambra State. It is about 17 km southeast of Agro-Industrial Hub, Ogboji. The site is notably positioned near the Anambra-Abia State boundary, the site is approximately 1 kilometre from the southwestern boundary and 500 meters from the northeastern boundary. The Orumba South Headquarters, Umunze, is approximately 13 km southwest of the site. The major access road is the Ajali-Ihube Road, which connects with the Umunze-Owerre-Ezukala Road to the north and leads to Abia State in the southern direction. The Isiokpu Village Town Hall is about 1.6 km in the southwest direction, while the Ogbunka Primary Health is also located about 1.4 km, also in the southwest direction from the site. The topography of the site is relatively flat, with an elevation of about 150 ASL. The light is light brown in colour and the surrounding areas are primarily secondary regrowth forests.

Sensitive Areas: The site's proximity to state boundaries requires careful consideration of jurisdictional regulations and potential cross-border environmental impacts. Furthermore, the surrounding secondary regrowth forests are vital for local biodiversity and may require conservation measures to protect native flora and fauna. Impacts relating to displacement due to the conversion of farmland to industrial uses in the area also require special consideration.

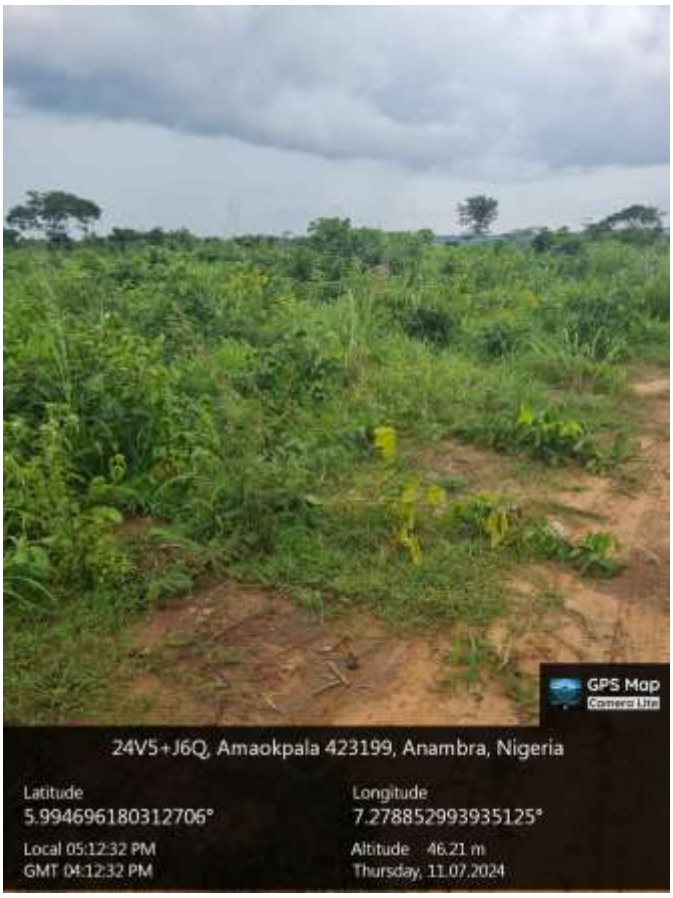


Plate 3.6: Proposed Project Site in Ogbunka, Orumba South LGA, Anambra State

3.3 Project Technology and Processes

3.3.1 SAPZ Agro-Industrial Hub (AIH)

Situated within AMIC in Ogboji, the SAPZ AIH is poised to be a central processing facility for agricultural produce sourced from the ATCs and procurement areas. Its success relies on a reliable and cost-effective supply of raw materials and an efficient procurement system.

The SAPZ AIH will feature advanced facilities tailored for agro-processing, including:

- Processing Units: Specialised units for handling various commodities, including anchor units for major processing activities and ancillary units for supporting functions.
- Storage Facilities: Dedicated spaces for raw material collection and finished goods storage.
- Packing and Labelling Zone: Automated lines for efficient and accurate packaging. The exact number of automated lines is yet to be determined and will be based on operational requirements and the scale of production.
- Specialised Infrastructure: State-of-the-art technology and facilities for comprehensive processing needs

Key technologies in the SAPZ will include:

Milling Equipment: For processing cereals (such as rice and maize) and pulses (like beans).

Oil Extraction Systems: High-efficiency systems for extracting oil from oilseeds such as sesame and oil palm.

Cold Storage Units: Advanced refrigeration systems to preserve perishable goods, especially fruits and leafy vegetables.

Automated Packing Lines: Integrated labelling systems to streamline the packaging process.

The SAPZ will also include quality control laboratories equipped with high-tech analytical equipment to ensure the excellence of both raw materials and finished products. Research and development spaces will support ongoing innovation in processing techniques and product development.

Supporting infrastructure will feature a robust logistics hub for efficient product distribution, with ample warehousing and transportation facilities. An export emporium will cater to international markets with specialised quality control and packaging tailored for export requirements.

Figure 3.2 shows an overview of the Anambra SAPZ within the AMIC masterplan while Figure 3.3 is a 3-D overview of the proposed mega facility.

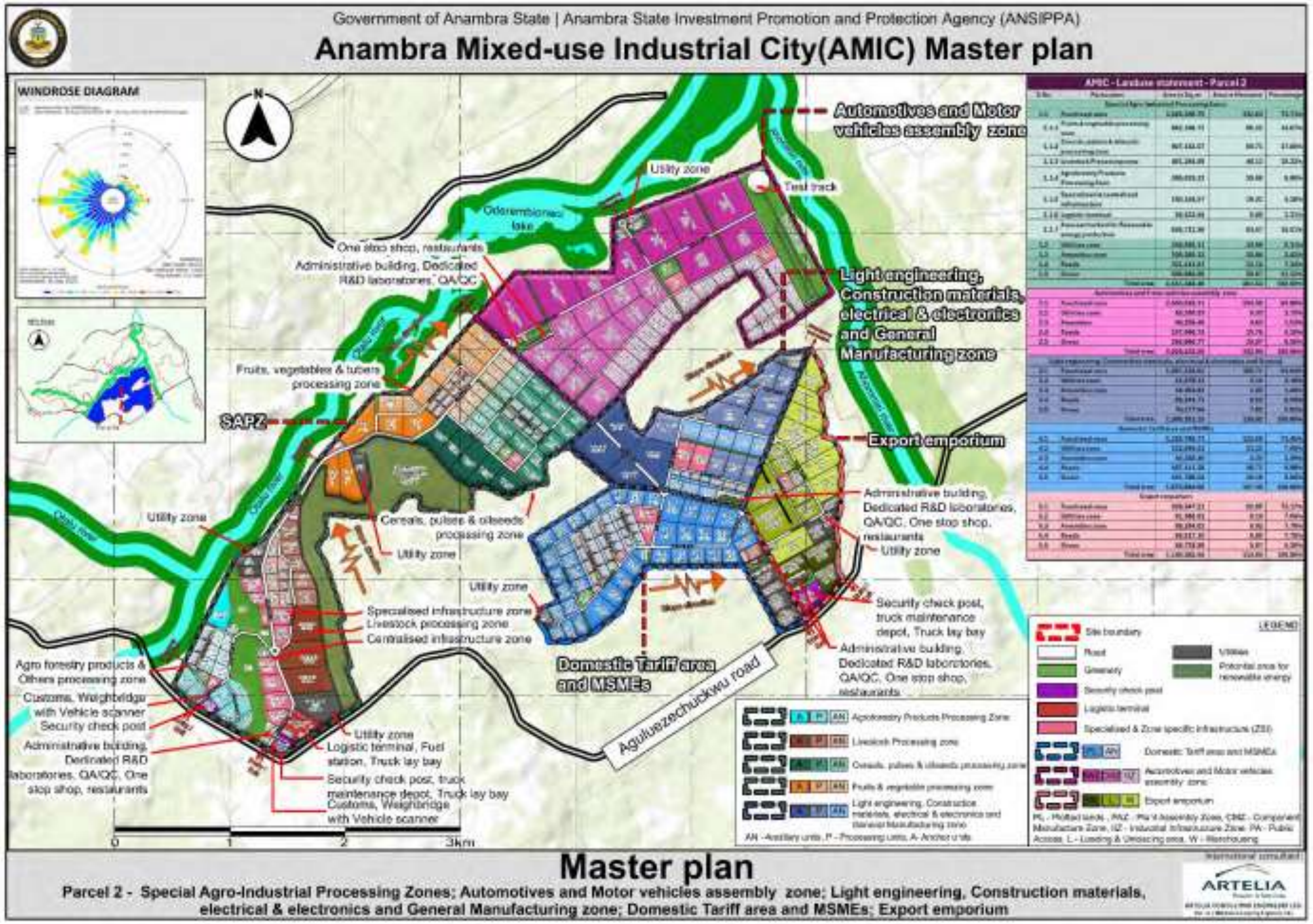


Figure 3.2: a section plan of AMIC showing the SAPZ, automobile and motor vehicle assembly zone, light engineering, construction materials, electrical & electronics and general manufacturing zone; domestic tariff area and MSMEs and export emporium.
Source: ANSG (2024)

Figure 3.3: Bird's Eye View of AMIC
Source: ANSG (2024)

Sustainability is a core principle of the SAPZ design. The hub will implement comprehensive waste management systems, including biogas production from organic waste and composting for agricultural use. Water conservation will be prioritised, with primary reliance on groundwater and surface water, complemented by rainwater harvesting systems if necessary. Water recycling technologies will optimise water use efficiency within the processing units. Energy efficiency will be supported through the use of solar panels and energy-efficient machinery.

The SAPZ will integrate seamlessly with AMIC, fostering industrial synergy and efficient resource utilisation across different zones. Knowledge and technology transfer between sectors within AMIC will enhance overall capabilities, while essential utilities and services, such as water treatment and sewage management, will support the SAPZ's operations.

Designed for scalability, the SAPZ will accommodate future expansion and technological upgrades. Continued investment in research and development will ensure ongoing innovation and maintain the SAPZ's role as a pivotal element in Anambra's agro-industrial landscape.

3.3.1.1 Proposed Land Use Statement for the SAPZ AIH, Ogboji

Figure.1 below details the planned land use allocation for the Anambra State SAPZ AIH. The total area of the AIH is 451.53 hectares, divided into various functional zones dedicated to industrial activities, utilities, amenities, green spaces, and roads. This breakdown ensures the SAPZ functions efficiently while promoting environmental sustainability.

Table 3.1: Land Use State for Anambra SAPZ AIH

S/N	Category	Description	Percentage (%)
1	**Functional Areas**	Specific zones dedicated to various types of agricultural processing.	(73.71%)
		Fruits & Vegetables Processing Zone	14.67
		Cereals, Pulses, Oilseeds Processing Zone	17.88
		Livestock Processing Zone	10.22
		Agroforestry Products Processing Zone	6.86
23	**Infrastructure**	Allocation of space for essential infrastructure.	(4.28%)
		Raw Material Storage	0.5
		Grading & Sorting Areas	0.73
		Packing & Labelling Zones	0.62
		Finished Goods Storage Areas	0.51
		Centralised Processing Centres	0.57
		Boilers, Chillers & Compressors	0.46
	Amenities	Areas for public amenities, administrative buildings, and support services.	(2.42%)
		Public Amenities	1.15
		Admin. Buildings, R&D Labs, QA/QC	0.15
		Security Checkpoints	0.92
		Restaurants & One-Stop Shops	0.2
4	**Roads & Transportation**	Land dedicated to transportation infrastructure.	(7.34%)
		30 m Wide Roads	3.61

		24 m Wide Roads	3.06
		18 m Wide Roads	0.67
5	**Green Spaces**	Inclusion of green zones for environmental sustainability.	(11.22%)
		Peripheral Green Areas	4.12
		Buffers Between Zones	1.52
		Elevated Areas & Close Contour Areas	5.58
6	**Utilities Zone**	Allocation for utilities.	(5.31%)
		Zone-Specific Infrastructure	1.33
		Substation & Overhead Tanks	1.9
		Water Treatment Plants	0.36
		Summer Storage Tanks	0.45
		Sewage Treatment & Solid Waste Management	0.38
		Additional Overhead Tanks	0.88
7	**Renewable Energy Production**	Designated areas for renewable energy infrastructure.	18.51
	Total Area	**(451.53 hectares)**	**(100%)**

Source: ANSG (2024)

3.3.2 Agricultural Transformation Centres (ATCs)

Figures 3.4 and 3.5 present a typical blueprint of an Anambra ATC design and a bird-eye overview of the proposed infrastructure. The ATCs serve as collection and distribution points for agricultural products; thus, pivotal in linking local farmers with the processing units within the Anambra SAPZ AIH. Each ATC, covering approximately 4.5 hectares (which may increase depending on need), is designed to accommodate facilities for pre-processing, storage, and value addition tailored to meet the specific needs of the SAPZ industries. As discussed in Chapter 2, the selection of ATC locations was based on several factors, including:

1. The extent of agricultural land in Anambra, focusing on areas suitable for cereals, pulses, oilseeds, fruits, vegetables, and tubers, livestock rearing and agroforestry products
2. Presence of mixed vegetation types
3. Proximity to existing road networks
4. Distance from the proposed AMIC
5. Radius of influence of each ATC

Three ATCs are proposed at strategic nodes, namely: ATC1 in Ogbunka (Orumba South LGA, ATC2 in Omor (Ayamelum LGA), and ATC3 in Ugbene (Awka North LGA), each equipped with collection facilities to support local farmers. These ATCs will feature single-day storage capabilities, with 1,000 m² reserved for dry bulk storage, for the immediate transfer of agricultural produce to the SAPZ AIH for processing.

Figures 3.4 and 3.5 show the masterplan and a bird's eye view of a typical ATC, respectively.

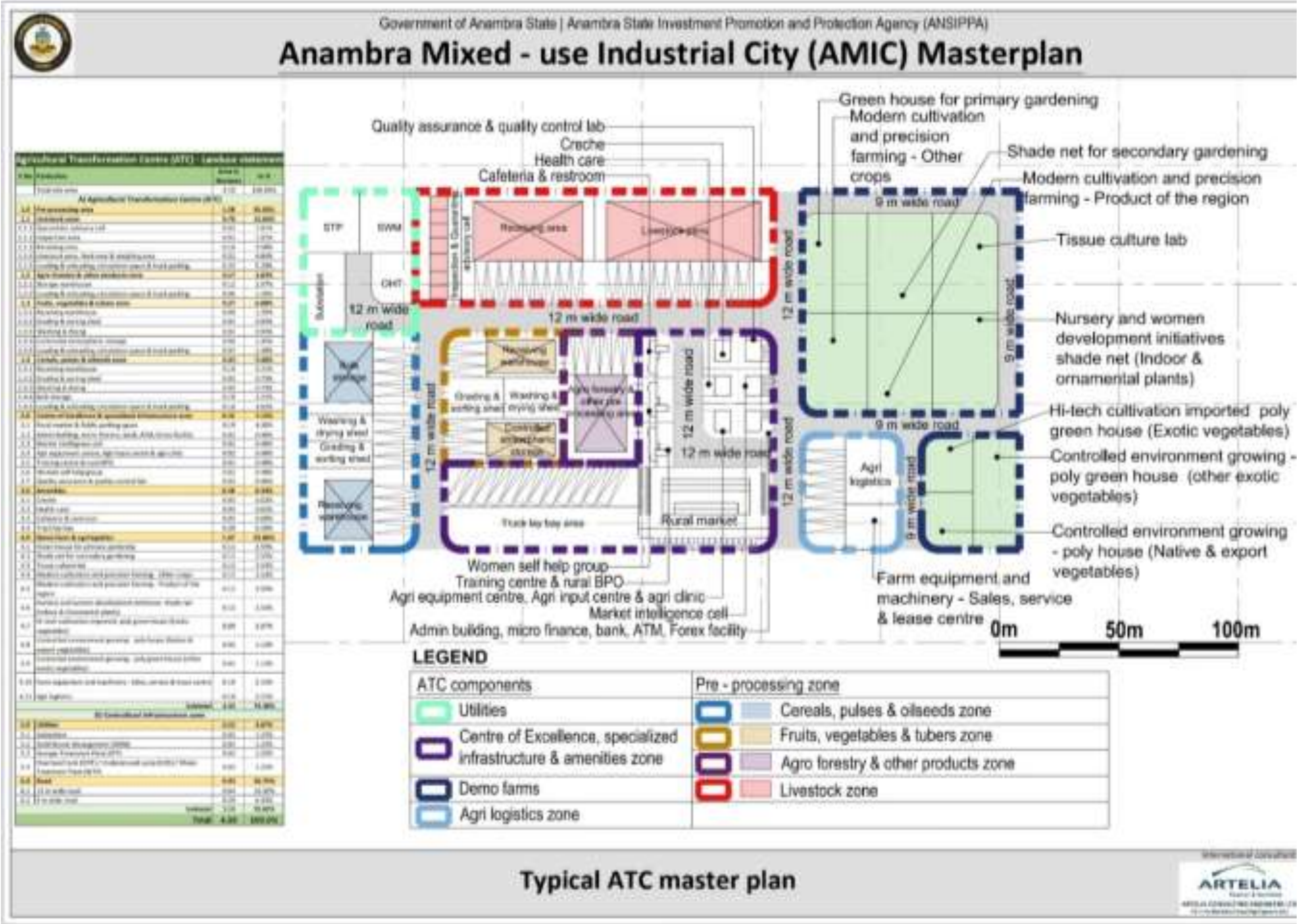


Figure 3.4: Masterplan of a Typical ATC
Source: ANSG (2024)

Figure 3.5: Bird's Eye View of a Typical ATC
Source: ANSG (2024)

3.3.2.1 Effective Procurement Zone for the SAPZ

The establishment of ATCs plays a key role in creating an effective procurement zone for the SAPZ. A successful and sustainable SAPZ relies on a continuous inflow of raw materials from the surrounding influence zone. Due to variations in factors like net marketable surplus, transportation costs, and proximity to processing facilities, different areas within the designated zone will have varying advantages in supplying the SAPZ. To identify the most competitive zone for procurement, a sub-zoning approach was undertaken. This analysis resulted in the selection of Omor, Ugbene, and Ogbunka as suitable locations for establishing ATCs. These locations offer a combination of high crop yields, efficient transportation links, and minimal legal complexities for procurement from neighbouring areas.

3.3.2.2 Feeder Zone Potential

Analysis indicates that theoretically, by dedicating all agricultural and mixed cultivation land within the designated feeder zone to growing crops specifically for the SAPZ, maintaining existing productivity levels, and transporting all produced materials to the SAPZ for processing, this zone could potentially supply 100% of the SAPZ's raw material requirements. This scenario assumes crop diversification to meet the specific needs of the SAPZ.

It is important to acknowledge that achieving 100% reliance on the feeder zone would require a significant shift in land use and agricultural practices. The project acknowledges the need for a more balanced approach that considers factors such as:

- Long-term sustainability of agricultural practices, including soil health and potential impacts of monoculture.
- Economic incentives for farmers to participate in supplying the SAPZ.
- The importance of maintaining some level of diversification to mitigate the risk of market fluctuations.

Potential logistical challenges associated with transporting 100% of production to the SAPZ.

3.3.2.3 Infrastructure

The ATCs are designed to provide vital backward linkages to AMIC, handling key agricultural products including cereals, pulses, and oilseeds; fruits, vegetables, and tubers; livestock; and agroforestry products. The sustained and sustainable operations of ATCs require the provision of an appropriate infrastructure network, categorised as follows:

A. **Support Infrastructure:**

- **Quality Control Lab:** Ensures the quality of incoming and outgoing produce.
- **Auction House:** Facilitates the trading of agricultural commodities.
- **Agri-Clinic:** Provides healthcare services for livestock and crops.
- **Certification Lab:** Certifies the quality and standards of agricultural products.
- **Training Centre:** Offers training programs for farmers and staff.

- **Animal Inspection Area:** Dedicated area for the health check-up of livestock.

B. **Specialised Infrastructure:**

- **Storage Facilities:** These include warehouses and cold storage to preserve produce.
- **Drying Yard:** For drying grains and other produce before storage or sale.
- **Auction Centre:** Venue for selling agricultural products.
- **Mechanised Agricultural Equipment:** For leasing or renting to farmers.
- **Fertilizer and Pesticide Storage:** Safe storage for agricultural inputs.
- **Soil Testing Facilities:** To analyse soil health and fertility.
- **Demonstration Farms:** Showcasing modern farming techniques and practices.
- **Centre of Excellence (CoE):** Hub for technology dissemination and capacity building.

C. **Social Infrastructure:**

- **Health Centre:** Provides medical services to farmers and staff.
- **Nursing Mother Area and Crèche:** Supports working mothers.
- **Restrooms:** Basic sanitary facilities.
- **Administrative Block:** Offices for management and administration.
- **Women Self-Help Groups:** Empowerment and support groups for women.

D. **Commercial Infrastructure:**

- **Bank & ATM:** Financial services for farmers and staff.
- **Microfinance:** Providing financial support to small farmers.
- **Rural BPO:** Business process outsourcing services to support agribusinesses.
- **Food Court:** Catering services for workers and visitors.

3.3.2.4 Highlight on Livestock Service Centre (LSC)

An integral part of the ATCs, the LSC aims to enhance the productivity of small- and medium-scale livestock keepers. The infrastructure includes:

- Pens for handling livestock
- Facilities for castration, dehorning, branding, tagging, veterinary checks, blood sampling, vaccinations
- Plunge dip-tank or spray race for tick control

- Office and accommodation for staff
- Shelter and ablution facilities for farmers
- Technology Dissemination and Capacity Building:

3.3.2.5 Highlight on Centre of Excellence (CoE)

The CoE hub within the ATCs will focus on structured knowledge interventions, technology dissemination, and capacity-building initiatives. These activities include:

- Training in modern agricultural techniques such as precision farming and controlled environment growing.
- Demonstrations of advanced cultivation methods and integrated farming solutions for horticulture, dairy, animal husbandry, aquaculture, and apiculture.
- R&D on high-yielding varieties and soil/water management.
- Extension services for technology transfer and farmer support.

3.3.2.6 Highlight on Knowledge Cell and Market Information Centre:

The ATCs will house a comprehensive market information cell, providing data on domestic and global trends. This cell will leverage various methods like agri-portals, web-based systems, and on-farm services to reach a wide audience. It will also facilitate collaboration with national and international research centres.

3.3.2.7 Land Use Statement for ATCs

The ATCs are designed to optimise agricultural processing and logistics within a total area of 4.5 hectares. Table 3.2 summarises the land use statement for the allocation of space across various key zones, including pre-processing facilities, specialised infrastructure, amenities, and centralised utilities. The largest portion (35.03%) is dedicated to the pre-processing area, which handles various agricultural products. The Demonstration Farm & Agri-Logistics zone utilises a significant area (23.86%) for research, education, and support services. Amenities and a Centre of Excellence with specialised infrastructure occupy a smaller portion but cater to essential needs and support activities. Finally, centralised infrastructure like utilities and roads account for the remaining area. Strategically organising these components will enhance the efficient handling of agricultural products, foster innovation, and promote operational effectiveness within the broader agricultural landscape.

Table 3.2: Summary of Land Use Statement for ATC

Sl. No.	Particulars	Area in Hectares	In %
	Total site area	**4.50**	**100.00%**
A) Agricultural Transformation Centre (ATC)			
1.0	**Pre-processing area**	**1.58**	**35.03%**
1.1	**Livestock zone**	**0.70**	**15.64%**
1.1.1	Quarantine advisory cell	0.05	1.01%
1.1.2	Inspection area	0.05	1.01%
1.1.3	Receiving area	0.16	3.58%
1.1.4	Livestock pens, feed area & weighing area	0.22	4.84%
1.1.5	Loading & unloading, circulation space & truck parking	0.23	5.20%
1.2	**Agroforestry & Other Products zone**	**0.17**	**3.83%**
1.2.1	Storage warehouse	0.12	2.57%
1.2.2	Loading & unloading, circulation space & truck parking	0.06	1.26%
1.3	**Fruits, vegetables & tubers zone**	**0.27**	**6.08%**
1.3.1	Receiving warehouse	0.06	1.35%
1.3.2	Grading & sorting shed	0.04	0.94%
1.3.3	Washing & drying	0.04	0.94%
1.3.4	Controlled atmospheric storage	0.06	1.35%
1.3.5	Loading & unloading, circulation space & truck parking	0.07	1.49%
1.4	**Cereals, pulses & oilseeds zone**	**0.43**	**9.48%**
1.4.1	Receiving warehouse	0.10	2.21%
1.4.2	Grading & sorting shed	0.03	0.73%
1.4.3	Washing & drying	0.03	0.73%
1.4.4	Bulk storage	0.10	2.21%
1.4.5	Loading & unloading, circulation space & truck parking	0.16	3.62%
2.0	**Centre of Excellence & specialized infrastructure zone**	**0.32**	**7.15%**
2.1	Rural market & Public parking space	0.19	4.30%
2.2	Admin building, micro finance, bank, ATM, Forex facility	0.02	0.48%
2.3	Market intelligence cell	0.02	0.48%
2.4	Agri equipment centre, Agri input centre & agri clinic	0.02	0.46%
2.5	Training centre & rural BPO	0.02	0.48%
2.6	Women self-help group	0.02	0.48%
2.7	Quality assurance & quality control lab	0.02	0.46%
3.0	**Amenities**	**0.38**	**8.34%**
3.1	Creche	0.03	0.62%
3.2	Health care	0.03	0.62%
3.3	Cafeteria & restroom	0.03	0.60%
3.4	Truck lay bay	0.29	6.50%
4.0	**Demonstration farm & Agri logistics**	**1.07**	**23.86%**
4.1	Green house for primary gardening	0.11	2.53%
4.2	Shade net for secondary gardening	0.11	2.55%
4.3	Tissue culture lab	0.11	2.53%
4.4	Modern cultivation and precision farming - Other crops	0.11	2.53%
4.5	Modern cultivation and precision farming - Product of the region	0.11	2.55%
4.6	Nursery and women development initiatives shade net (Indoor & Ornamental plants)	0.11	2.53%
4.7	Hi-tech cultivation imported poly greenhouse (Exotic vegetables)	0.09	2.07%

4.8	Controlled environment growing - poly house (Native & export vegetables)	0.05	1.13%
4.9	Controlled environment growing - poly greenhouse (other exotic vegetables)	0.05	1.13%
4.10	Farm equipment and machinery - Sales, service & lease centre	0.10	2.15%
4.11	Agri logistics	0.10	2.15%
	Subtotal	**3.35**	**74.38%**
	B) Centralized Infrastructure zone		
5.0	**Utilities**	**0.22**	**4.87%**
5.1	Substation	0.05	1.22%
5.2	Solid Waste Management (SWM)	0.05	1.22%
5.3	Sewage Treatment Plant (STP)	0.05	1.22%
5.4	Overhead tank (OHT) / Underground sump (UGS) / Water Treatment Plant (WTP)	0.05	1.22%
6.0	**Road**	**0.93**	**20.75%**
6.1	12 m wide road	0.64	14.32%
6.2	9 m wide road	0.29	6.43%
	Subtotal	**1.15**	**25.62%**
	Total	**4.50**	**100.0%**

Source: ANSG (2024)

3.4 Raw Materials and Resources

3.4.1 Raw Materials

Te SAPZ is designed as a comprehensive hub for processing various agricultural products. Core raw materials include cereals and pulses for milling and food processing, oilseeds like sesame and oil palm for oil extraction, timbers for packaging materials, and a variety of fruits and vegetables for processing, cold storage, and packaging. Additionally, livestock products, including meat and dairy, will be processed and preserved at the hub.

3.4.2 Water Needs and Infrastructure

The SAPZ AIH and the three ATCs require substantial water resources to support their processing activities. The AIH is estimated to have a total average water demand of 5973 m^3 per day, including 3703 m^3 per day for potable water, 2270 m^3 per day for non-potable water, and an additional fire demand (fire hydrant) of 129 m^3 per day, resulting in a total of 6102 m^3 per day. For the three ATCs, the estimated water demand is 597.8 m^3 per day per ATC, which totals 1793.4 m^3 per day for all three ATCs.

Substantial storage capacities are planned to ensure continuous water supply and manage operational demands. For the AIH, underground storage will accommodate 3693 m^3 of potable water and 2397 m^3 of non-potable water. Additionally, elevated-level service reservoirs (ELSR) or overhead tanks will provide an extra 923 m^3 for potable water and 567 m^3 for non-potable water. The exact number of water storage tanks required is currently being determined through detailed engineering assessments to ensure adequate capacity and efficiency for the project's water supply needs. A detailed breakdown of the water demand and storage capacities for both the AIH and ATCs is provided in **Table 3.3.**

For the ATCs, two underground storage tanks (UGS) will store both potable and non-potable water, along with overhead water storage tanks designed to meet a 4-hour storage requirement based on the ATCs' operational demands. The specific capacities of these tanks will be determined through detailed engineering assessments.

Table 3.3: Anambra SAPZ Estimate Water Needs

Facility	Potable Water Demand (m^3/day)	Non-Potable Water Demand (m^3/day)	Fire Demand (m^3/day)	Total Water Demand (m^3/day)	Underground Storage (m^3)	Overhead Storage (m^3)
SAPZ AIH	3703	2270	129	6102	Potable: 3693 Non-potable: 2397	Potable: 923 Non-potable: 567
One ATC	370.8	227	12.9	597.8	Based on 4-hour storage requirement	Based on 4-hour storage requirement
Three ATCs	1112.4	681	38.7	1793.4	Based on 4-hour storage requirement	Based on 4-hour storage requirement

Sources: SAPZ AIH Requirements from ANSG (2024).

Efficient water management strategies will include the use of metres and smart monitoring mechanisms for the water supply and distribution networks. The primary sources of water will be groundwater (boreholes drilled at the site) and surface water (River Ahomiri), supplemented with rainwater harvesting systems and wastewater recycling systems. The system is designed to maintain water losses below 10% through high-quality piping materials and diligent management practices.

Water infrastructure will include a pumping station to facilitate the movement of water from underground storage to ELSR. The distribution network, designed for peak flow efficiency, will use ductile iron (DI) and high-density polyethylene (HDPE) pipes for various sections of the network.

3.4.3 Energy Demand and Supply

During the construction phase, the SAPZ AIH in AMIC will require approximately 110 kVA, representing 22% of the total 500 kVA AMIC construction power demand. Each of the three ATCs is estimated to need about 11 kVA during construction, resulting in a combined power requirement of 33 kVA for all three ATCs. Therefore, the total construction power demand for the SAPZ AIH and the three ATCs will be around 143 kVA. This power can be sourced from the nearest grid connection or provided by two portable or truck-mounted diesel generator sets with 160 kVA capacities.

Once construction is complete, the operational phase will demand an estimated 19,482 kVA for the SAPZ AIH. Each ATC is projected to require 194.82 kVA, which is 1% of the SAPZ AIH's operational power demand for a total combined operational power demand of about 584.46 kVA for all three ATCs. Thus, the total operational power demand for the SAPZ AIH and the three ATCs will be approximately 20,066.46 kVA.

As discussed in Chapter 2, the Anambra SAPZ II will be integrated into both existing and proposed national grid infrastructure, ensuring a reliable and efficient energy supply for its operations. This integration leverages the nearby Enugu Electricity Distribution Company (EEDC). While this setup provides the high capacity needed to support the SAPZ's energy-intensive processes, it introduces potential risks, such as vulnerability to grid outages and limited control over energy costs.

To complement this and address sustainability concerns, the project will incorporate onsite renewable energy technologies, specifically rooftop solar photovoltaic (PV) panels. These installations are designed to reduce the project's carbon footprint and long-term operational costs. Although the initial investment is significant and energy production can be weather-dependent, the scalability of this renewable option aligns with the project's broader sustainability goals.

However, detailed engineering for the solar system at AMIC is currently unavailable, as the solar park will be developed once a sufficient occupancy level is reached. In the interim, the project will rely on grid electricity, with a dedicated power line being extended from Oji River to AMIC, providing a guaranteed 22-hour daily power supply.

3.5 Operational and Resource Management

The envisaged lifespan of the project is 20 years, supported by a strategic plan designed to ensure sustainable operations and continuous improvement throughout its duration. To achieve these goals, careful consideration will be given to various maintenance and operational factors:

- **Maintenance and Operational Standards:**
  - **Energy Requirement:** The energy requirements of the equipment will also be established at the time of procurement, allowing for accurate planning and integration into the project's energy management system.
  - **Maintenance Schedule:** The frequency of maintenance for machines and equipment will adhere to the recommendations provided by the original equipment manufacturers (OEM).
  - **Operating temperatures:** The operating temperatures of the equipment will be determined upon procurement, ensuring optimal performance and longevity.
  - **Noise Levels:** The noise levels during the operation of the machines will also be assessed and confirmed once the equipment has been procured.
- **Raw Material Sourcing:** The primary source of raw materials will be the Agricultural Transformation Centres (ATCs), supplemented by other local sources within Nigeria. This approach ensures a steady and reliable supply chain for the project.
- **Workforce Sourcing and Local Content:** The workforce for the project will be sourced primarily locally, covering all levels of labour, including unskilled, semi-skilled,

and skilled workers. For specialised skills that are not available locally, labour from outside the project areas will be utilised. A robust skill transfer system will be implemented to facilitate the upskilling of the local workforce, ensuring that the community benefits from knowledge and expertise gained during project execution.

3.6 Project Phases and Activities

This section is concerned with describing the activities associated with implementing the SAPZ AIH and ATC programme. These activities fall into five broad categories, including:

1. Feasibility Studies, Engineering Design
2. Pre-construction Phase (Site Preparation)
3. Construction Phase
4. Operational Phase
5. Decommissioning Phase

3.6.1 Feasibility Studies (Feasibility Studies, Engineering Design)

The project begins with comprehensive feasibility studies to assess viability. This includes market analysis to identify demand for processed agricultural products, technical feasibility to evaluate infrastructure and equipment needs, financial feasibility to estimate costs and returns, and environmental and social feasibility to address potential impacts and stakeholder engagement.

3.6.2 Preconstruction Phase (Site Preparation)

This phase involves identifying and acquiring suitable land for the Agro-Industrial Hub (AIH) and the three Agricultural Transformation Centres (ATCs). Detailed Environmental and Social Impact Assessments (ESIA) are conducted, and necessary permits are secured. Site preparation includes clearing vegetation, grading, and setting up drainage systems.

Major activities during this phase include:

1. **ESIA Study**: Conduct thorough assessments to evaluate potential environmental and social impacts of the project, identify mitigation measures, and engage with stakeholders to ensure community acceptance.
2. **Site Clearing and Preparation:** Clear vegetation, grade the land and prepare the site for construction activities while ensuring minimal environmental disruption.
3. **Utility Infrastructure Setup:** Install essential utilities such as temporary power, water supply, and sanitation facilities to support construction activities.
4. **Establishing Construction Camps:** Set up temporary camps for construction workers, ensuring they have adequate living conditions and access to necessary services.

5. **Logistics Planning:** This includes:
    a. Material Procurement and Transportation: Arranging for the procurement and transportation of construction materials, machinery, and equipment to the site, ensuring minimal environmental impact.
    b. Access Road Development: Constructing or upgrading access roads to facilitate the movement of materials and personnel to and from the site.

3.6.3 Construction Phase

This phase involves the physical development of the infrastructure required for the SAPZ AIH and ATCs (Agricultural Transformation Centres). Major activities during this phase include:

1. **Foundation Works**: Laying the foundation for buildings and structures within the SAPZ AIH and ATC, following the approved designs and engineering specifications.
2. **Building Construction:** Constructing the various facilities as per the plans, including office buildings, warehouses, pre-processing units within the ATC (separate zones for cereals, fruits & vegetables, livestock, agro-forestry), and other required structures. This involves following building codes and safety standards.
3. **Infrastructure Development:** Building the necessary infrastructure within the zone, such as roads, drainage systems, water supply networks, sewage systems, and power supply, to ensure proper functionality.
4. **Landscaping:** Building outdoor spaces to enhance their aesthetic appeal, functionality, and environmental sustainability. It includes activities such as planting trees, shrubs, and flowers; creating pathways; and constructing drainage channels.
5. **Equipment Installation:** Installing the specialised processing equipment and machinery within the ATC based on the designated functionalities for each zone (e.g., sorting and grading equipment, washing stations, storage facilities).

3.6.4 Operational Phase

Once construction is complete, the focus shifts to the ongoing management and maintenance of the facilities. Activities during the phase include:

- Tenant management involves attracting and onboarding private agribusinesses to set up processing units within the AIHs, facilitating connections between processors and local farmers, and ensuring a steady supply of raw materials.
- Commissioning and testing of facilities and equipment.
- Operating and maintaining the project infrastructure and facilities.
- Managing daily operations (e.g., production processes, service delivery).
- Implementing environmental monitoring and management plans.
- Continuous engagement with local communities and stakeholders.

- Conducting routine maintenance and repairs.
- Managing operational waste and emissions.
- Monitoring and ensuring compliance with regulatory requirements.
- Continuous monitoring and evaluation are conducted to track the program's performance in terms of agricultural productivity, processing capacity, job creation, and economic development. Efforts are made to maintain operational efficiency, uphold environmental and social management plans, and support the SAPZ's overall objectives through ongoing improvement and adaptation.

3.6.5 Decommissioning Phase

Following a period of successful operation, a decommissioning plan will be developed and implemented to ensure the safe, responsible dismantling of facilities and restoration of the site. This plan will consider environmental and social factors throughout the process to manage the impacts of the project. Activities to be carried out during the decommissioning phase include planning for the decommissioning activities, site preparation and mobilisation, destruction and removal of facility buildings and site restoration activities.

3.7 Health, Safety, and Environmental Management

3.7.1 Health and Safety Management

The AN SAPZ II prioritises the health and safety of workers, visitors, and the surrounding community. A comprehensive Health, Safety, and Environment (HSE) strategy will be developed for the SAPZ project, aligned with the National Policy on Occupational Safety and Health 2006, the Factories Act 1987, and the AfDB's Operational Safeguard 5 on Labour Conditions, Health, and Safety. The goal is to achieve zero accidents and fatalities throughout the project lifecycle.

Key components of the HSE strategy include:

- **Occupational Health and Safety (OHS) Policy:** A detailed OHS policy will be created and enforced, adhering to both national and international standards. This policy will encompass all facets of workplace safety, with mandatory training for all staff. The HSE policy will be activated at all times to ensure the safety, security, and good health of all human settlements near the project site.
- **Safety Training:** Regular safety training sessions will be held for all employees, covering hazard recognition, emergency response, and safe work practices.
- **Personal Protective Equipment (PPE):** PPE such as helmets, gloves, goggles, and other necessary equipment will be provided as required and their use strictly enforced.
- **Emergency Response Plan**: An emergency response plan will be established, covering procedures for fire, chemical spills, medical emergencies, and natural disasters. Regular drills, including quarterly fire drills, will ensure preparedness. The project design includes an emergency evacuation plan.
- **Incident Reporting and Investigation**: A system for reporting and investigating workplace incidents will be implemented to prevent recurrence and continually improve safety practices.

- **Fire Safety:** The project design incorporates firefighting systems such as storage tanks, hydrants, and on-site fire extinguishers. Fire drills will be conducted quarterly to ensure readiness.
- **Safety Signs:** Safety and warning signs will be posted around the site to ensure awareness and preparedness.

3.7.2 Environmental Management

The SAPZ's operations will prioritise environmental protection to minimise impacts on natural surroundings and enhance the local environment's aesthetics and biodiversity. Strategies include:

- **Environmental Policy:** A policy emphasising sustainability, pollution prevention, and compliance with environmental regulations will be formulated.
- **Air and Noise Quality Control:** Air emissions and noise from project activities will be monitored and controlled with appropriate technologies, such as air filtration systems and noise barriers, to maintain acceptable environmental quality levels.
- **Soil Management:** Soil conservation measures, including erosion control (using vegetation cover, mats, blankets, and sediment basins) and contamination prevention (proper storage and handling of hazardous materials), will be implemented. Regular soil quality testing and remediation plans will be in place to ensure soil health.
- **Water Management:** Efficient water management practices, including metering, rainwater harvesting, and wastewater recycling, will be adopted to prevent contamination and protect water sources.
- **Waste Management:** A robust waste management system following the "5 Rs" hierarchy (Refuse, Reduce, Reuse, Recycle, and Recover) will be implemented to prevent contamination of water sources and ensure no damage to land and water bodies around the project site (Section 3.7).
- Biodiversity Protection: Efforts will be made to create green spaces and buffer zones, avoiding disruption to local wildlife and habitats beyond what is necessary for facility construction.
- **Environmental Monitoring:** Continuous environmental monitoring will be conducted to assess operational impacts and implement corrective actions as needed.
- **Sustainable Practices:** Sustainable practices in energy use, resource management, and production processes will be adopted to minimise the environmental footprint of the SAPZ and ATCs.

3.7.3 Implementation and Compliance

To ensure the effective implementation of HSE measures, the following actions will be taken:

- **Designated HSE Team:** A dedicated Health, Safety, and Environmental (HSE) team will oversee all related activities, ensuring compliance and promoting continuous improvement.

- **Compliance with Regulations:** The SAPZ and ATCs will adhere to all relevant local, national, and international regulations and standards, including donor and funder requirements. Regular audits will be conducted to ensure adherence.
- **Stakeholder Engagement:** Regular communication and engagement with stakeholders, including local communities, regulatory bodies, and employees, will address concerns and incorporate feedback into HSE practices.
- **Continuous Improvement:** HSE practices will be regularly reviewed and updated based on new insights, technological advancements, and changing regulations to ensure ongoing improvement in health, safety, and environmental performance.

These measures will ensure that the SAPZ project upholds high standards of health, safety, and environmental management, fostering a safe and sustainable working environment for all.

3.8 Waste Management

The Anambra SAPZ project prioritises responsible environmental stewardship through an effective waste management plan. Waste, defined as any unwanted material (solid, liquid, gas, or mixture), will be managed following established guidelines and regulations, and in compliance with the Federal and Anambra State Waste Management Policies and Guidelines, such as:

- National Environmental Regulations (including Sanitation and Waste Control, 2009; Hazardous and Solid Waste, 1991; Harmful Waste Act, 1988)
- National Policy on Waste Battery Management, 2022
- Anambra State Waste Management Authority (ANWAMA) Guidelines, 2015
- Other identified relevant regulations and standards

A core principle of the waste management plan is waste avoidance and minimisation. Consequently, the project's waste management plan will include the adoption of the "5 Rs" hierarchy: Refuse, Reduce, Reuse, Recycle, and Recover. Strategies for material optimisation, efficient procedures, and good housekeeping practices will be implemented to minimise waste generation at the source. Furthermore, only contractors certified by the relevant authorities like NESREA and the ASWAMA (Anambra State Waste Management Authority) will be authorised to handle regulated waste, such as electronic waste. The selection process for vendors for both regulated and general waste handling is currently underway.

3.8.1 Waste Management Approach

A systematic approach will be employed for managing waste generated during the project lifecycle, including:

1. **Segregation**: Separating waste streams at the source for proper handling and

disposal.

2. **Inventorying**: Identifying and documenting all waste streams.
3. **Classification**: Categorising waste based on type and hazard potential.
4. **Quantification**: Measuring the volume and weight of each waste stream.
5. **Tracking**: Monitoring the movement of waste from generation to disposal.
6. **Disposal**: Implementing safe and environmentally sound disposal methods for all waste streams, in compliance with relevant regulations.

3.8.2 Waste Stream

The project will primarily generate solid waste streams such as food processing residuals, packaging materials, and construction debris. Liquid waste streams may include used oil, wastewater from processing activities, and sanitary waste, as detailed in Table 3.4. However, potential air pollutants from vehicle emissions and depending on specific agricultural processes, gaseous emissions like methane and ammonia would be considered for effective environmental management. The project will develop a comprehensive waste management plan that addresses all these waste streams to minimise environmental impact.

3.8.2.1 E-Waste

The likely sources of e-waste during the operational phase are lithium batteries, used solar panels, damaged electric boards, used air conditioners, damaged printers and spent light emitting diode (LED) bulbs and security lights. Each lithium battery weighs about 35 kg and lasts about seven years. The air conditioners and printers can last up to five to seven years. Some solar panels can last up to 25 years, while other electronic waste has varying lifespans of at least one year. The SAPZ management will include buy-back agreements with its Original Equipment Manufacturers (OEMs), which will also replace the electrical components, air conditioners, solar panels and lithium batteries. Where an agreement with an OEM is lacking, for example, for used LED and security lights, the SAPZ management will appoint a state-accredited waste management contractor to collect and dispose of the waste per regulatory guidelines. Figure 3.6 shows a representation of the cradle-cradle approach to managing e-waste from the project, while Table 3.4 summarises the waste management approach for all phases of the project. Estimate of wastes

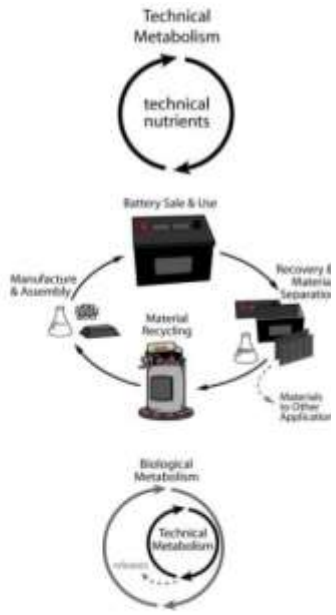


Figure 3.6: Diagrammatic Representation of Cradle-to-Cradle Battery Management Source: Stanford University (2003)

Note: Technical metabolism refers to modelling technical behaviour after natural processes to productively cycle industrial materials. According to Stanford University 2003, the materials are technical nutrients, designed to circulate safely and perpetually through cradle-to-cradle product life cycles of production, use, recovery, and re-manufacture

Table 3.4: Anambra SAPZ Project Waste Streams and Sources

Project Phase	Waste Source	Potential Waste	State	Type	Disposal Method	Est Qty (Tonnes/ Day)*
Pre-construction	Land clearing activities	• Vegetation waste (leaves, branches, trunks, grasses, crops)	Solid	Non-hazardous	Sell usable parts/ Composting	TBD
Construction	Construction and demolition activities	♦ Scrap metals, concrete debris, wood scraps ♦ Packaging materials (plastic, cardboard)	Solid	Non-hazardous	Sell usable parts/ State-accredited vendor	TBD
	Construction crews	♦ Sanitary waste (hygiene products) ♦ General waste (food scraps wrappers,	Solid	Non-hazardous	State-accredited vendor	TBD

Project Phase	Waste Source	Potential Waste	State	Type	Disposal Method	Est Qty (Tonnes/ Day)*
		plastic containers)				
Operational	Agricultural processing activities	Food processing: ♦ Fruit/vegetable peels, cores, pomace, spoiled produce ♦ Grain processing: Hulls, cobs, chaff ♦ Animal processing: Manure, bones, blood	Solid	Non-hazardous	Feed conversion/ Composting	TBD
	Packaging used for processed products	♦ Packaging waste (plastic packaging materials, cardboard boxes)	Solid	Non-hazardous	State-accredited vendor	TBD
	Office activities	♦ Office waste (paper, toner cartridges, printer ink cartridges)	Solid	Non-hazardous	Sell usable part/Refill/State-accredited vendor	TBD
	Personnel on-site	♦ Sanitary waste (hygiene products) ♦ General waste (food scraps wrappers, plastic containers)	Solid	Non-hazardous	Sold/ State-accredited vendor	TBD
	Maintenance activities	Hazardous waste: ♦ Used batteries ♦ Paint and solvent residues, ♦ Light bulb waste	Liquid/Solid	Hazardous	State-accredited vendor	TBD

Project Phase	Waste Source	Potential Waste	State	Type	Disposal Method	Est Qty (Tonnes/ Day)*
		♦ Used oils, lubricants, and filters				
	Spent oil	♦ Accidental releases of crude oil from tankers, rigs, wells, and offshore platforms	Liquid	Non-hazardous	State-accredited vendor	TBD
	E-waste	♦ Electronic devices used for administration, security, or specific processing equipment	Solid	Non-hazardous	Re-cycling through State-accredited vendor	TBD
	Animal Manure	♦ Rearing of animals	Solid	Non-hazardous	Composting	TBD
	Crop Residues	♦ Straw, stalks, and other non-grain parts of crops	Solid	Non-hazardous	Composting	TBD
	Wastewater	♦ Treatment process may generate sludge that requires management	Liquid	Non-hazardous	Treated and re-used	TBD
Decommissioning	Dismantling of structures	♦ Demolition waste (concrete, bricks, metals)	Solid	Non-hazardous	Sold/ State-accredited vendor	TBD
	End-of-life equipment	♦ Scrap metal, electrical components	Solid	Non-hazardous	Sell usable parts/ State-accredited vendor	TBD

*: The estimated quantities for each waste type are currently marked as "TBD" (To Be Determined) and will be finalised based on once the project becomes operational.

Source: ESIA Project Team (2024)

3.9 Project Schedule

The entire Anambra Mixed Industrial City (AMIC) project, including the SAPZ component, is envisioned for completion within a six-year timeframe. A phased development approach will be employed to manage the project's complexity and ensure efficient execution. This phased approach prioritises the Agricultural Transformation Centres and SAPZ within the first two years. ATCs are critical elements of the SAPZ infrastructure, playing a key role in facilitating agricultural processing, value addition, and market access for zone occupants from the initial stages.

Table 3.5 summarises the detailed schedule for the entire AMIC project development, including key investment considerations for each phase.

Table 3.5: Proposed Schedule With SAPZ Integration

Project Phase	1-6 Month	7-24 Months	25-54 Months	55-60 Months	Note on SAPZ Focus
Phase 1: Pre-Development	Feasibility study, approvals, partnerships, financing				♦ Establish project foundation
Phase 2: Master Plan & ATCs		Master plan, common infrastructure, zone design, prioritise ATCs			♦ Ensure ATCs operational by phase end
Phase 3: Zone Development			Phased zone construction and attract occupants.		♦ Integrate SAPZ infrastructure & processing
Phase 4: Zone Operations				Facilitate operations, monitor performance	♦ Begin full-scale SAPZ operations & continuous improvement

Source: Based on data from ANSG (2024)

CHAPTER 4 DESCRIPTION OF THE EXISTING PROJECT ENVIRONMENT

This chapter presents a comprehensive overview of the prevailing biophysical and socioeconomic conditions within the project area designated for the Anambra SAPZ. The project will take place in four communities of three LGAs, namely: Ogboji and Ogbunka in Orumba South LGA, Ugbene Town in Awka North LGA, and Omor in Ayamelum LGA (Figures 4.1 – 4.4).

A thorough data collection and analysis was undertaken to establish the current environment and assist in predicting potential impacts in the context of the project areas. Primary data was gathered through field surveys conducted during the rainy season (9-13 July 2024), complemented by secondary data (dry season) from the previously approved Coscharis Farms Limited Environmental Impact Assessment (EIA), 2020. The Federal Ministry of Environment (FMEnv) permitted one-season sampling. Biophysical assessments encompassed soils, groundwater, surface water, sediment, flora, fauna, air quality, and noise levels. Additionally, thirty years of meteorological data from the Nigeria Meteorological Agency (NiMet) provided a climatic context, while instantaneous weather observations during the biophysical survey enabled comparison with regional trends.

Concurrently, a socioeconomic and health baseline study was conducted in all four project communities and Aguluezechukwu in Aguata, which land forms part of the Anambra Mixed Industrial City, Ogboji. Data from the Nigeria Bureau of Statistics and the National Population Commission augmented this analysis. Community involvement through meetings, interviews, and questionnaires contributed to a comprehensive understanding of local perspectives.

The baseline data presented here is indispensable for evaluating potential project impacts and formulating effective mitigation strategies. Its comprehensiveness is crucial for ensuring the long-term sustainability and success of the Anambra State SAPZ.

Table 4.1:Summary of the data used for the ESIA

Parameter	Source	Date	Parameters
In-situ Meteorology, Air Quality, Noise, Surface Water, Groundwater, Soil and land Use, Sediment, Vegetation, Aquatic Studies, Wildlife, Socioeconomics, health study	Anambra SAPZ ESIA Field Data	July 2024	*In-situ* Meteorology, Air Quality, Noise, Surface Water, Groundwater, Soil and land Use, Sediment, Vegetation, Aquatic Studies, Wildlife, Socioeconomics, health study
Dry Season Baseline Data	Coscharis Farms Limited Environmental Impact Assessment (EIA) for the Integrated Rice Farm Project and Associated Infrastructure in Anambra State, 2020.	2020	Dry Season Baseline Data for Groundwater, Surface water and Soil
Meteorology: Temp, Rainfall, RH, and Wind	NiMet	1991-2020	Meteorology: Temp, Rainfall, RH, and Wind

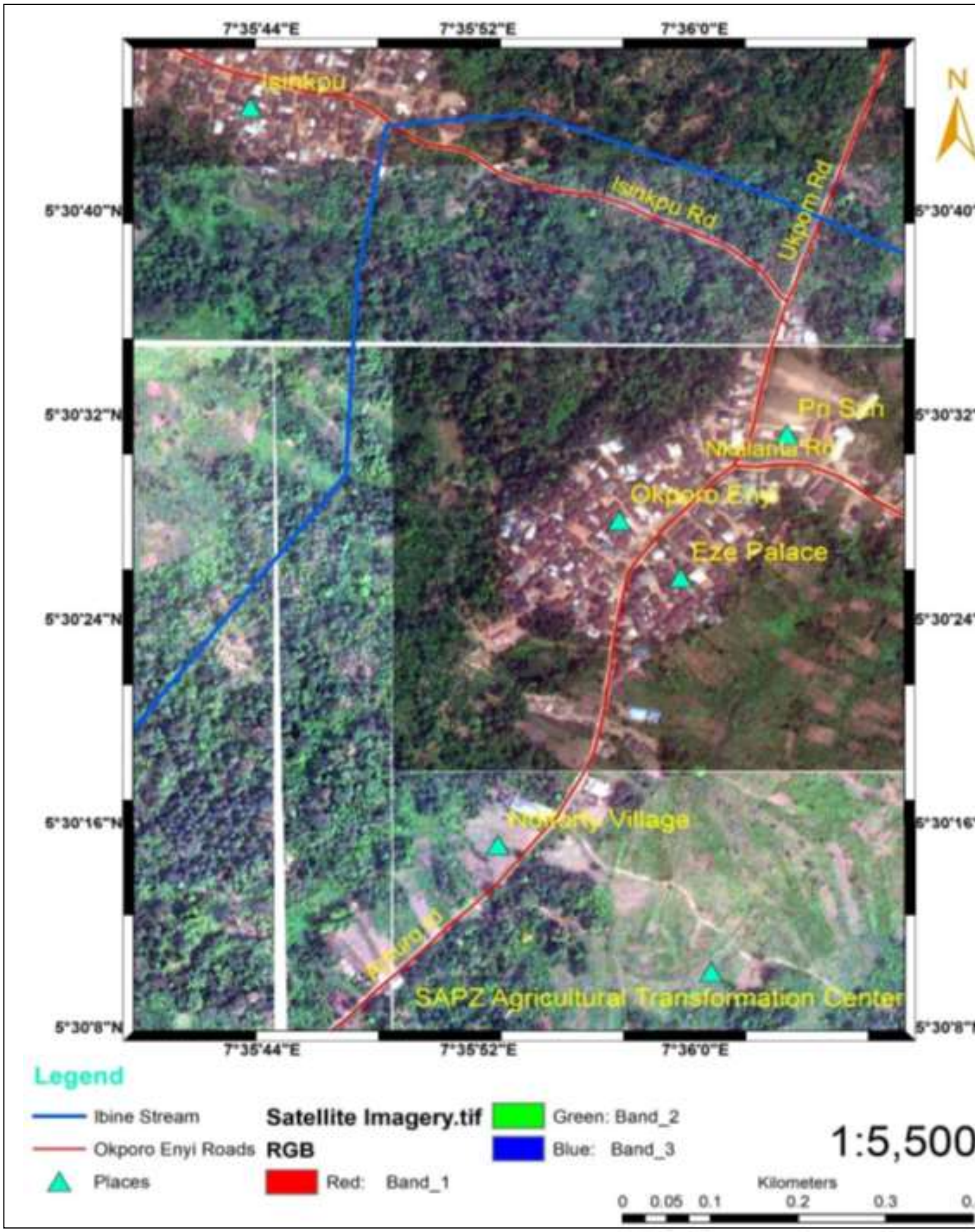


Figure 4.1: Satellite Imagery of Ogboji, Orumba South LGA

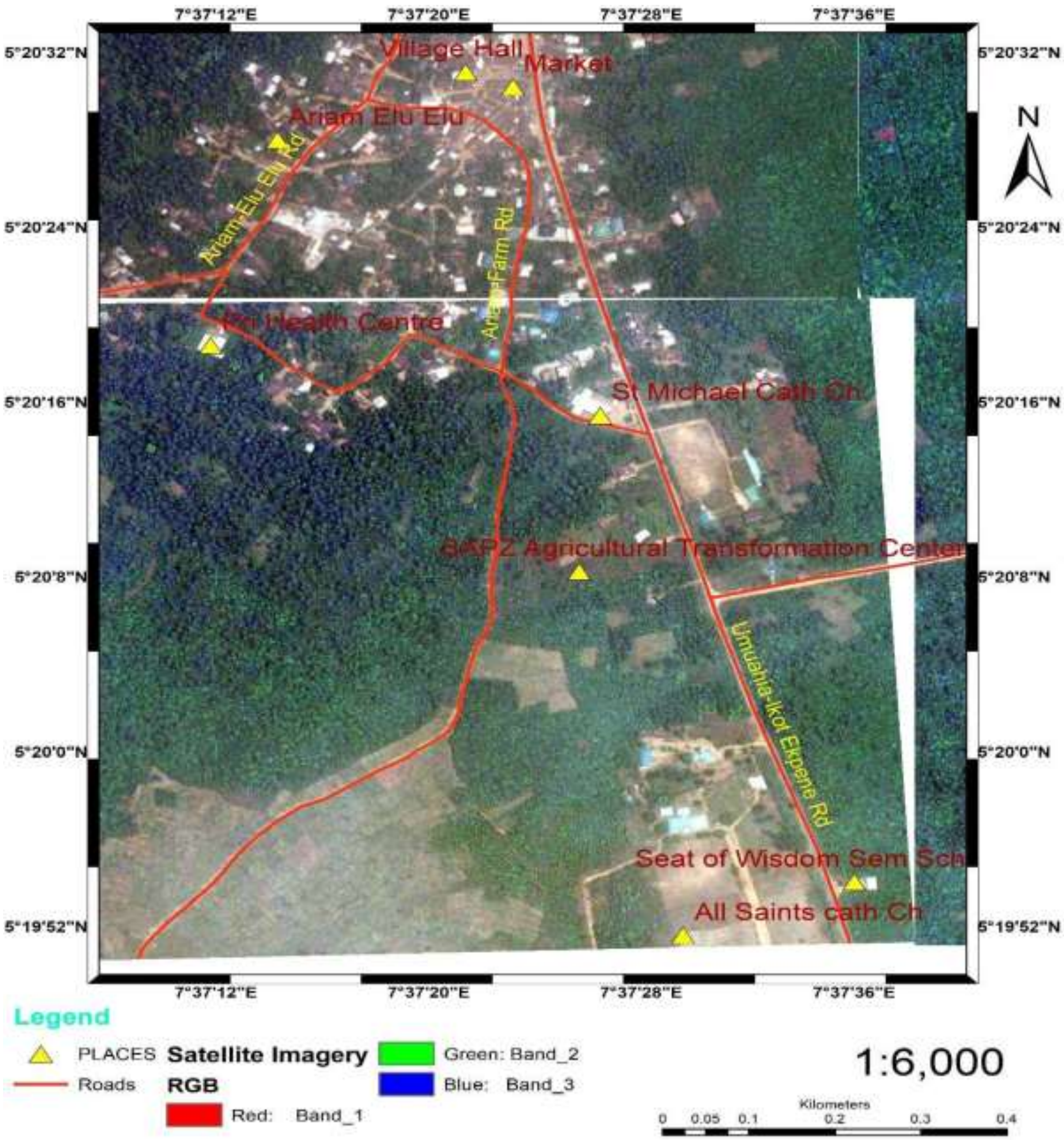


Figure 4.2: Satellite Imagery of Ugbene Town, Awka North LGA

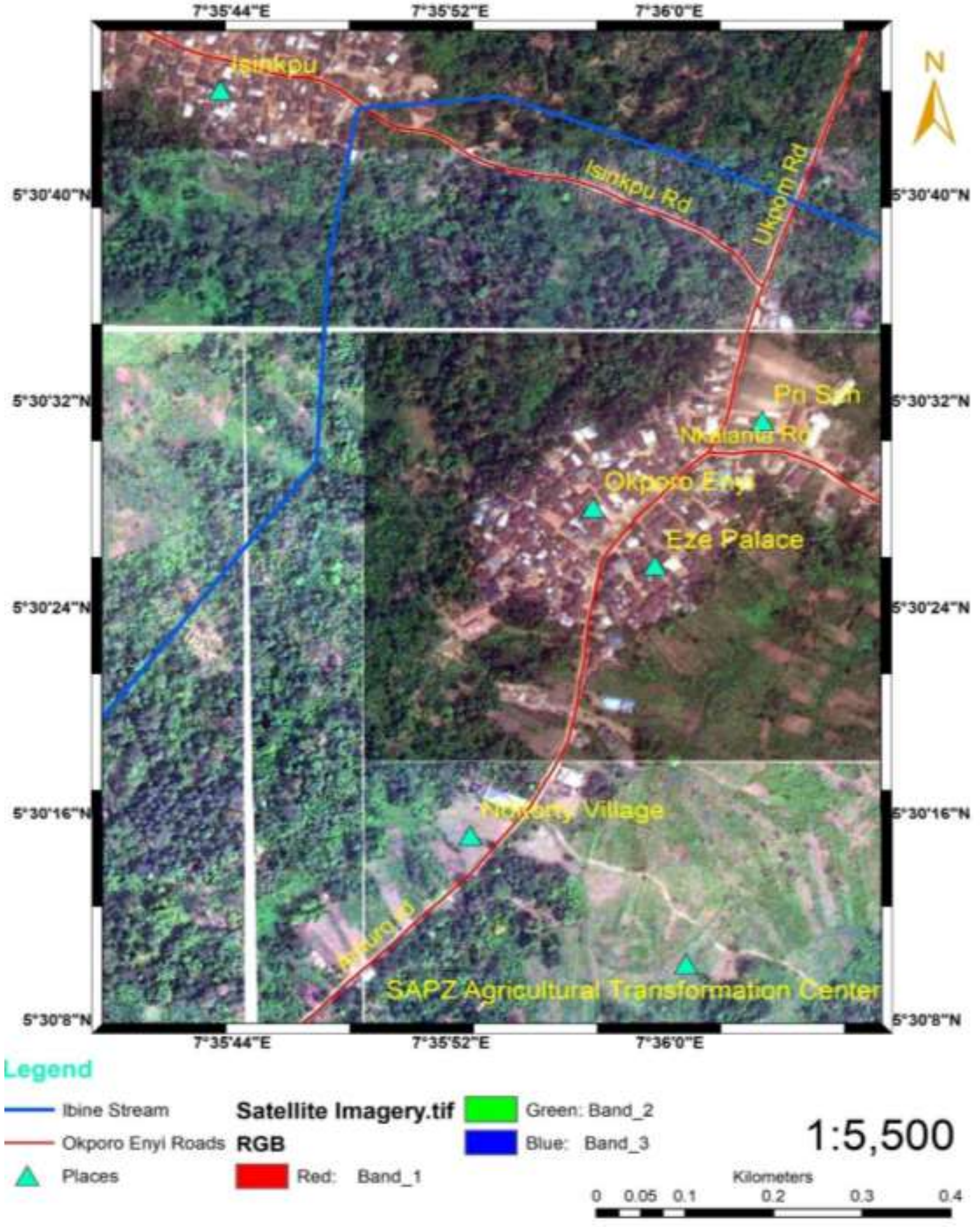


Figure 4.3: Satellite Imagery of Omor, Ayamelum LGA

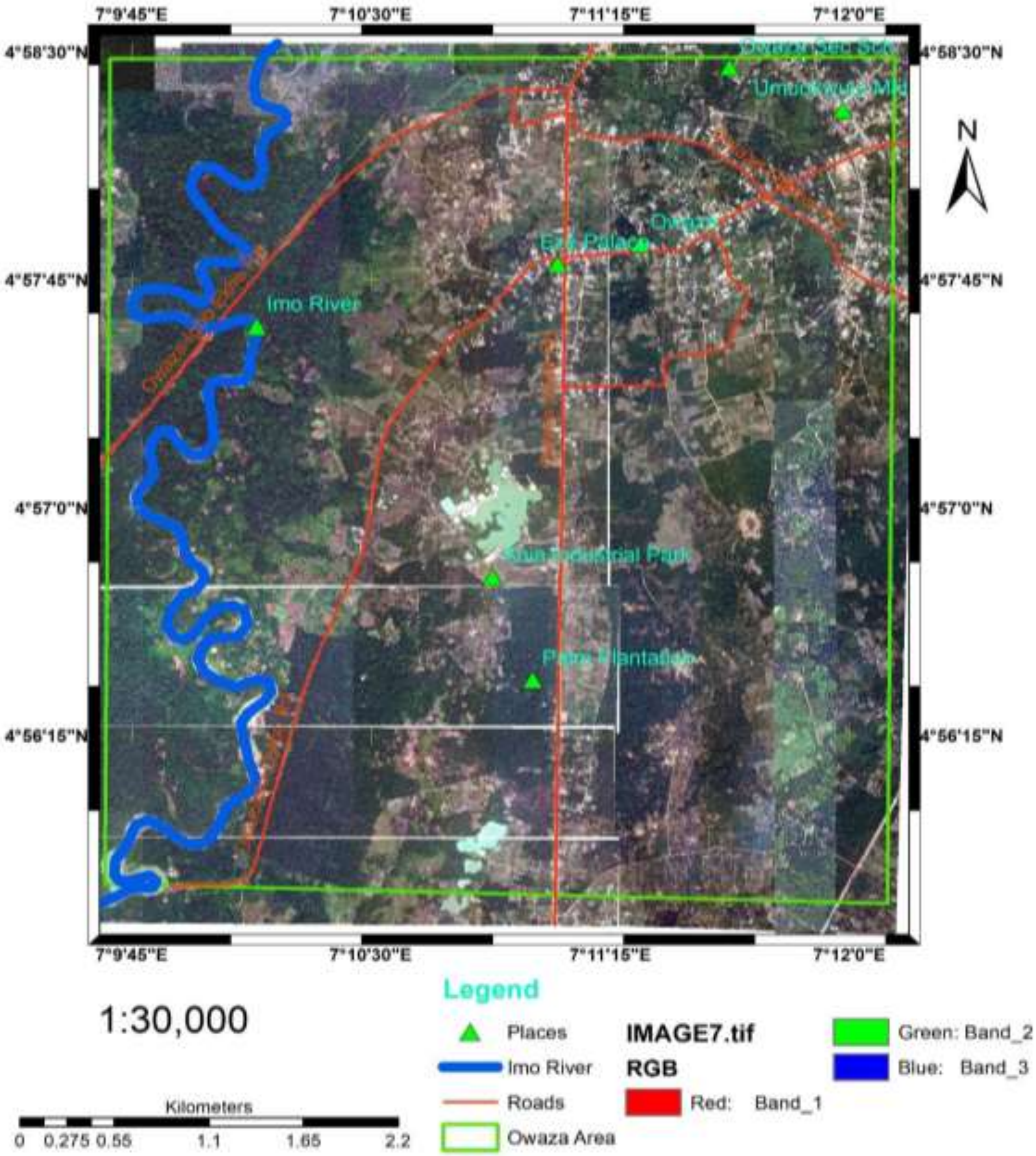


Figure 4.4: Satellite Imagery of Ogbunka, Orumba South LGA

4.1 Study Approach

Field studies and data collection for the characterisation of the baseline conditions of the proposed project environment were conducted following the approved TOR by the FMEnv. The studies covered:

- Climate and Meteorological data
- Air quality measurement
- Noise Level
- Land Use

- Landscape
- Geology
- Groundwater
- Surface water
- Sediment
- Hydrobiological studies (Plankton and Benthos),
- Water Microbiology
- Vegetation
- Socioeconomics
- Health Assessment

4.1.1 Scoping Workshop

A Scoping Workshop and Site Verification exercises were conducted on 10 July 2024 at the International Conference Centre, Awka. The exercises were attended by key stakeholders, including officers of the Federal Ministry of Environment (FMEnv), Anambra State Ministry of Environment (ANSME), Anambra State Ministry of Agriculture (ANSMA), and Anambra Investment Promotion and Protection Agency (ANSIPPA) who oversees the project on behalf of Anambra State and serves as Programme Coordinating Unit (PCU). Others are community leaders and representatives of the four communities (Ogboji, Ugbene, Omor and Ogbunka). The Scoping Workshop and Site Verification activities were supervised by officers of the FMEnv.

Plate 4.1: Scoping Workshop Pictures Showing Participants Contributing to the Discussion

Plate 4.1 Cont.: Scoping Workshop Pictures Showing Participants Contributing to the Discussion 2

Plate 4.2: Scoping Workshop Group Picture

Source: AN SAPZ ESIA Study (2024)

4.1.2 Baseline Data Acquisition Method

Baseline data was collected through literature review, reconnaissance visits, and field surveys. A multidisciplinary approach was used to characterise the project area's biophysical and socio-economic conditions.

Primary data acquisition involved comprehensive field surveys, measurements, and the collection of representative samples to describe the study area's environmental conditions. Field surveys for groundwater, hydrobiology, soil, air quality, noise, local meteorology, and socioeconomic conditions were conducted at predetermined sampling stations. Representative samples were collected to establish baseline environmental conditions for the proposed Anambra SAPZ sites. Fieldwork was conducted from the 9th to the 13th of July 2024, and socioeconomic data collection continued throughout the ESIA study. A summary of the collected data types is provided in Table 4.2.

Table 4.2: Data Collection Summary for Anambra SAPZ

S/N	Environmental Components	Sample Number /Station	Requirements
1	Surface Water	12	Physiochemistry/Heavy Metal/Microbiology
2	Sediment	4	Physiochemistry/Heavy Metal
3	Groundwater Sampling	8	Physiochemistry/Heavy Metal/Microbiology
4	Benthic/Plankton Survey	4/9	Species Identification
5	Air quality	50	PM_{10}, $PM_{2.5}$, SO_2, NO_2, CH_4, CO_2, H_2S, CO VOC and O_3.
6	Noise Measurements	50	Ambient Noise Levels at the time of sampling
7	Meteorology	10	Relative Humidity, Rainfall, Wind Speed, Air Temperature
8	Soil Sampling	50	Physiochemistry/Heavy Metal/Microbiology
9	Vegetation and Terrestrial Wildlife	4	Biodiversity study: Species identification, protected areas, and endangered species identification
10	Socio-economic Survey*	5	Project host communities

*: Aguluezechukwu town in Aguata LGA was identified as a project stakeholder since part of the proposed location for AIH falls within the community, necessitating its inclusion in socioeconomic studies.

Source: Anambra SAPZ ESIA Field Work (2024)

To ensure data quality and integrity, rigorous QA/QC protocols were implemented, covering sample collection, handling, laboratory analysis, and reporting. Chain of custody procedures were maintained. All laboratory analyses were conducted at the FMEnv-accredited Mozuk Scientific and Analytics Laboratories in Abuja, CS35 Drive 2 Corner Shop Prince and Princess Estate, Abuja, adhering to federal and international standards. The confirmation of the type and number of analysis is included as Appendix 2.

Secondary data involves identifying and analysing relevant literature to establish the project baseline characteristics. This was done through desktop studies.

4.1.3 Sampling Design

Environmental sampling was carried out in compliance with the Environmental Impact Assessment (EIA) Act CAP E12 LFN 2004 and the FMEnv EIA Procedural Guidelines 2017. Both grid and transect sampling methods were employed for the environmental parameters under investigation. Detailed sampling coordinates are presented in Table 4.3, while Figures 4.5 – 4.8 show their corresponding locations using Google Earth.

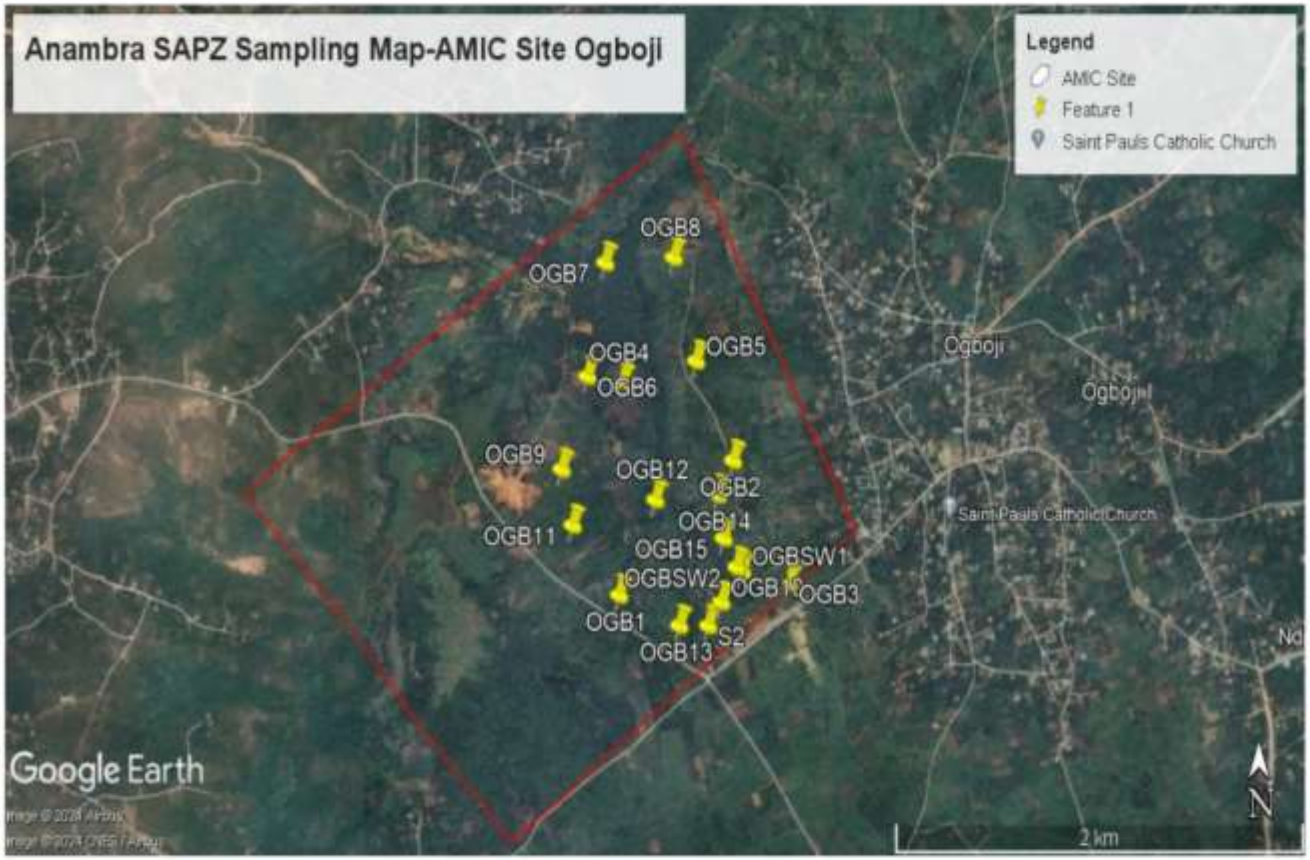
Table 4.3: Sampling Coordinates – Anambra SAPZ

S/N	Code	Latitude	Longitude	Elevation	Sample Type
	Ogboji (AMIC), Orumba North LGA				
1	OGB1	6.007689	7.134372	130	A, N, S
2	OGB2	6.012851	7.139412	129	A, N, S
3	OGB3	6.008145	7.141861	140	A, N, S
4	OGB4	6.015738	7.134520	131	A, N
5	OGB5	6.016872	7.137766	120	A, N, S
6	OGB6	6.015987	7.132971	124	A, N
7	OGB7	6.020312	7.133749	115	A, N
8	OGB8	6.020500	7.136778	119	A, N, S
9	OGB9	6.012480	7.131842°	132	A, N, S
10	OGB10	6.007405	7.138886	119	A, N, S
11	OGB11	6.010337	7.132317	119 Starting point	A, N, S
12	OGB12	6.011291	7.135965	121	A, N, S
13	OGB13	6.006527	7.137027	122	A, N
14	OGB14	6.011488	7.138730	121	A, N
15	OGB15	6.009826	7.138986	109	A, N
16	SSCTTL1	6.0218174	7.10661623	3 km from the site	S
17	OGBSW1	6.008589	7.1397977	111	SW
18	OGBSW2	6.008730	7.139553	110	SW
19	OGBGW	5.994906	7.1401426	123	GW

S/N	Code	Latitude	Longitude	Elevation	Sample Type
20	OGBGWCT	6.224074	7.224074	22km from the site	GW
	Ogbunka, Orumba North LGA				
1	OGK1	5.994683	7.278838	156	A, N, S
2	OGK2	5.997839	7.278750	155	A, N, S
3	OGK3	5.993347	7.276971	152	A, N
4	OGK4	5.990697	7.279678	148	A, N, S
5	OGK5	5.991815	7.278131	148	A, N, S
6	OGK6	5.990747	7.277844	153	A, N, S
7	OGK7	5.989843	7.277711	153	A, N
8	OGK8	5.991413	7.276987	150	A, N
9	OGK9	5.990028	7.278919	150	A, N
10	OGK10	5.992675	7.278892	154	A, N,
11	OGK11	5.994588	7.277476	154	A, N
12	OGK12	5.994106	7.275840	150	A, N
13	OGK13	5.993065	7.275003	148	A, N, S
14	SSCTTL1	6.0218174	7.10661623	17 km from the site	S
15	OGKSW1	ND	ND	ND	SW, SD, PL, BNT
16	OGKSW2	ND	ND	ND	SW, SD, PL, BNT
17	OGKSW3	ND	ND	ND	SW, SD, PL, BNT
18	OGKGW1	6.015490	7.277262	178	GW

S/N	Code	Latitude	Longitude	Elevation	Sample Type
19	OGKW2	6.0213174	7.270033	149	GW
	Omor, Ayamelum LGA				
1	OM1	6.499272	6.986133	28	A, N, S
2	OM2	6.498443	6.987652	28	A, N,
3	OM3	6.497505	6.987050	27	A, N, S
4	OM4	6.498969	6.986988	28	A, N
5	OM5	6.496291	6.985995	26	A, N,
6	OM6	6.496030	6.985000	25	A, N, S
7	OM7	6.497111	6.985051	26	A, N,
8	OM8	6.496208	6.986592	27	A, N,
9	OM9	6.497973	6.985872	27	A, N, S
10	OM10	6.498252	6.985223	27	A, N, S
11	SSCTTL2	6.3307633	6.9421742	19 km from the site	S
12	OMSW1	6.493191	7.002022	26	SW, PL
13	OMSW2	6.493942	7.0025394	25	SW, PL
14	OMSW3	6.49394	7.002594	25	SW, PL
15	OMSCT	6.4947957	7.0026748	24	SW, PL
16	OMGW1	6.499372	6.9852071		GW
17	OM GW2	6.502435	6.97708		GW
18	OM GW3	6.502596	6.980189		GW
	Ugbene, Awka North LGA				
1	UG1	6.408278	7.080497	29	A, N, S
2	UG2	6.408651	7.081757	29	A, N,

S/N	Code	Latitude	Longitude	Elevation	Sample Type
3	UG3	6.409214	7.082390	30	A, N,
4	UG4	6.408411	7.082986	29 Starting coordinates	A, N, S
5	UG5	6.407055	7.083548	29	A, N,
6	UG6	6.405916	7.084407	29	A, N, S
7	UG7	6.404947	7.083799	30	A, N,
8	UG8	6.405678	7.082693	29	A, N, S
9	UG9	6.404157	7.083207	28	A, N,
10	UG10	6.404744	7.082093	29	A, N
11	UG11	6.405602	7.081415	30	A, N, S
12	UG12	6.407220	7.081888	29	A, N, S
13	SSCTTL2	6.3307633	6.9421742	17 km from the site	S
14	UGSW1	6.407055	7.083548	29	SW, SD, PL
15	UGSW2	6.3691716	7.066927	28	SW, PL
16	UGSW3	6.3888790	7.066084	30	SW S



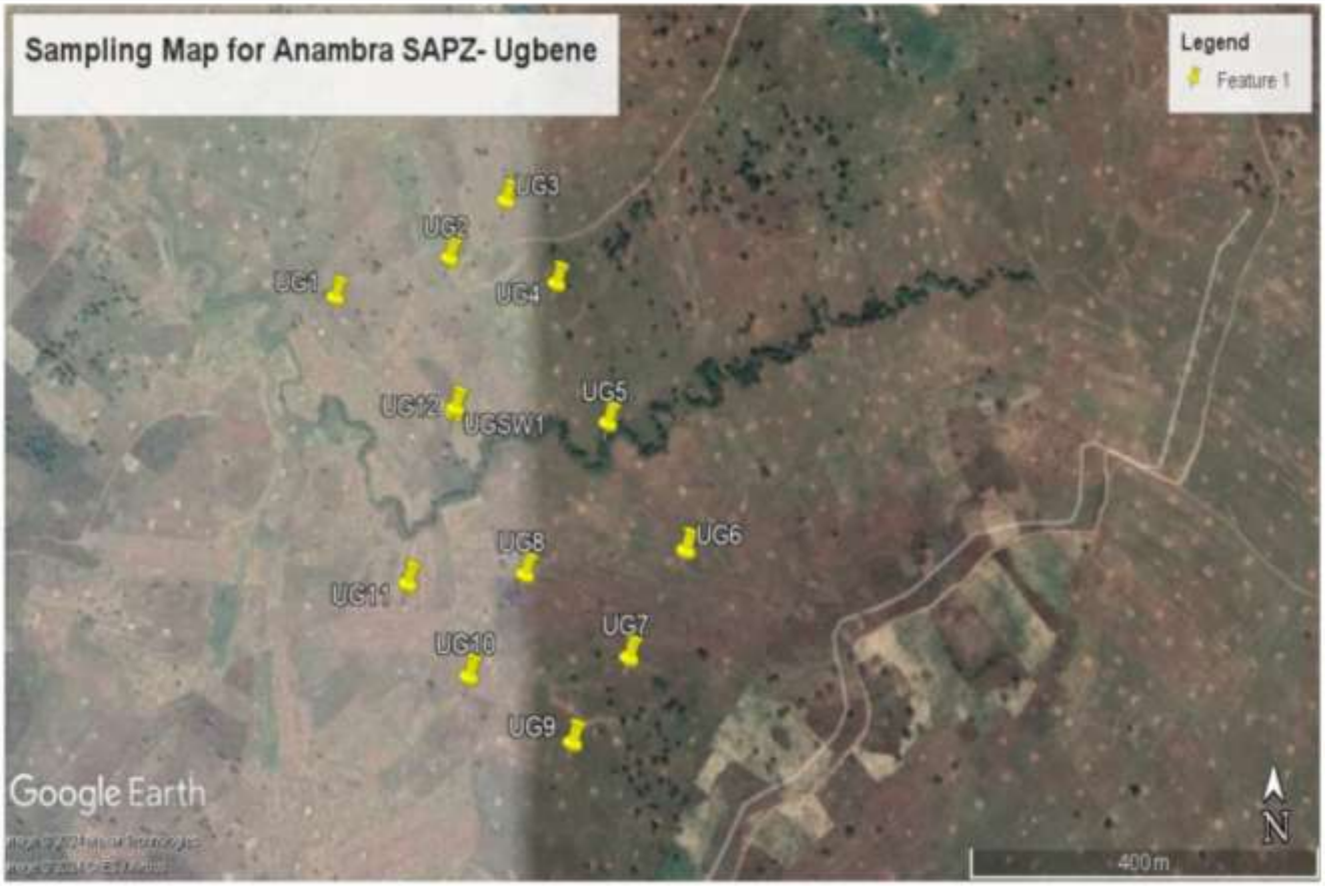
Sample Code	Sample Type
OGB1	A, N, S
OGB2	A, N, S
OGB3	A, N, S
OGB4	A, N
OGB5	A, N, S
OGB6	A, N
OGB7	A, N
OGB8	A, N, S
OGB10	A, N, S
OGB11	A, N, S
OGB12	A, N, S
OGB13	A, N
OGB14	A, N
OGB15	A, N

A: Air Quality

N: Noise

S: Soil

Figure 4.5: Sampling Map for Ogboji, Orumba South LGA



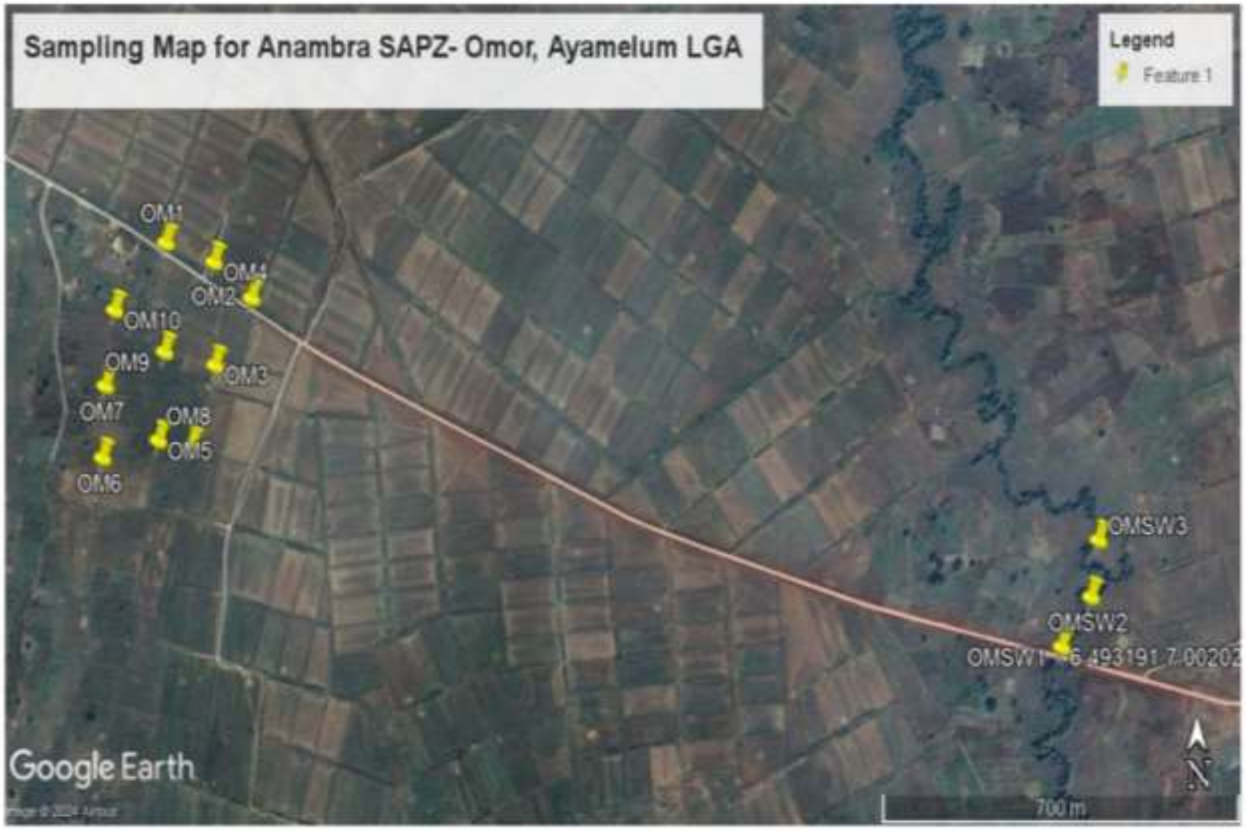
Sample Code	Sample Type
UG1	A, N, S
UG2	A, N,
UG3	A, N,
UG4	A, N, S
UG5	A, N,
UG6	A, N, S
UG7	A, N,
UG8	A, N, S
UG9	A, N,
UG10	A, N
UG11	A, N, S
UG12	A, N, S

A: Air Quality

N: Noise

S: Soil

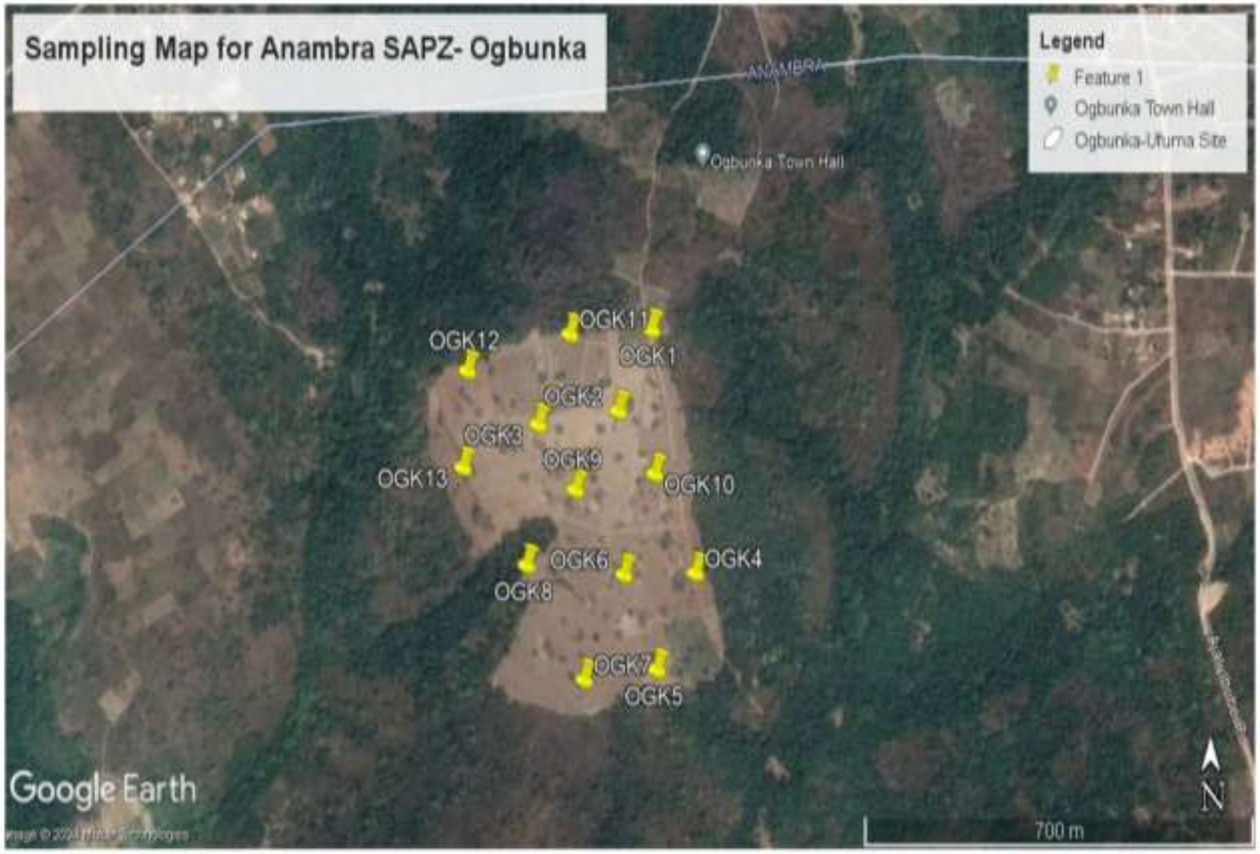
Figure 4.6: Sampling Map for Ugbene, Awka North LGA



Sample Code	Sample Type
OM1	A, N, S
OM2	A, N,
OM3	A, N, S
OM4	A, N
OM5	A, N,
OM6	A, N, S
OM7	A, N,
OM8	A, N,
OM9	A, N, S
OM10	A, N, S
OMSW1	SW, PL
OMSW2	SW, PL

A: Air Quality
N: Noise
S: Soil
SW: Surface Water
PL: Plankton

Figure 4.7: Sampling Map for Omor, Ayamelum LGA



Sample Code	Sample Type
OGB1	A, N, S
OGB2	A, N, S
OGB3	A, N, S
OGB4	A, N
OGB5	A, N, S
OGB6	A, N
OGB7	A, N
OGB8	A, N, S
OGB10	A, N, S
OGB11	A, N, S
OGB12	A, N, S
OGB13	A, N

A: Air Quality

N: Noise

S: Soil

Figure 4.8: Sampling Map for Ogbunka, Orumba South LGA

4.1.4 Biophysical Field Data Gathering

4.1.4.1 Desktop Studies

Desktop research involved a comprehensive review of existing literature pertaining to environmental, social, and health aspects within and around the project's area of influence. Literature sources included publications from the FMEnv and other reputable government agencies (National Environmental Standards and Regulations Enforcement Agency [NESREA], NUPRC, National Bureau of Statistics [NBS], National Population Commission [NPC]), peer-reviewed scientific papers (fully referenced in the Reference Section), and the previously FMEnv-approved EIA for Coscharis Farms Limited Integrated Rice Farm Project and Associated Infrastructure in Anambra State, Nigeria (2020), peer-reviewed scientific papers, cited where they appeared and with full references provided in the Reference Section. Long-term meteorological data were obtained from the Nigerian Meteorological Agency (NiMet).

4.1.4.2 Online Survey of Project Sites

The Anambra State Government (ANSG) provided the project team with the geographical coordinates of the proposed SAPZ AIH at the AMIC Agricultural Industrial Hub (AIH) and three Agricultural Transformation Centres (ATCs). To gain initial insights into the biophysical characteristics of these locations, the team conducted online assessments using available geospatial data and remote sensing imagery. These assessments provided a preliminary understanding of each site's topography, land cover, hydrology, and potential environmental sensitivities.

4.1.4.3 Reconnaissance Survey

Prior to moving to the site for the rainy season field investigation, a reconnaissance survey of the Ogboji project area was carried out on the 9th of July 2024 to confirm the sampling map and set the boundaries of the study area.

The key features of visual assessment included:

- Location and grid referencing of areas to be extensively studied.
- Nature of the areas
- Ecological characteristics of the natural community
- Slope, feature, drainage and other habitat parameters.
- Transient and resident populations of mammals in different seasons of the year
- Gross impacts/community disturbance

- Existing resource use associated with the project areas (fisheries, tourism, cultivation, forestry practices).

In line with the criteria evolved by Turnbull (1992), the study area was evaluated based on the following criteria:

- Distinctive and unusual landforms
- Unusual habitat with a rarity value
- Unusual high diversity of biological communities due to a variety of geomorphological features etc
- Provision of a habitat for a rare or endangered species
- Large areas providing a habitat for species that require such extensive areas.

4.1.4.4 Biophysical Field Sampling Procedures

The ESIA team completed the first phase of field data gathering from 9 July to 13 July 2024 during the daytime (rainy season), during which time biophysical data were collected at the four proposed project locations. Site visit preparation included planning for logistics, quality assurance, and developing a sampling strategy to meet the scope of the ESIA and regulatory requirements. Sampling was witnessed by personnel of FMEnv.

The following general sampling procedures were followed:

- Samples were collected samples sequentially following the sampling plan to prevent mixing them and obtain accurate results.
- Soil samples were collected at two depths: topsoil (0-15cm) and subsoil (15-30 cm)
- Sufficient samples were collected to ensure they were representative of the study area.
- Each sampling point was uniquely coded, and its precise coordinates were recorded using GPS technology for future reference and spatial analysis.
- Collected samples were placed in carefully labelled containers for proper identification and tracking.
- Labelled water samples were placed in an ice chest.
- 2 ml nitric acids were added to water samples for heavy metal analysis
- All samples were carefully handled to maintain sample integrity until laboratory analysis.
- Stratified random sampling was employed to study the vegetation.

This comprehensive sampling program aimed to gather reliable and representative data for the environmental and social impact assessment.

4.1.4.1-1 Field Equipment

Field equipment was gathered and cleaned to ensure, according to standard operating procedures (SOP). The certificates of measuring equipment were inspected to ensure that their calibrations were still valid.

Table 4.4 summarises the specific equipment, detection limits, and models used for *in-situ* measurement of various environmental parameters.

Table 4.4:List of *In-situ* Measurement Equipment

Parameter	Unit	Equipment	Model	Calibration Date
Air quality	ppm	Aeroquel	500 Series	5 Apr 2024
Noise	dB	Extech Sound Level Meter	407730	15 May 2024
Relative Humidity, Wind Speed and Temperature	Hanna	Extech Meteorology Meter	45170	04 Oct 2024
Water pH		Hanna	Hanna	04 Oct 2023
Conductivity	μScm^{-1}	Hanna	Hanna	04 Oct 2023
Temperature	°C	Hanna	Hanna	04 Oct 2023
Total Dissolved Solids	ppm	Hanna	Hanna	04 Oct 2023
Dissolved Oxygen	%	YSI	YSI	15 May 2024

Source: AN SAPZ ESIA Field DATA (2024)

In addition to the *in-situ* measurement equipment, the following equipment was also used by the team during sampling collection:

- Soil Sampling:
    - Soil Auger
    - Hand Trowel
    - Ziplock bags
- Biological Sampling:
    - Plankton Net
    - Benthos Sieve
    - Trowel
- Others
    - GPS

4.1.4.1-2 Laboratory Equipment and Technique

Laboratory analysis of samples followed the recommendations of APHA (20220), Goltermanet *et al*. (1978), and the US Environmental Protection Agency (EPA) 1979. Table 4.5 summarises the methodology that will be employed for analysing each parameter.

Table 4.5:Summary of Methodology for Sample Analysis

S/N	Parameter	Test method	Equipment Name and Model	Equipment Calibration Date
	Groundwater and Surface Water Sample(APHA Standard Method for Water and Wastewater Test)			
1	Atomic Absorption Spectrophotometer	Biobase N320	<0.007µg/ml	15/07/24
2	UV-Vis Spectrophotometer	LBDI-UV-5800	-	15/07/24
3	Multi-Parameter Probe	Starter 3100M	-	17/07/24
4	Analytical Balance	NJBONITALAB-MTL224	0.0001g	17/07/24
5	Laboratory Oven	SM-9023A	-	-
6	Laboratory Incubator	SM-9052A	-	-
7	Autoclave	SM-280-A	-	-
8	Colony Counter	U-Clear,J-2	-	-
9	Centrifuge	-	-	-
	Soil and Sediment Sample(American Society for Testing Materials(ASTM) Standards for Soil and Sediment Testing)			
10	Atomic Absorption Spectrophotometer	Biobase N320	<0.007µg/ml	15/07/24
11	UV-Vis Spectrophotometer	LBDI-UV-5800	-	15/07/24
12	Multi-Parameter Probe	Starter 3100M	-	17/07/24
13	Analytical Balance	NJBONITALAB-MTL224	0.0001g	17/07/24
14	Laboratory Oven	SM-9023A	-	-
15	Laboratory Incubator	SM-9052A	-	-
16	Autoclave	SM-280-A	-	-
17	Colony Counter	U-Clear,J-2	-	-
18	Muffle Furnace	-	-	-
19	Water Bath	-	-	-
20	Desiccator	-	-	-
21	Heating Mantle	-	-	-
22	Magnetic Stirrer	-	-	-
	Zooplankton Sample Analysis(EPA LG 403 Standard Operating Procedure), Phytoplankton Sample Analysis(EPA LG 401 Standard Operating Procedure), Bethnic Sample Analysis(EPA LG 407 Standard Operating Procedure)			
23	Compound Microscope	-	-	-
24	Calibrated Pipette	-	-	-
25	Counter	-	-	-
26	Analytical Balance	NJBONITALAB-MTL224	0.0001g	17/07/24
27	Small Sieve 63 and 500 µm mesh	-	-	-
28	Cellulose filter paper	-	-	-
29	Centrifuge	-	-	-

30	Syringe, 20ml	-	-	-
31	Petri Dishes	-	-	-

Source: Anambra SAPZ ESIA Field Data(2024)

4.1.4.1-3 Climate and Meteorology

To establish the meteorological conditions around the project areas, five factors were assessed: rainfall, temperature, relative humidity, wind speed, and wind direction. Historical data for these factors were obtained from NiMet Onitsha weather station, the nearest synoptic station to the project area. Additionally, relevant literature on the study area was reviewed. Furthermore, instantaneous weather conditions at each sampling point were captured using a hand-held, battery-powered, high-precision Extech Meteorology Meter Model 45170, which measures temperature, relative humidity, and wind speed. Field data was then compared with the NiMet data to verify its accuracy and to gain a more comprehensive understanding of the local meteorological conditions. This also allowed the study to identify extreme weather events, potential impacts on project design and timing, microclimates, their dynamics, and influencing factors to inform project implementation.

4.1.4.1-4 Noise and Air Quality Measurement

To investigate noise and air quality at the project sites, *in-situ* measurements of ambient noise levels and air quality parameters were taken at 15 locations in Ogboji, 10 in Omor, 12 in Ugbene, and 13 in Ogbunka for a total of 50 points. The coordinates of the sample points were determined using GPS (Global Positioning System) and are provided in Table 4.3.

Hand-held noise and air quality measuring equipment, as shown in Table 4.4, was used to monitor the following parameters over 30 minutes: sulphur dioxide (SO_2), nitrogen dioxide (NO_2), hydrogen sulphide (H_2S), carbon monoxide (CO), carbon dioxide (CO_2), volatile organic compounds (VOCs), methane (CH_4) and particulate matter ($PM_{2.5}$ and PM_{10}). Table 4.6 shows the national air quality limits, which were used as a benchmark for comparing the air quality measurements obtained during the sampling period.

Table 4.6: FMEnv and NESREA Air Quality Standards

S/N	Pollutant	Time-weighted Average	NESREA Standard Concentration In Ambient Air	FMEnv	WHO AQG
1	Sulphur dioxide (SO_2)	Annual	$80\ \mu g/m^3$		
		24 hours	$120\ \mu g/m^3$		$40\ \mu g/m3 \approx 0.015\ ppm$
		1 hour	$350\ \mu g/m^3$	$0.1\ ppm$	
		Daily Average of Hourly		$0.01\ ppm$	
2	Nitrogen dioxide (NO_2)	Annual	$80\ \mu g/m^3$		
		24hours	$120\ \mu g/m^3$		$25\ \mu g/m^3 \approx 0.013\ ppm$
		1 hour	$200\ \mu g/m^3$	$0.04\ ppm - 0.06\ ppm$	

S/N	Pollutant	Time-weighted Average	NESREA Standard Concentration In Ambient Air	FMEnv	WHO AQG
				$(75.0\ ug/m^3 - 113\ ug/m^3)$	
3	Carbon monoxide (CO)	24 hours			$40\ mg/m^3 \approx\ 3.43\ ppm$
		8 hours	5.0 mg/m^3	$20\ ppm\ (22.8\ ug/m^3)$	
		1 hour	$10\ mg/m^3$	$10\ ppm\ (11.4\ ug/m^3)$	
	Particulate Matter ($PM_{2.5}$)	Annual			$5\ \mu g/m^3$
		24 hours			$15\ \mu g/m^3$
4	Particulate Matter (PM_{10})	Annual	$60\ \mu g/m^3$		
		24 hours	$150\ \mu g/m^3$	$250\ \mu g/m3$	
		1 hour		$*600\ \mu g/m3$	
5	Ozone (O_3)	24 hours			$100\ \mu g/m^3 \approx\ 0.05\ ppm$
		8 hours	$100\ \mu g/m^3$		
		1 hour	$180\ \mu g/m^3$		
6	Ammonia (NH_3)	Annual	$0.2\ mg/m^3$		
		24 hours	$0.6\ mg/m^3$		

*: Concentration not to be exceeded more than once a year

Sources: NESREA Air Quality Control Regulations 2014, FMEnv Guidelines and Standards for Industrial Effluent, Gaseous Emissions and Noise Limitations 1991 and WHO Global Air Quality Guidelines 2021

Plate 4.3: Air quality *In-situ* Measurement

4.1.4.1-5 Soil Sampling Methodology

Soil samples were obtained from predetermined locations identified using Google Earth satellite imagery and geographical coordinates. A stainless-steel auger was used to collect two soil samples, topsoil (0-15 cm) and subsoil (15-30 cm), at each sampling point. Each sample was placed in a labelled Ziplock bag, and all samples were transported to the laboratory for analysis. A total of 76 samples were collected across the four project sites control: Ogboji: (9 topsoil and 9 subsoil samples), Omor (5 topsoil and 5 subsoil samples), Ugbene (6 topsoil and 6 subsoil samples), Ogbunka (6 topsoil and 6 subsoil samples), control (2 topsoil and 2 subsoil samples), bringing the total number of samples to 56. A Garmin Etrex GPS device was used to record accurate sample locations.

Plate 4.4: Soil Sampling at Ogboji Location

4.1.4.1-6 Groundwater and Surface Water Sampling

Groundwater samples were collected from existing boreholes, where available, around the communities. Surface water samples were collected from streams closest to the project sites, including Eso Stream in Ogboji, River Uruokpukpo in Ogbunka, River Otakpu in Omor and River Nnamuzu in Ugbene. 8 groundwater samples were collected as follows: 3 samples in Omor, 2 in Ogbunka, 1 in Ogboji, and 2 controls. Groundwater was not available in the community of Ugbene, as the people rely on rainwater and streams for their water needs.

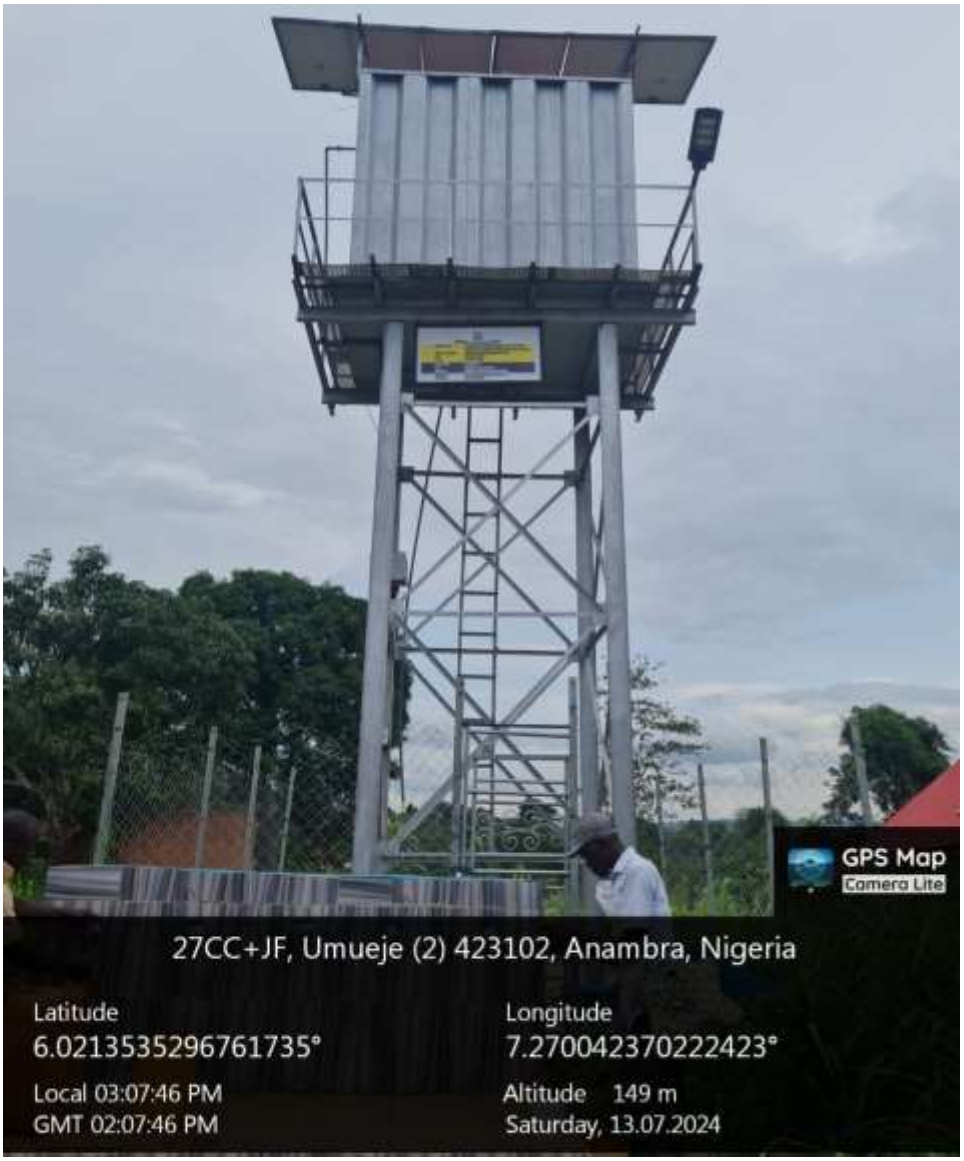


Plate 4.5: Borehole sampling at Ogbunka, Orumba SOuth LGA

A total of 12 surface water samples were also collected, with samples taken upstream, midstream, and downstream. However, two samples were collected at Ogbojii due to the inaccessibility of the downstream location. An additional sample was collected as a control at a location in Omor that is secluded from the stream, about 200 m from the upstream At each water sampling point, samples for specific analyses were collected in designated containers. Samples for physiochemistry were collected in one-litre polyethylene bottles while those for heavy metals were collected in separate one-litre glass containers.

All samples for heavy metal analysis were fixed with 1% nitric acid and were kept cool in insulating materials with ice chests, labelled clearly with the type of sample, the purpose of collection, location, date, and time of collection, and then transported to the laboratory for further analysis.

The ice helps to preserve the integrity of the samples by slowing down biological processing while maintaining chemical stability. Nitric acid helps to prevent heavy metal precipitation,

Each sample analysis was conducted according to the standard operating protocols developed by the US Environmental Protection Agency (US EPA) or the American Public Health Association (APHA) (2022) methodologies for water analysis. These standards are approved by the Federal Ministry of Environment (FEPA, 1991).

Plate 4.6: *In-situ* Measurements of Selected Water Quality Parameters

Sample Handling

Sample handling was carried out as far as possible in accordance with FMEnv guidelines. Where the guideline cannot be followed strictly for safety or logistic reasons, other proven, scientifically acceptable methods of sample collection and handling were used, for example by storing samples in ice chests in the field prior to laboratory analysis. All samples collected were properly sealed and labelled. Samples sent to the laboratory for analysis were accompanied by a duplicate copy of this information. All movements of the samples were included in the samples' chain of custody (CoC). Basic information was recorded together with the results of analysis, in a register.

i. Sample Preservation

Physicochemical parameters including potential of hydrogen (pH), temperature, conductivity, total dissolved solids, and dissolved oxygen were measured *in-situ* using appropriate meters. Samples for subsequent analysis of heavy metals and total hydrocarbons were collected and preserved according to standard protocols. These samples underwent pH adjustment and chemical pretreatment before laboratory analysis. Field samples were stored in ice chests and transferred refrigerator in the laboratory prior to analysis. All samples were analysed within two weeks of collection, following APHA (2022) methodologies.

ii. Analytical Quality Control

Standard analytical methods outlined in the APHA manual were employed for water quality assessments (Table 4.7). Trace metal concentrations were determined using atomic absorption spectrophotometry with appropriate calibration standards. High-purity analytical-grade reagents were used exclusively for solution and standard preparation. Rigorous laboratory practices, including equipment decontamination and the analysis of blank and standard samples, were implemented to ensure data accuracy and reliability.

Table 4.7: Methods of Chemical Analyses for water samples

Parameter	Method
pH	Potentiometric
Appearance	Human Receptor
Total Dissolved Solid (mg/L)	Gravimetric
Salinity Brix %@ 20 ℃	Refractometric
Total Solid (mg/L)	Gravimetric
Conductivity (µS/cm)	*In-situ*
Temperature (℃)	Electrode thermometer
Colour (PCU)	Photometric
Dissolved Oxygen (m/l)	Electro-membrane
Total chloride (mg/L)	Argentometric
Total hardness (mg/L)	Gravimetric
Total Suspended Solid (mg/L)	Gravimetric
Total Alkalinity (mg/L)	Titrimetric
Bicarbonate (mg/L)	Titrimetric
COD (mg/L)	Titrimetric

Parameter	Method
Calcium (mg/L)	Ethylenediamine Tetra Acetic Acid (EDTA) Titrimetric
Magnesium (mg/L)	EDTA Titrimetric
Calcium (mg/L)	EDTA Titrimetric
Magnesium (mg/L)	EDTA Titrimetric
Phosphorus (mg/L)	Ascorbic acid
Nitrite (mg/L)	Diazotisation
Nitrate (mg/L)	Ultraviolet (UV) Spectrophotometer
Ammonia (mg/L)	Phenate Spectrophotometric
Phosphate (mg/L)	Ascorbic acid
Sulphate (mg/L)	UV Spectrophotometer
All heavy metals	Atomic Absorption Spectrometer (AAS)

Source: AN SAPZ ESIA Field Study (2024)

4.1.4.1-7 Microbiology (Water, Soil and Sediment)

Water, soil, and sediment samples for microbiological investigation were collected in sterile containers and correctly labelled according to their locations and the date of collection. Upon arrival at the laboratory, samples underwent microbiological analysis to determine the presence and abundance of microbial populations. Parameters analysed included total bacteria count (TBC), total fungi count (TFC), total coliform count (TCC), bacteria and fungi, *Bacillus* spp., *Pseudomonas aeruginosa,* and faecal coliform. Appropriate positive and negative controls were included in all analyses. Statistical analysis was performed to determine significant differences in microbial populations among sampling sites.

Total Bacteria and Fungi Count

TBC and TFC were determined by plating serial dilutions of samples onto nutrient agar and potato dextrose agar for bacterial and fungal enumeration, respectively. Plates were incubated at 37°C for 48 hours under aerobic conditions. Colony-forming units (CFU) were counted and expressed as CFU/g for soil or CFU/100ml for water.

Total Coliforms

TCCs were enumerated using the membrane filtration technique. A 100 ml volume of water sample was filtered through a sterile membrane filter with a pore size of 0.45 μm. The filter was placed on MacConkey agar and incubated at 37°C for 24 hours. Typical coliform colonies (pinkish, with or without black centres) were counted and expressed as colony numbers per 100 ml of water.

4.1.4.1-8 Sediment

Accessibility and safety concerns limited the type and number of samples that could be collected for benthos, plankton, and sediment. Where collected, sediment samples were taken from shallow depths using a pre-cleaned silicone spatula. Sediment samples were collected from the top 0-2 cm depth of the water body at locations corresponding to surface water sampling points. This co-location of sampling points allows for a more comprehensive understanding of the potential interaction between the water column and the underlying sediments. The top 0-2 cm layer of the sediment was targeted as it typically has the highest concentration of contaminants and reflects recent depositional events (Thompson, 2018). The sampling strategy aimed to gather information on various aspects of the sediment, including physiochemistry characteristics and microbial activity Approximately 100 g of sediment was collected into rinsed, labelled Ziplock bags. Samples were stored in a cooler with ice packs and transported to the laboratory for immediate analysis.

Study Limitations

While collecting sediments from shallow depths facilitates the assessment of sediment-water interactions, the limited number of samples may underestimate biodiversity and provide a biased representation of the overall ecosystem. Consequently, the results were interpreted cautiously, considering the potential limitations of the dataset.

4.1.4.1-9 Hydrobiology Studies

Understanding the hydrobiology of surface waters is crucial for assessing the health and ecological balance of aquatic environments, particularly in Nigerian rivers (Ogbeibu and Anagboso, 2004). Hence the sampling methodology employed in this study aims to provide comprehensive data on the biological components of the surface water, including phyto and zooplanktons, macroinvertebrates (benthic species) and microorganisms. These biological indicators are essential for evaluating water quality, identifying potential sources of contamination, and understanding the overall ecological dynamics of the water body (Odume *et al.*, 2015).

Collection of phytoplankton and zooplankton samples

Plankton samples were collected using a 55 µm mesh size plankton net, which was lowered into the river for two minutes. The samples are concentrated and transferred into properly labelled 500 ml plastic containers with screw caps. Collected samples were preserved in 4% unbuffered formalin before being transferred to the laboratory for analysis.

Plankton Analysis

Plankton analysis followed the method described by Onyema and Ojo (2008). Plankton samples were concentrated by sedimentation over a minimum of two days. The resulting concentrated sample was then homogenised and small aliquots were mounted on glass slides for microscopic examination. This process was repeated five times per sample.

The organisms were identified and counted under a compound microscope equipped with a calibrated eyepiece. Abundance data were calculated as the average number of individuals per millilitre. Taxonomic classification followed Barnes *et al*. (1993), while species identification was verified using established literature (Newell and Newell, 1966; Round, 1965; Wimpenny, 1966; Waife and Frid, 2001; Gibbons, 2001). Zooplankton community structure was assessed using diversity, richness, and evenness indices.

Collection of Macroinvertebrate (Benthos) Samples

Samples for macrobenthic analysis were collected by sieving sediment samples through a 0.5 mm mesh net, which was thoroughly cleaned using river water from the site to avoid cross-contamination. Care was taken to maintain the integrity of the benthic organisms during the sieving process. The collected samples were placed in labelled Ziplock bags and preserved in a 10% buffered formalin solution. Samples were then stored in ice coolers to maintain their condition until laboratory analysis. All sampling equipment was thoroughly cleaned between sampling events to ensure no contamination occurred.

Macroinvertebrate Identification

Macroinvertebrates were identified to the lowest practical identification level—typically genus or species. If an animal was a member of one of the "minor" taxonomic groups, identifications might only be to that higher taxonomic level.

Statistical Analysis

The following indices were used to characterise the animal community structure:

i. Total Plankton Abundance (N):

$$N = \sum n_i$$

where

N = total abundance of all species

n_i = number of individuals in each species.

ii. Species Diversity (S): The count of distinct species in the samples.

$$S = Number\ of\ different\ species\ present$$

iii. Shannon-Wienner Diversity Index (H): The index indicates both the number of plankton species and their relative abundance within the community. The higher the index the greater the diversity. The result ranges from 0 (low diversity) to 4 (high diversity).

$$= \sum^{S} \left(\frac{N_i}{N}\right) . \log_2 \frac{N_i}{N}$$

where

N = total number of individuals across all species.

N_i = number of individuals in each species (Abundance of species i).

iv. Menhinick Index (D): Measures the species richness relative to the total abundance

$$D = \frac{S}{\sqrt{N}}$$

Where

S = number of species and N = total number of individuals

v. Margalef's Index (d): Assesses taxa richness, considering both the number of species and the abundance of individuals.

$$d = \frac{S-1}{In(N)}$$

where

S = number of taxa (species or other taxonomic groups).

N = total number of individuals(Abundance)

In = natural logarithm

vi. Equitability Index (j): Equitability (or Evenness) is derived by dividing the Shannon-Wiener Index (H') by the natural logarithm of the total number of species (S). It reflects how evenly (uniformly) individuals are distributed among the taxa

$$j = \frac{H}{In(S)}$$

where H = Shannon-Wienner Diversity Index

$In(S)$ = logarithm of the number of species in the population

vii. Simpson's Dominance Index (D): Gives the probability that two individuals randomly selected from a sample will belong to the same species, emphasising the dominance of common species.

$$D = \sum \left(\frac{n_i}{N}\right)^2$$

where n_i = abundance of species i

N = total number of individuals (abundance)

4.2.2.9-1 Vegetation Studies

A standard methodology was employed to collect baseline information on plant life at the project site. This methodology focused on specific floral groups (taxa). Floristic parameters assessed include growth habits, species diversity and richness, identification of alien species and documentation of indigenous uses of plants.

The project team adopted a random sampling methodology where the team walked through the vegetation to observe the plant species. This methodology was applied because the project areas were mostly secondary forests with cultivated areas, harbouring crops like rice, maize, cassava, melon etc., either as a multi-cropping or mono-cropping enterprise. Furthermore, security concerns preclude the team from spending overly too much time during the surveys. To address the issue of underreporting species diversity, the project team supplemented field observations with interviews with the locals about the occurrence of species reported in the literature that are known to commonly occur in similar vegetation types (Ekwealor *et al.*, 2020, Ratnam *et al.*, 2011; Floyd, 1969)

- **Plant Identification and Data Collection**

Plants were identified to the species or genus level in the field or later with the aid of a digital plant application, utilising immediate recognition techniques. Plants not immediately recognised were later identified using appropriate literature, manuals, checklists, and botanical floras (Akobundu & Agyakwa, 1998; Etukudo, 2003; Aigbokhan, 2014). Species found during the survey were recorded. Data was collected on various aspects of the plants, including species, habitat type, growth habits, and indigenous and local names. The IUCN Red List of Threatened Species database was used to determine the IUCN status of identified species.

- **Data Presentation**

The results of the vegetation survey will be presented in a tabular form, showing the following information for each identified species.

- Botanical Name
- Common Name
- Family
- Growth Habit
- Use
- Abundance
- IUCN Status

4.2.2.9-1 Wildlife

The wildlife within the study area was evaluated using a combination of field surveys and qualitative methods, such as interviews of hunters according to Lamprey (1963). Wildlife surveys were integrated with the existing vegetation walk-throughs to optimise data collection efficiency to provide a baseline understanding of the wildlife community utilising in the areas covered by the transects. The target species for the wildlife study were mammals, birds (Aves), and herpetofauna native to the area.

In addition to field surveys, residents with knowledge of the area were interviewed about wildlife occurrences. This can be a valuable source of information on mammals, birds (Aves), and reptile/amphibian (herpetofauna) species native to the area, particularly for elusive or nocturnal species (Lamprey, 1963).

Limitations to Study Wildlife Approach

- Daytime walkthrough surveys conducted during daylight hours may miss nocturnal or cryptic wildlife species.

- Survey might miss species with larger home ranges that do not use the specific walkthrough areas.
- Many species might also hide or run away at the sound of human approach. Local ecological knowledge.
- interviews may be limited by recall bias or incompleteness of information.

4.1.4.5 Safety Procedure

In compliance with GGCL health and safety policies, all field staff followed the following safety procedures:

- Complied with all Local, State, and Federal legislations on health, safety, environment, community affairs, and security.
- Field Assistants were employed from the project host community.
- Designated a project safety officer that ensured compliance with all safety regulations.
- All personnel were kitted with the appropriate PPE.
- Provided adequate security for equipment and personnel on the field.
- Field staff respected customs, sacred places, and practices of project host communities.
- All technical personnel were duly certified as competent.
- First-aid kit was provided in the field.
- No working in isolation under any circumstances was allowed.

4.1.4.6 Quality Control and Assurance Plan

To ensure a high level of reliability and repeatability of our analysis, the study followed a comprehensive quality control and assurance protocol as described below.

- **Pre-sampling Preparations:** Equipment Decontamination: Sampling equipment, such as nets, samplers, and trowels, was thoroughly cleaned before use to prevent cross-contamination between sampling sites. Decontamination was achieved by washing equipment with detergents, rinsing with distilled water, and allowing it to dry before reusing. Pre-cleaned containers were chosen for different sample types to minimise contamination and ensure sample integrity.
- **Use of Equipment Checklist:** An equipment checklist was used before field visits to ensure all necessary tools and materials were prepared and functional.
- **Sampling Templates:** Sampling templates were used to ensure all necessary field data were collected consistently.
- **GPS Usage:** A GPS was employed to accurately record sampling points and locations.
- **Daily Fieldwork Meetings:** Daily meetings were held after each day of fieldwork to

review procedures, address issues, and plan for subsequent activities.

- **Standardised Sample Collection and Handling:** The study followed established environmental sampling guidelines. Where logistical and safety considerations precluded strict compliance with these guidelines and standards, other proven, scientifically acceptable methods of sample collection and handling were used.
- **Sample Storage and Preservation:** Samples were appropriately stored and transported in ice chests and in refrigeration or freezers in the laboratory to minimize degradation. Specific preservation methods were adopted for different sample types to ensure integrity during storage. For heavy metal analyses, samples were preserved with 1:1 nitric acid.
- **Equipment Calibration**: To ensure the accuracy and reliability of water quality data, all field and laboratory equipment used in field measures and laboratory analysis were within their calibration validity and had been calibrated according to the manufacturer's instructions and documented to maintain traceability.
- ***In-situ* Measurements:** *In-situ* measurements of key unstable water parameters like dissolved oxygen (DO), total dissolved solids (TDS), conductivity, and temperature were taken directly at the sampling site to capture the most accurate and immediate reading.
- **Laboratory Analysis:** Analytical instruments were within their valid calibration periods. Internationally recognised analytical standards (e.g., APHA for water quality) were adopted for laboratory analysis.
- **Statistical Analysis:** Proper instrument calibration and standardised observation procedures minimised errors in field data collection, including those due to instrument limitations and observer bias. Statistical analysis, including the calculation of mean and variance, was used to assess the confidence level in the results, with a low variance relative to the mean indicating a good representation of the sampled environment.
- **Data Management:** Data coding forms facilitated accurate and direct data entry from the field. Samples were properly labelled with essential information, including sample type, collection purpose, location, date/time, and photograph details. A chain of custody (CoC) procedure was used to track sample movements. A duplicate copy of sample information and the chain of custody form was submitted alongside the samples to the laboratory, where a sample register was maintained for record-keeping.

4.1.5 Socioeconomic Environment

Understanding the socioeconomic baseline is crucial for assessing the current state of a community before implementing any interventions or projects. This baseline encompasses various aspects such as demographics, economic activities, education levels, health status, and living conditions. By establishing a comprehensive baseline, the impact of the SAPZ II developments can be effectively identified and managed, ensuring that they address the community's needs. The socioeconomic baseline data provides a critical foundation for understanding the potential impacts of the project on local communities, aiding in the identification of vulnerable groups, the assessment of potential risks, and ensuring that project benefits are equitably distributed.

4.1.5.1 Approach to Socioeconomic Study

The methodology used to gather the socioeconomic baseline data, including the tools, techniques, and sources utilised, is described in Section 4.3 of this report, which outlines the systematic approach taken to ensure the accuracy and relevance of the data collected.

4.2 Biophysical Baseline Characteristics of Project Areas

Understanding the baseline biophysical environment is crucial for assessing the potential environmental impacts of the project and for developing effective mitigation strategies. This section provides an in-depth analysis of the natural conditions within the project areas, including climate, air quality, geology, hydrology, soil characteristics, vegetation, wildlife and hydrology. These baseline findings offer a comprehensive account of the current biophysical state of the areas, serving as a reference point for measuring changes and ensuring that project activities are environmentally sustainable.

The project areas are situated within Anambra State, which lies between latitudes 5.6904° N and 6.8041° N and longitudes 6.6294° E and 7.3386° E (Figure 1.1), covering 4,844 km². The state is bordered by Imo and Rivers States to the south, Enugu State to the east, Kogi State to the north, and the River Niger to the west. Its topography varies from low-lying floodplains along the River Niger—a prominent geographical feature—to higher elevations in the northern regions. These geographical variations influence local climate patterns, drainage systems, and vegetation, creating a diverse biophysical landscape that is evident in the proposed project locations.

Given these diverse natural features within Anambra State, understanding the baseline biophysical environment is even more critical. The findings from this analysis provide essential context for evaluating the potential environmental impacts of the project and ensuring that any planned activities adhere to sustainable environmental practices.

4.2.1 Climate and Meteorological Studies

Anambra State falls under the tropical monsoon (Am) climate under the Köppen classification system. This climate type is characterised by high temperatures and significant seasonal variations in precipitation, resulting in distinct rainy and dry seasons. Average annual temperatures are consistently high, typically ranging between 26°C and 28°C, with minimal variation between seasons. The rainy season typically lasts from April to October and is marked by heavy rainfall, while the dry season lasts from November to March, with a significant reduction in rainfall. Transitional months, such as March and November, exhibit gradual shifts in temperature and humidity.

The ESIA team used 11 years of meteorological data from the NiMet observation centre in Onitsha to establish the climate of the study areas. This data included rainfall, temperature, relative humidity (RH), wind speed (WS), and wind direction. Monthly and seasonal averages were calculated to identify trends and variations in these climatic factors. The historical data were compared with field weather conditions measured during the study, focusing on temperature, relative humidity, and wind speed. Field data were recorded during daytime hours (10 am to 4 pm) at Omor (10 July 2024), Ogboji (11 July 2024), Ugbene (12 July 2024), and Ogbunka (13 July 2024), as shown in Table 4.8.

This approach ensured a comprehensive understanding of the climate, considering both long-term regional trends and specific, localised conditions observed during the field study. The analysis indicated some variations between historical averages and recent field measurements, potentially influenced by local microclimatic conditions and environmental factors unique to each study site.

Table 4.8: Summary of Observed Meteorological Parameters Across the Project Locations (July 2024, Rainy Season)

Date	11-Jul-24			12-Jul-24			10-Jul-24			13-Jul-24		
Period	**Daytime**											
Location	**Ogboji**			**Ugbene**			**Omor**			**Ogbunka**		
Statistics	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
RH (%)	51.1	64.4	60.4	58.3	62.2	60.4	0.9	6.3	2.71	58.1	62.3	60.1
WS (m/s)	0.9	2.6	1.53	0.6	2.7	1.4	31.3	36.2	33.36	0.7	2.6	1.5
Temp (°C)	29.9	38.3	30.9	29.5	33.7	31.4	45.9	56.9	49.77	28.3	34	30.9

Source: AN SAPZ ESIA Field Data (2024)

4.3.1.1 Rainfall

Rainfall in the study area is generally high and falls all year. Rainfall peaks between June and September, as indicated by the data obtained for the NiMet meteorological station in Onitsha, Anambra State. The data indicated that the average annual rainfall was 1825.56 mm during the period in Anambra State. The driest month was January when the average rainfall was 2.37 mm during the 11 years, while the corresponding wettest month was June when the average monthly rainfall was 287.85 mm (Figure 4.9).

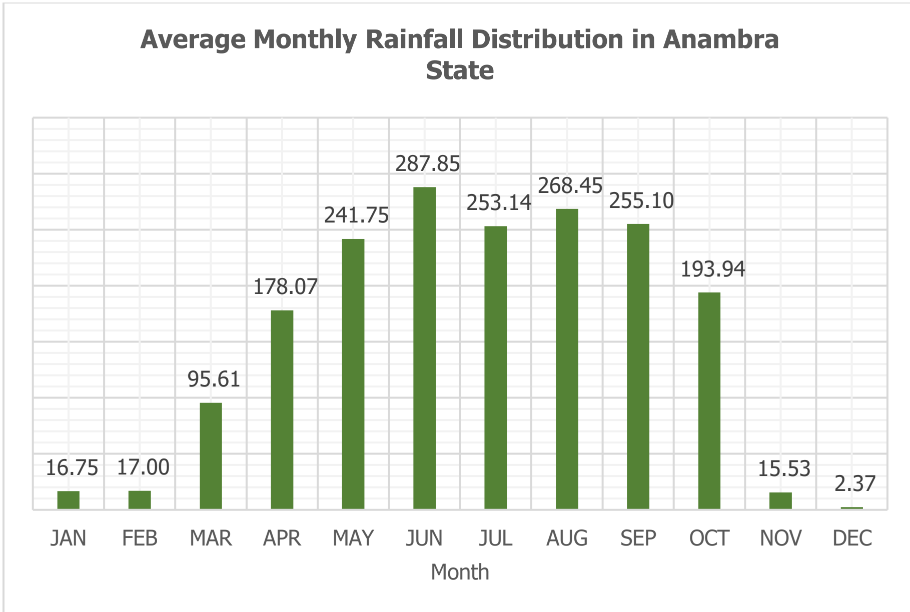


Figure 4.9: Average Monthly Rainfall Distribution in Onitsha, Anambra State (1991 to 2020)
Source NiMet

4.3.1.2 Temperature

The overall average monthly temperature was 28.20°C. The average monthly maximum temperature was 32.41°C, while the average monthly minimum temperature was 24.0°C.

Temperature Patterns: Higher temperatures were recorded from November to March, coinciding with the dry season, when cloud cover is less. The warmest month was February, with an average maximum temperature of 35.57°C and an average minimum temperature of 25.22°C (Figure 4.10).

The coldest months were July and August. In July, the average maximum temperature was 29.37°C, and the average minimum temperature was 23.42°C. In August, the average maximum temperature was 29.4°C, and the average minimum temperature was 23.42°C. This data indicates some seasonal variations, with the highest temperatures occurring during the dry season (November to March) and the coolest during the rainy season (July and August).

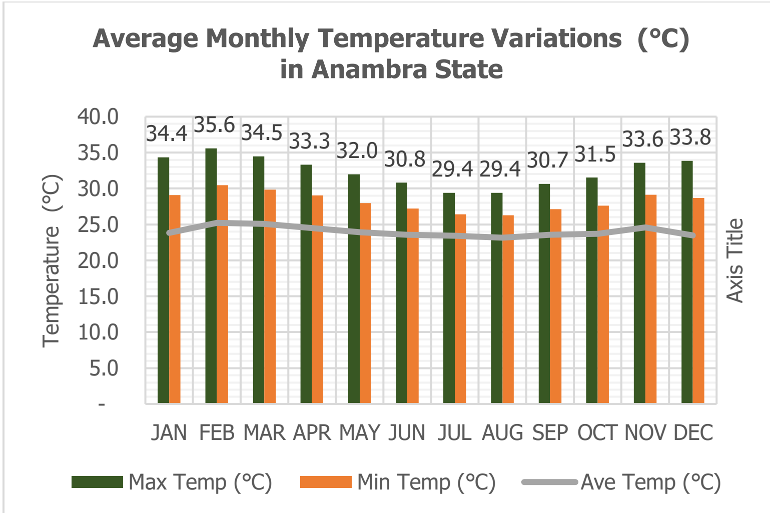


Figure 4.10: Ave Monthly Distribution of Temp in Onitsha, Anambra State from 1991-2020
Source: NiMet

On the other hand, during the study in July 2024, daytime temperatures recorded at the study sites ranged as follows: 29.9 °C to 38.2 °C (mean = 30.9 °C) at Ogboji, 29.5 °C to 33.7 °C (mean = 31.4 °C) at Ugbene, 31.3 °C to 36.2 °C (mean = 33.3 °C) at Omor, and 28.3 °C to 34.0 °C (mean = 30.0 °C) at Ogbunka. The values are comparable to the average July temperature observed in the NiMet data for Onitsha, which ranged from 29.37 °C to 33.84 °C (mean = 31.40 °C). However, higher temperatures than the NiMet maximum were observed in a few instances at Omor and Ogbunka. These pockets of higher-than-average temperatures may be due to local microclimatic conditions. For example, the locations at Omor, a swampy rice field, might experience higher temperatures due to the heat retention properties of waterlogged soils and reduced airflow (Figure 4.11). Each sampling station at Ogboji may have specific localised factors contributing to meteorological variations. Additionally, the variation in land use, vegetation cover, and human activities across these sites could also influence the observed temperature differences.

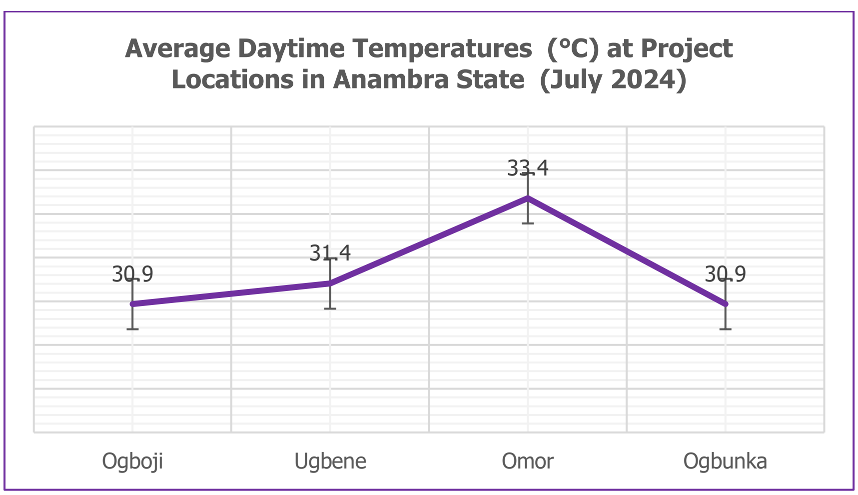


Figure 4.11: Actual Temperatures Recorded at Project Sites in Ogboji, Ugbene, Omor, and Ogbunka April 2024, Rainy Season
Source: AN SAPZ ESIA Field Data (2024)

This discrepancy can likely be attributed to variations in weather conditions, rather than to the waterlogged nature of the rice field since waterlogged conditions often have a cooling effect due to increased moisture and evaporation. Cs cloud cover, wind patterns, and overall climatic variability are key factors influencing local temperatures.

4.3.1.3 Relative Humidity (RH)

The RH data indicated that the average minimum monthly RH at 1500hrs was 68.5% (January), while the average maximum of 87.8% was recorded in the month of August (Figure 4.12) during the period considered. The maximum RH was 90% in July 2014. Higher RH values were recorded during the rainy season with values of at least 80% between May and October. RH values are generally lower during the dry months of December to March. 52% was the lowest value in the data and was recorded in January 2018.

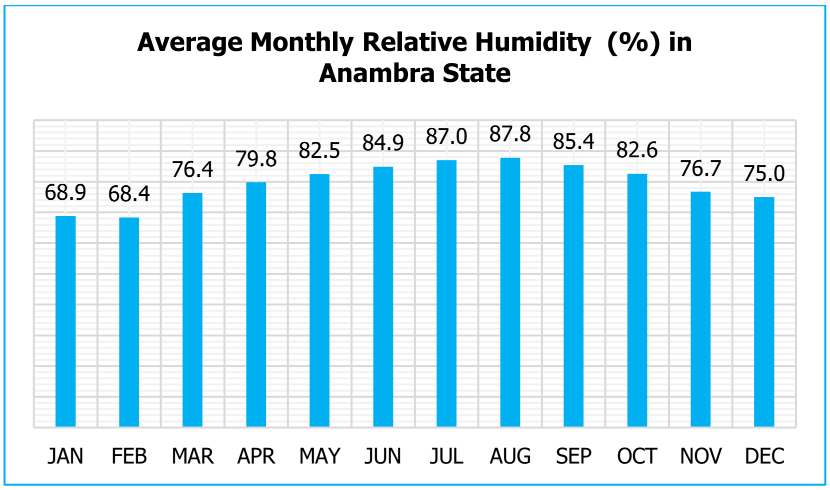


Figure 4.12: Average Monthly RH Distribution in Onitsha, Anambra State (1991 to 2020)
Source: NiMet

The RH across the four locations showed some variation. At Ogboji, the RH ranged from 51.1% - 64.4% (mean = 60.4%), indicating a moderate humidity level with some fluctuations across the 15 sampling points. Ugbene recorded RH values ranging from 58.3% - 62.2% (mean = 60.4%), showing less variability compared to Ogboji. Omor had the broadest range of RH values among the four locations, ranging from 54.3% - 69.2% (mean = 62.5%), and the maximum RH values were recorded here. Ogbunka showed less variability among the 13 sampling points, with RH values ranging from 58.1% - 62.3% (mean of 60.1%). Overall, the mean RH values among the four locations were close, ranging from 60.1% - 62.5% (Figure 4.13).

Compared to the NiMet data, the RH values measured at the study sites in July 2024 were significantly lower than the average RH for Onitsha in July, which was approximately 86.1%. Although Omor showed the highest RH among the study sites, it was still substantially lower than the Onitsha average. This disparity could be attributed to local microclimatic conditions, differences in terrain and land use, or other environmental factors specific to each study site.

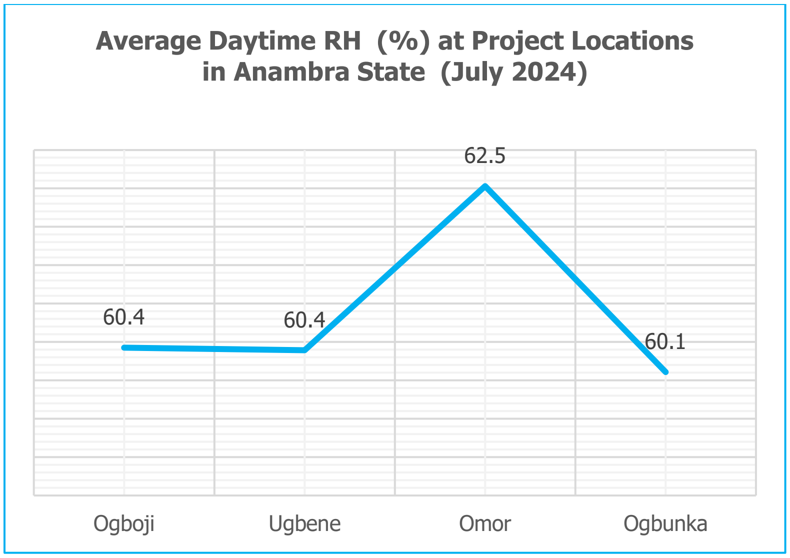


Figure 4.13: Actual RH Recorded at Project Sites in Ogboji, Ugbene, Omor and Ogbunka July 2024, Rainy Season

Note: Field data was recorded during the daytime between 11 am and 3 pm at Omor (10 July, Ogboji (11 July, Ugbene (12 July) and Ogbunka (13 July).

Source: AN SAPZ ESIA Field Data (2024)

4.3.1.4 Wind Speed and Direction

The wind patterns in Onitsha from 1991 to 2020 exhibited a clear seasonal cycle, as shown in Figure 4.14. During the dry season (November to February), the winds predominantly come from the northeast (NE), reflecting the influence of harmattan winds. As the wet season approaches from March, the wind direction shifts mainly to the southwest (SW), driven by the southwest monsoon bringing moisture from the Atlantic Ocean. As October arrives, the winds begin to shift again, predominantly coming from the Southwest (SW) and West (W). This change signals the end of the rainy season and the beginning of the dry season. November is characterised by a mix of south (S), southwest (SW), and west (W) winds, reflecting the transitional nature of this month. East (E) winds were dominant only a few times in December. This cyclical pattern highlights the alternating influence of the harmattan and monsoon systems.

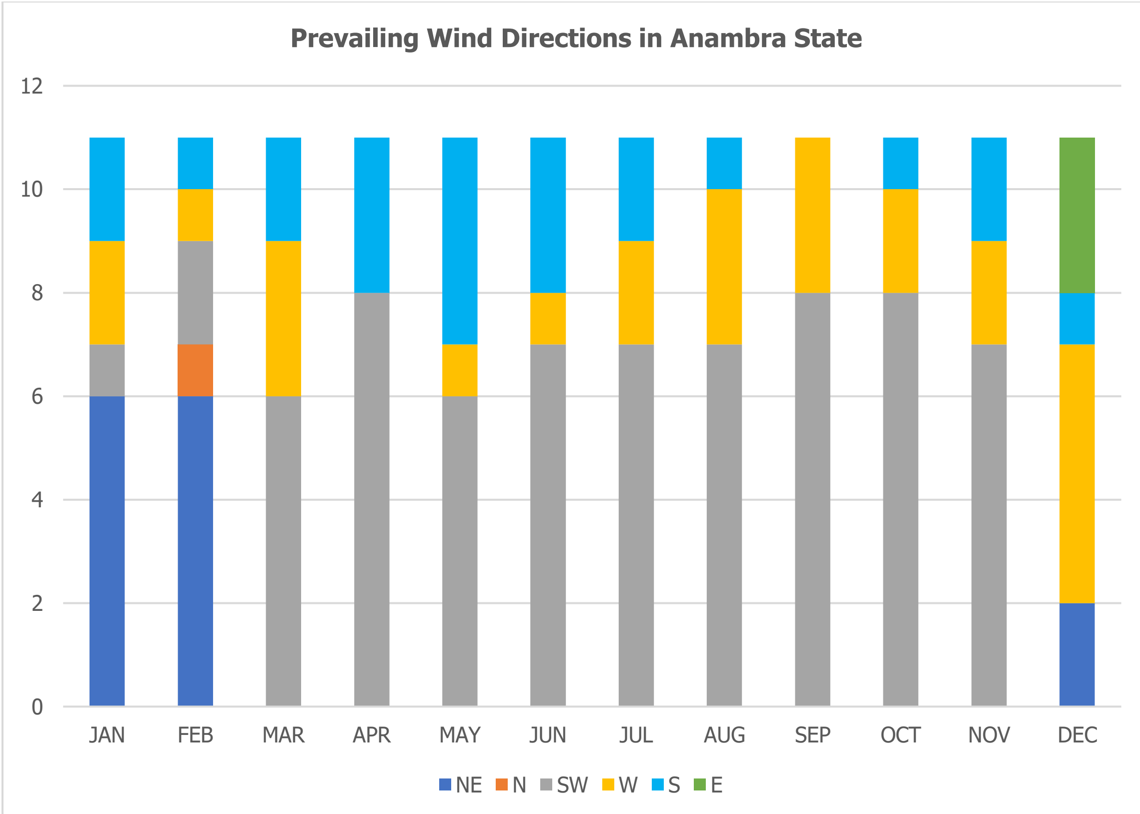


Figure 4.14: Dominant Wind Direction from 1991 to 2020 in Onitsha, Anambra State

Source: NiMet

Wind speeds ranged from 1.8 m/s in October 2013 to 5.3 m/s in March 2020, with an average of 3.62 m/s over the 11 years from 1991 to 2020. The highest average monthly wind speeds were recorded at the onset of the rainy season in March, while the lowest monthly average wind speeds occurred during the dry season months of November and December, with values of 2.78 m/s and 2.96 m/s, respectively (Figure 4.15). out at the onset of the rainy season (March to April).

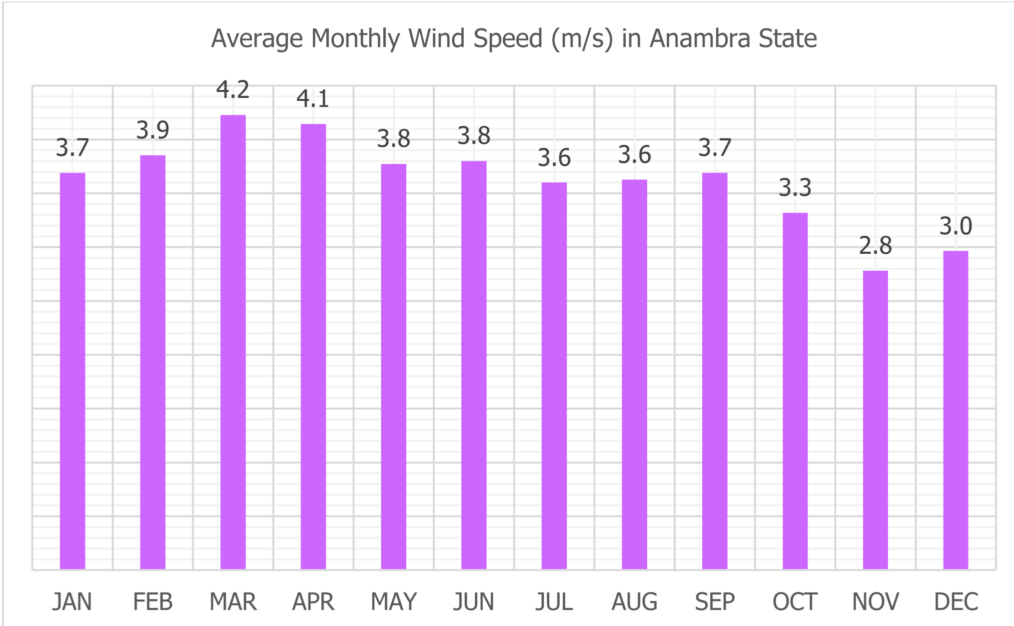


Figure 4.15: Average Monthly Wind Speed in Onitsha, Anambra State from 1991 to 2020

Source: NiMet

In contrast, the wind speeds measured at the proposed project locations were significantly lower than the NiMet data for Onitsha. The windspeed in Ogboji ranged from 0.90 m/s - 2.60 m/s (mean = 1.53 m/s), suggesting moderate wind activity with occasional higher speeds. Ugbene recorded windspeed values ranging from 0.60 m/s - 2.70 m/s (mean = 1.44 m/s), indicating a wider variability across the 12 sampling stations and a slightly lower average windspeed compared to Ogboji but with a similar range of variation. Omor exhibited the widest variability in measured windspeed and the highest observed windspeed among the four locations, with values ranging from 0.90 m/s - 6.30 m/s (mean = 2.71 m/s), suggesting more dynamic wind conditions. Windspeeds between 3.20 m/s and 6.30 m/s were recorded in the first four sampling points in Omor, after which the speed dropped to values comparable to those observed in other locations, suggesting a potential localised influence on wind patterns in the early part of the Omor study area. Ogbunka's windspeed ranged from 0.70 m/s - 2.60 m/s (mean = 1.53 m/s), indicating a similar wind profile to Ogboji and Ugbene (Figure 4.16).

Compared to the NiMet windspeed data for Onitsha, windspeed values measured at the four locations in July 2024 were significantly lower than the average for Onitsha in July, which was approximately 3.6 m/s. This disparity could be influenced by local geographical features, differences in vegetation, and other environmental factors specific to each study site.

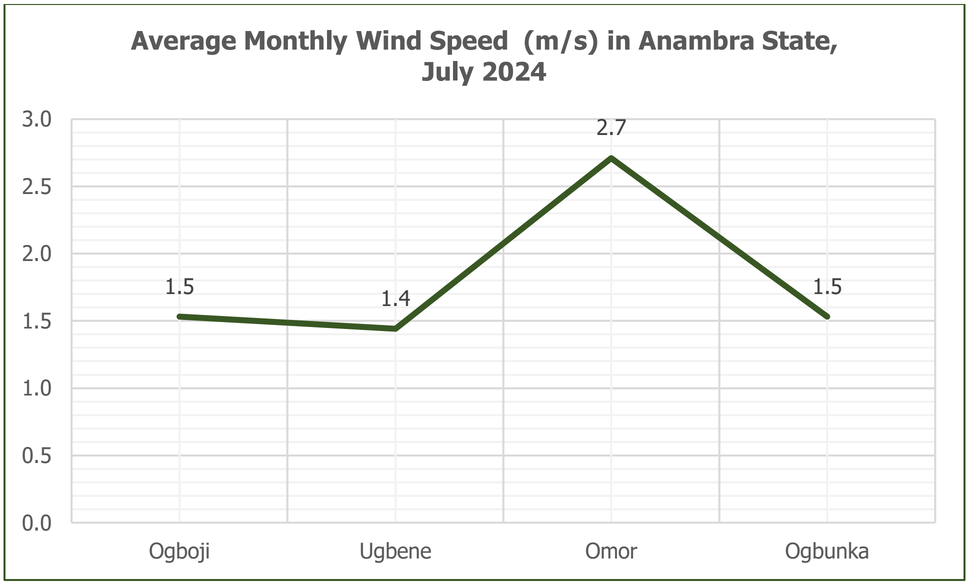


Figure 4.16: Actual wind speeds recorded at project sites in Ogboji, Ugbene, Omor, and Ogbunka July 2024, Rainy Season

Field data was recorded during day time between 11 am and 3 pm at Omor (10 July, Ogboji (11 July, Ugbene (12 July), and Ogbunka (13 July). Source: AN SAPZ ESIA Field Data (2024)

4.2.2 Air Quality

Air quality generally refers to the degree to which the air in a particular environment is free from pollution. It is important for two main reasons: health implications and climate concerns.

From a health perspective, air pollutants with the greatest evidence of concern include particulate matter (PM), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), and sulphur dioxide (SO_2). Fine particulate matter ($PM_{2.5}$) is particularly concerning because it can penetrate deeply into the lungs and enter the bloodstream, causing systemic damage to tissues and cells, according to the World Health Organisation (WHO, n.d.). On the other hand, methane (CH_4) and carbon dioxide (CO_2) are greenhouse gases that contribute significantly to climate change, while SO_2 contributes to acid rain, which can have devastating effects on crops and cause corrosion of metal surfaces.

In the context of an Environmental and Social Impact Assessment (ESIA) study, measuring air quality parameters helps establish the baseline air quality and identify local sources of air pollution around the project area at the time of the study. Meteorological factors such as wind speed, direction, and atmospheric stability also play a critical role in pollutant dispersion and consequently in the air quality of an area. Air quality measurements obtained at the proposed SAPZ and ATCs are discussed below.

4.2.2.1 Ogboji Site

The air quality data monitored on 10 July 2024 at the Ogboji site showed generally low levels of $PM_{2.5}$ and PM_{10}, ranging from 0.003 - 0.014 µg/m^3 (Table 4.9). CO_2 levels were largely consistent, ranging from 474 to 600 ppm, indicating relatively stable levels. CO was very low and mostly non-detectable, except in OGB 1, OGB 6, and OGB 7, with values of 0.32 ppm, 0.40 ppm, and 0.12 ppm, respectively. CH_4, SO_2, NO_2, NH_3, H_2S, and Ozone levels were all at 0 ppm, indicating no detectable presence of these pollutants. VOC was detected occasionally in low amounts (0.32 ppm at OGB 4, 0.23 ppm at OGB 10, 0.14 at OGB 11, and 0.3 at OGB 13; however, the values were below the ambient regulatory limit for non-methane hydrocarbon. When compared with WHO and FMEnv limits, the maximum PM_{10} recorded was well below the recommended ambient limits. The FMEnv has not specified a limit for $PM_{2.5}$. CO levels were also below regulatory guidelines. Overall, the data indicated good ambient baseline air quality for the monitored parameters at this location.

Table 4.9: Air Quality Measurements at Ogboji (11 July 2024, Rainy Season)

Parameters	$PM_{2.5}$	PM_{10}	CO_2	CO	SO_2	NO_2	VOC	CH_4	NH_3	H_2S	Ozone
Unit	Mg/M^3	Mg/M^3	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
OGB 1	0.003	0.006	586	0.32	0	0	0	0	0	0	0
OGB 2	0.006	0.007	551	0	0	0	0	0	0	0	0
OGB 3	0.008	0.012	474	0	0	0	0	0	0	0	0
OGB 4	0.01	0.021	531	0	0	0	0.32	0	0	0	0
OGB 5	0.009	0.011	583	0	0	0	0	0	0	0	0
OGB 6	0.005	0.007	500	0.40	0	0	0	0	0	0	0
OGB 7	0.011	0.019	489	0.12	0	0	0	0	0	0	0
OGB 8	0.006	0.009	493	0	0	0	0	0	0	0	0
OGB 9	0.003	0.005	570	0	0	0	0	0	0	0	0
OGB 10	0.008	0.014	563	0	0	0	0.23	0	0	0	0
OGB 11	0.014	0.019	494	0	0	0	0.14	0	0	0	0
OGB 12	0.007	0.011	600	0	0	0	0	0	0	0	0
OGB 13	0.005	0.009	523	0	0	0	0.3	0	0	0	0
OGB 14	0.009	0.015	574	0	0	0	0	0	0	0	0
OGB15	0.014	0.018	600	0	0	0	0	0	0	0	0
Min	0.003	0.005	474	0	0	0	0	0	0	0	0
Max	0.014	0.021	600	0.4	0	0	0.32	0	0	0	0
Equipment Detection Limit	0.001	0.001	10	0.2	0.04	0.005	1	10	0.2	0.04	0.001
FMEnv Limit	NS	0.25	NS	10	0.1	0.04-0.06	160	NS	NS	NS	NS
WHO Air Quality Guidelines*	0.015	0.045	NS	3.43	0.015	0.013	NS	NS	NS	NS	0.05

*: Measured over 24 hours; NS: Not Specified; Source: AN SAPZ ESIA Field Data (2024)

4.2.2.2 Ugbene Site

At the Ugbene site, $PM_{2.5}$ and PM_{10} levels were generally low, ranging from 0.003 – 0.013 mg/m^3 and 0.005 - 0.08, respectively (Table 4.10). CO_2 levels vary between 486 and 674 ppm. CO, SO_2, NO_2, NH_3, H_2S, and Ozone are mostly non-detectable. VOC was occasionally detected, with the highest level in UGB 2 at 0.3 ppm. When compared with WHO and FMEnv limits, all parameters were within ambient regulatory limits, indicating a baseline air quality that is generally free from air pollutants.

Table 4.10: Air Quality Measurements at Ugbene (12 July 2024, Rainy Season)

Parameters	$PM_{2.5}$	PM_{10}	CO2	CO	SO_2	NO_2	VOC	CH_4	NH_3	H_2S	Ozone
Unit	Mg/M^3	Mg/M^3	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
UGB 1	0.006	0.014	614	0	0	0	0	0	0	0	0
UGB 2	0.003	0.006	619	0	0	0	0.3	0	0	0	0
UGB 3	0.006	0.01	600	0	0	0	0	0	0	0	0
UGB 4	0.005	0.08	582	0	0	0	0	0	0	0	0
UGB 5	0.004	0.007	594	0	0	0	0	0	0	0	0
UGB 6	0.008	0.01	674	0.3	0	0	0	0	0	0	0
UGB 7	0.013	0.019	532	0	0	0	0	0	0	0	0
UGB 8	0.003	0.007	499	0	0	0	0	0	0	0	0
UGB 9	0.006	0.01	486	0	0	0	0.1	0	0	0	0
UGB 10	0.005	0.005	502	0	0	0	0	0	0	0	0
UGB 11	0.004	0.007	572	0	0	0	0.32	0	0	0	0
UGB 12	0.003	0.008	514	0	0	0	0	0	0	0	0
Min	0.003	0.005	486	0	0	0	0	0	0	0	0
Max	0.013	0.08	674	0.3	0	0	0.32	0	0	0	0
Equipment Detection Limit	0.001	0.001	10	0.2	0.04	0.005	1	10	0.2	0.04	0.001
FMEnv Limit	NS	0.25	NS	10	0.1	0.04-0.06	160	NS	NS	NS	NS
WHO Air Quality Guidelines*	0.015	0.045	NS	3.43	0.015	0.013	NS	NS	NS	NS	0.05

*: Measured over 24 hours; NS: Not Specified

Source: AN SAPZ ESIA Field Data (2024)

4.3.2.3 Omor Site

The air quality measurements in Omor showed that particulate matter (PM2.5 and PM10), CO_2, CO, and VOCs were within WHO and FMEnv's ambient limits, as presented in Table 4.11. SO_2 had one instance of exceeding the FMEnv limit at OM1 sampling, indicating a potential localised source. Other parameters such as NO_2, NH_3, H_2S, and ozone were below the equipment detection limits. CH_4 was detected at very low levels in OM1 2 and 4. undetectable or within the detection limits of the equipment, suggesting low ambient concentrations. VOC was detected in most samplings, with a maximum value of 16.9 ppm recorded at OM1. However, the presence of VOCs suggests potential sources of organic emissions, especially at OM1. In general, the baseline air quality at Omor is within acceptable limits for most parameters, though specific attention should be given to the localised sources of SO_2 and VOCs at OM1 to ensure they do not pose significant environmental or health risks.

Table 4.11: Air Quality Measurements at Omor (10 July 2024, Rainy Season)

Parameters	$PM_{2.5}$	PM_{10}	CO_2	CO	SO_2	NO_2	VOC	CH_4	NH_3	H_2S	Ozone
Unit	Mg/M^3	Mg/M^3	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
OM 1	0.008	0.01	688	0.25	0.13	0	16.9	1	0	0	0
OM 2	0.006	0.011	582	0.01	0	0	6.5	3	0	0	0
OM 3	0.008	0.02	587	0.02	0	0	4.2	0	0	0	0
OM 4	0.008	0.012	612	0	0.06	0	2	3	0	0	0
OM 5	0.007	0.015	682	0	0.06	0	0.14	0	0	0	0
OM 6	0.007	0.008	510	0.06	0	0	9.4	0	0	0	0
OM 7	0.006	0.019	670	0	0	0	1.3	0	0	0	0
OM 8	0.008	0.012	480	0	0.03†	0	0	0	0	0	0
OM 9	0.007	0.014	467	0	0	0	2.3	0	0	0	0
OM 10	0.006	0.011	568	0	0	0	1.8	0	0	0	0
Min	0.006	0.008	467	0	0	0	0	0	0	0	0
Max	0.008	0.02	688	0.25	0.13	0	16.9	3	0	0	0
Equipment Detection Limit	0.001	0.001	10	0.2	0.04	0.005	1	10	0.2	0.04	0.001
FMEnv Limit		0.25	NS	10	0.1	0.04-0.06	160	NS	NS	NS	NS
WHO Air Quality Guidelines*	0.015	0.045	NS	3.43	0.015	0.013	NS	NS	NS	NS	0.05

*: Measured over 24 hours; NS: Not Specified

†: Value below the detection limit but within the sensor's range. This likely indicates low concentrations or environmental factors affecting sensor performance.

Source: AN SAPZ ESIA Field Data (2024)

4.2.2.4 Ogbunka Site

The air quality measurements in Ogbunka indicated that the concentrations of $PM_{2.5}$ (range = 0.003 - 0.019 mg/m^3), PM_{10} (range = 0.004 - 0.022 mg/m^3), CO_2, CO, SO_2, NO_2, VOCs (max =

0.6 ppm), CH_4, NH_3, H_2S and ozone were within safe limits as per the WHO and FMEnv guidelines, as shown in Table 4.12. The absence of significant levels of these pollutants suggests that the project site in Ogbunka has good air quality with no immediate environmental health concerns. The detected levels of particulate matter and VOCs, while within limits, would still need to be monitored to ensure they do not rise. Overall, the baseline air quality at Ogbunka was safe.

Table 4.12: Air Quality Measurements at Ogbunka (13 July 2024, Rainy Season)

Parameters	$PM_{2.5}$	PM_{10}	CO_2	CO	SO_2	NO_2	VOC	CH_4	NH_3	H_2S	Ozone
Unit	Mg/M³	Mg/M³	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
OGK 1	0.009	0.012	583	0	0	0	0.3	0	0	0	0
OGK 2	0.006	0.011	614	0	0	0	0.6	0	0	0	0
OGK 3	0.007	0.015	522	0	0	0	0	0	0	0	0
OGK 4	0.009	0.016	617	0	0	0	0	0	0	0	0
OGK 5	0.01	0.018	623	0	0	0	0.1	0	0	0	0
OGK 6	0.009	0.02	534	0	0	0	0	0	0	0	0
OGK 7	0.006	0.007	618	0	0	0	0.1	0	0	0	0
OGK 8	0.008	0.008	624	0	0	0	0.3	0	0	0	0
OGK 9	0.003	0.004	672	0	0	0	0	0	0	0	0
OGK 10	0.005	0.008	630	0	0	0	0.4	0	0	0	0
OGK 11	0.006	0.009	652	0	0	0	0	0	0	0	0
OGK 12	0.019	0.022	592	0	0	0	0	0	0	0	0
OGK 13	0.006	0.012	524	0	0	0	0.1	0	0	0	0
Min	0.003	0.004	522	0	0	0	0	0	0	0	0
Max	0.019	0.022	672	0	0	0	0.6	0	0	0	0
Equipment Detection Limit	0.001	0.001	10	0.2	0.04	0.005	1	10	0.2	0.04	0.001
FMEnv Limit	NS	0.25	NS	10	0.1	0.04-0.06	160	NS	NS	NS	NS
WHO Air Quality Guidelines*	0.015	0.045	NS	3.43	0.015	0.013	NS	NS	NS	NS	0.05

*: Measured over 24 hours; NS: Not Specified

Source: AN SAPZ ESIA Field Data (2024)

4.3.2.5 Summary of Air Quality Findings

Table 4.13 provides a snapshot of air quality findings. The table shows concentration levels for monitored parameters, offering insights into the baseline air quality conditions at each location. This data is essential for understanding the existing environmental context and assessing the potential impacts of the proposed Anambra State Special Agri-industrial Processing Zone and Agricultural Transformation Centres.

Table 4.13: Comparison of Air Quality Parameters Across Different Sites (July 2024, Rainy Season)

Site	$PM_{2.5}$	PM_{10}	CO_2	CO	SO_2	NO_2	VOCs	H_2S, Ozone, CH_4
Unit	Mg/M³	Mg/M³	ppm	ppm	ppm	ppm	ppm	ppm
Ogboji	0.003 – 0.014	0.005 - 0.021	474 - 600	Range: 0 - 0.40 Detected in OGB 1, 6 and 7	ND	ND	Range: 0-0.32 Detected in OGB 4, 10, 11 and 13	Not detected
Ugbene	0.003 - 0.013	0.005 0.08	486 - 674	Range: 0 - 0.03 Detected in OGB 6	ND	ND	Range: 0-0.32 Detected in UGB 2, 9 and 11	Not detected
Omor	0.006 - 0.008	0.08 - 0.02	467 - 688	0 - 0.25	Range: 0 - 0.13 Detected in OM 1, 4, 5 and 8	ND	Range: 0-16.9 Detected in most sampling points except OM 8	Not Detected except for CH_4 detected in OM1,2 and 4 only (Range: 0-3)
Ogbunka	0.003 - 0.019	0.004 – 0.022	522 - 672	Not Detected	ND	ND	Range: 0-0.6 Detected in most sampling points except OGK 3,4, 6, 7-8, 10 and 13	Not detected
FMEnv Limit	**NS**	**0.250**	**NS**	**10**	**0.1**	**0.04-0.06**	**160**	**NS**
WHO Air Quality Guidelines*	0.015	0.045	NS	3.43	0.015	0.013	NS	Ozone: 0.05; Others: NS

*: Measured over 24 hours; ND: Not Detected; NS: Not Specified
Source: Source: AN SAPZ ESIA Field Data (2024)

In conclusion, the baseline air quality assessment for the proposed SAPZ and the three ATCs across Ogboji, Omor, Ugbene, and Ogbunka sites reveals generally low levels of pollutants. $PM_{2.5}$ and PM_{10} concentrations were consistently below FMEnv limits, indicating minimal particulate matter pollution. CO_2 levels show some variability across sites but remain within acceptable ranges. NO_2 was detected in specific instances, such as in Ogboji and Ugbene, but overall levels were not significant. The presence of CO, SO_2, NH_3, H_2S, and Ozone is negligible or non-detectable, highlighting the absence of major industrial pollutants.

VOC levels, although detected occasionally, do not present a significant pollution concern. The stable and low levels of most air quality parameters suggest that the current air quality is relatively good, with minimal pollution sources in the area. This data establishes a critical baseline for assessing future impacts and ensuring that any project-related activities maintain or improve the current air quality standards. These findings are essential for informing mitigation strategies and ensuring the health and safety of the local population as well as the sustainability of the agricultural and processing activities planned for the areas.

4.2.3 Noise

Noise pollution, defined as unwanted and disruptive sound, is a significant environmental concern with well-documented health consequences (WHO, 2024). Natural noise sources include animal sounds, running water, seismic activities, wind, and thunder. Anthropogenic noise, which arises from human activities, tends to increase with population growth, density, mobility, and commercial and industrial activities (Jain *et al*., 2012). Common anthropogenic noise sources include road traffic, construction equipment, industrial activity, and household appliances. The project area is located within farmlands and natural forests; hence, the identified noise sources were from animal sounds and farming activities.

Noise levels are measured in decibels (dB), with higher decibel levels indicating louder noises. Prolonged exposure to loud noises can have a range of negative health impacts, varying depending on the level and duration of exposure. For instance, chronic exposure to loud noises exceeding 85 dB (A) over eight hours a day for several years can lead to permanent hearing loss (National Institute on Deafness and Other Communication Disorders [NIDCD], 2023). Even lower noise levels can disrupt sleep patterns (Job, 1996). Additionally, noise can interfere with animal communication by reducing the signal-to-noise ratio, affecting signal detection and discrimination (Erbe *et al*., 2022).

In Nigeria, ambient noise regulation standards vary based on the type of activity and time of day. Daytime permissible limits range from 45 dB (A) for hospital settings to 75 dB (A) for commercial areas, while nighttime limits range from 35 dB (A) to 60 dB (A) for hospitals and industrial perimeters, respectively (NESREA, 2009). Daytime is defined as 6 am to 10 pm, and nighttime as 10 pm to 6 am. In contrast, the FMEnv noise limit is 90 dB (A) which applies to industrial areas and for an 8-hour exposure period.

Table 4.14 shows the descriptive statistics for noise levels measured at the various locations of the different project sites.

Table 4.14: Summary of Noise Levels at the Project Sites (July 2024, Rainy Season)

	Number of Samples	Mean (dB[A])	St Dev (dB[A])	Min (dB[A])	Max (dB[A])
Ogboji	15	50.5	1.3	48.6	53.3
Ugbene	12	51.2	3.6	48.3	62.3
Omor	10	49.8	3.3	45.9	56.9
Ogbunka	13	52.3	4.4	47.4	62.7
Equipment Detection Limit				40	
NESREA Noise Limit (Daytime)	Residential			50	
	Mixed-Use			55	
FMEnv				90	

Source: AN SAPZ ESIA Field Data (2024)

At the Ogboji site, 15 samples were collected, with a mean noise level of 50.5 dB (A) and a standard deviation of 1.3 dB (A), suggesting a more uniform distribution of noise levels across the sites. This is a forested area unexpected as most noise observed during the study was from natural sources).

In Omor, 10 noise measurements were taken with a mean of 49.8 dB (A) and a standard deviation of 3.3 dB (A). The noise levels ranged from a minimum of 45.9 dB (A) to a maximum of 56.9 dB (A), meeting FMENv ambient noise standards and NESREA's standards for industrial use. This location is used for plant cultivation and several croppers were observed working on the farm, contributing to the variation in the noise levels.

At Ugbene, 12 noise measurements were taken, with a mean noise level of 51,7 dB (A) and a standard deviation of 3.6 dB (A). Rice cultivators were also observed at this site. The noise levels ranged from 48.3 dB (A) to 62.3 dB (A), suggesting localised noise levels at some areas of the site.

The Ogbunka site had 13 noise measurements, with a mean noise level of 52.3 dB (A) and a standard deviation of 4.6 dB (A). The noise levels ranged from 47.4 dB (A) to 62.7 dB (A). Although within ambient regulatory noise standards, the site exhibited more variability in noise levels. Like in other localities, farming activities were observed on this site and the project team observed more people working on their farms than at other locations.

The baseline noise levels at the Ogboji, Omor, Ugbene, and Ogbunka project sites complied with the NESREA and FMEnv standards. However, variations in noise levels exist across the sites, with some areas exhibiting higher noise levels. The primary noise sources identified were agricultural activities.

4.2.4 Land Use

Anambra State covers a total area of 4,844 km², with diverse land use patterns reflecting its varied economic activities. The major land use categories in the state are primary production and urban and built areas, according to the ANSG (2024). Other categories include flooded vegetation, bare land, and water bodies.

1. **Primary Production (70.04%):** This term includes all land areas used directly to harvest natural resources for food and/or raw materials. Land use for this category includes:
    i. **Agricultural and Agroforestry Areas (36.47%):** This category makes up 36.47% of the total land use in Anambra State, highlighting the state's strong focus on agriculture and agroforestry.
    ii. **Range Lands (27.14%):** Referring to land used for grazing and pastoral activities, this category comprises 27.14% of the total land use, demonstrating the significance of livestock farming in Anambra State. These lands are mostly found in the northern part of the state.
    a. **Crop Lands:** Making up 6.43% of the land, this category is critical for ensuring food production and security in Anambra State.
2. **Urban and Built-up Area (27.17%):** This category is predominantly found in the southern part of the state. It includes land areas marked by residential, commercial, and industrial development to support the growing urban population and economy, especially around Onitsha, Awka Town, and Nnewi.
3. **Flooded Vegetation and Bare Ground:** Making up about 0.28% of land use in Anambra State, this category is found mainly along the riverine areas. The lands are characterised by seasonal flooding and sparse vegetation.
4. **Water Bodies (2.16%):** Covering about 2.16% of the state's land area, surface waters are crucial to the socioeconomic well-being of the state. They enhance landscape aesthetics and provide water, food, economic opportunities, navigation, and transportation to riverine communities.

This diverse land use distribution illustrates the range of economic activities in Anambra State, from agriculture and livestock farming to urban development and trade.

Table 4.15 summarises the land use categories in Anambra State by hectares, while Figure 4.17 shows the land use map of the state.

Table 4.15: Major Land Use Classification in Anambra State

S/N	Land use classification	Total area in Ha	% of TLA
1	Primary Production	459,230.88	100.00%
1.1	Trees	167,511.47	36.47%
1.2	Range Land	124,625.79	27.14%
1.3	Crops	29,485.28	6.43%
2	Built Area	124,781.17	27.17%
3	Water	9,912.45	2.16%
4	Bare Ground	1,623.00	0.35%
5	Flooded Vegetation	1,291.72	0.28%

Source: ANSG (2024)

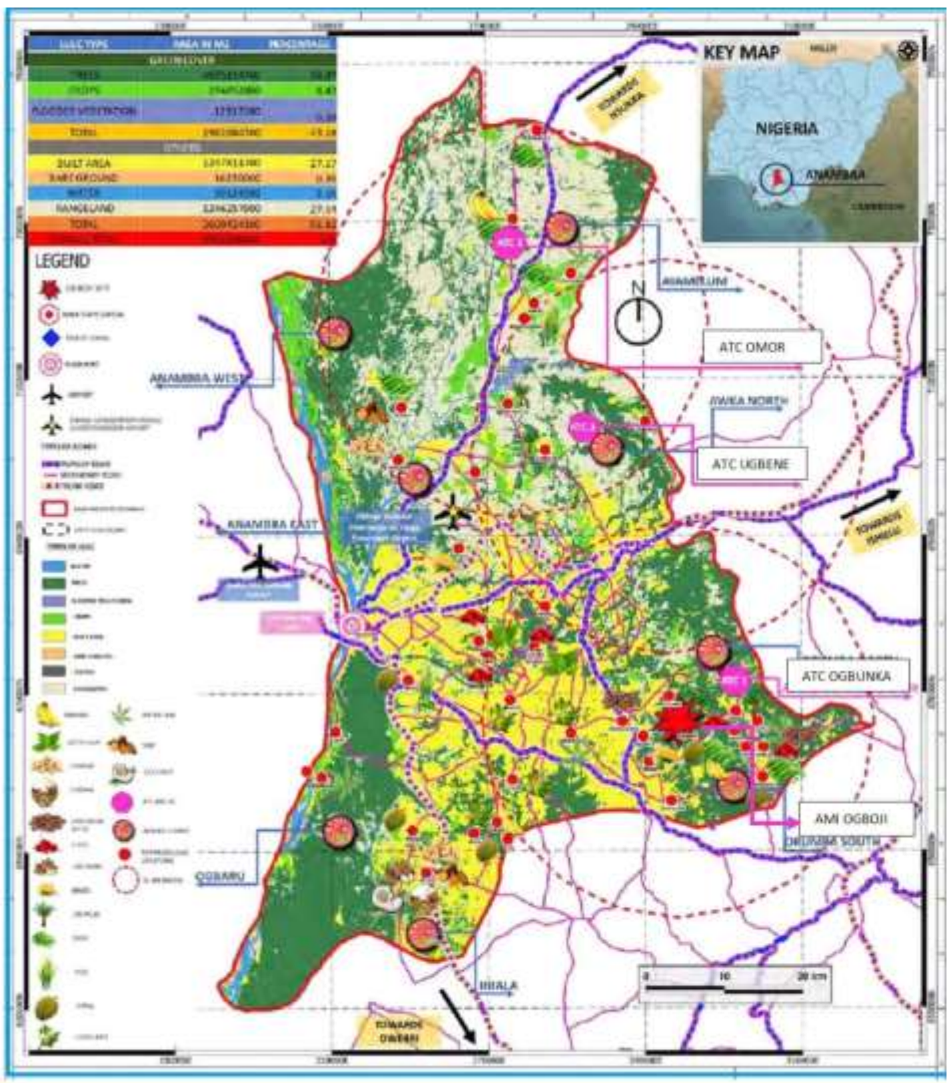


Figure 4.17: Land Use Map of Anambra With Indicative Locations of SAPZ AIH and ATCs

Source: ANSG (2024)

4.2.5 Landscape Characteristics

This subsection provides an overview of the physical landscape of the project areas based on Ayadiuno *et al*. (2022) and the ESIA Team's field observations:

4.2.5.1 Ayamelum LGA

Ayamelum LGA lies with latitudes 6.363° N and 6.713° N latitudes and longitudes 6.855° E and 7.133° E. The elevation in Ayamelum is generally below 60 meters above sea level. The terrain is predominantly flat and is prone to seasonal flooding due to its proximity to river systems, notably the Omambala and Niger Rivers. The flat, alluvial plains are susceptible to waterlogging, especially during the rainy season. Vegetation in the area includes lagoon-type species, and significant landscape changes are unlikely due to low anthropogenic influence, given the area's low population and development index.

4.2.5.3 Awka North LGA

Awka North LGA lies with latitudes 6.238° N and 6.44° N latitudes and longitudes 6.961° E and 7.160° E. Its elevation ranges from 16 meters to 139 meters above sea level, with an average elevation of 47 meters. The elevation here is also generally low, under 60 meters above sea level. The terrain is flat to gently sloping, with soils similar to those in Ayamelum, characterised by greyish alluvium and low slope angles. Like Ayamelum, Awka North is vulnerable to flooding, particularly during heavy rains. However, its proximity to the Awka capital territory could drive future development, potentially impacting the landscape significantly in the coming years.

4.2.5.3 Orumba South LGA

The geographical coordinates of Orumba South LGA fall between 5.921° North and 6.057° latitudes and 7.146° E and 7.339° E longitudes. The LGA's elevation ranges from 55 meters to 341 meters above sea level, with an average elevation of 142 meters. The regions feature talus slopes and undulating topography with broad hilltops and gentle valleys. Steeper slopes are present, especially near the scarps that separate these higher grounds from the floodplains and act as potential natural barriers against flooding for these higher elevations. However, the areas are highly susceptible to erosion, especially gullies and landslides, due to the steep slopes and the nature of the underlying geology. The continuous wear and tear by water-based denudation processes significantly impacts the landscape, causing considerable land degradation.

Although the naturally unstable landscapes in Orumba pose challenges, human activities have exacerbated these issues significantly. The fragile Nanka formation, a valuable construction material, has been extensively mined in the area, a practice that remains inadequately regulated by the government. This rampant sand mining has substantially degraded the landscape over time.

In addition to mining, rapid development and urbanisation have drastically altered the landscape. Recent studies indicate a nearly 5% annual reduction in vegetation, virgin land, and forest cover due to construction and development activities (Onuchukwu *et al*., 2024). The ongoing infrastructure projects and urbanisation efforts, particularly in Aguata, Orumba North, and South

LGAs, are expected to increase this rate of land-use change. This growth is likely to further impact the landscape, contributing to increased runoff and exacerbating the existing environmental challenges.

In summary, while Orumba Orumba South LGAs face significant challenges with erosion and land degradation due to their more varied and elevated terrain, Ayamelum and Awka North LGAs are more susceptible to flooding due to their low-lying, flat landscapes. The geology of these areas, with sedimentary rocks, shale formations, and alluvial deposits, plays a critical role in shaping these vulnerabilities.

4.3.6 Geology of Study Area

4.3.6.1 General Geology of Anambra State

Anambra State is characterised by a complex geological framework shaped by various epochs and processes. The region's geology primarily consists of Cretaceous sedimentary rocks and shale formations, which are prominently found in the Mamu Basin, Anambra Basin, and Niger Basin (Madukwe, 2019; Anyadike, 2002; Offodile, 1976). These basins are part of the broader Lower Benue Trough, an NE-SW trending rift basin associated with the separation of the African and South American plates during the Early Cretaceous. The Anambra Basin, bounded by the Niger Delta hinge line to the southwest, the Benue flank to the northwest, and the Abakaliki fold belt to the southeast, exhibits a triangular shape. Its sedimentary thickness increases southwards, reaching up to 12,000 meters in the central Niger Delta (Adebayo *et al*., 2015). The primary geological formations include the Nkporo Shale, Mamu Formation, Ajali Sandstone, and Nsukka Formation.

A drainage basin map of Nigeria is provided below, illustrating the various geological inland basins, including the location of the Anambra Basin, where the project area is situated. Geographically, the Anambra Basin corresponds to what was historically referred to as eastern Nigeria, extending into present-day Southeastern and South-Southern Nigeria, marked by significant sedimentary rock systems and well-documented stratigraphy.

The geographical layout of the various drainage basins is presented here, with the Anambra Basin highlighted first in the legend in purple. The proposed project area is geologically located within this basin, shown in Figure 4.18.

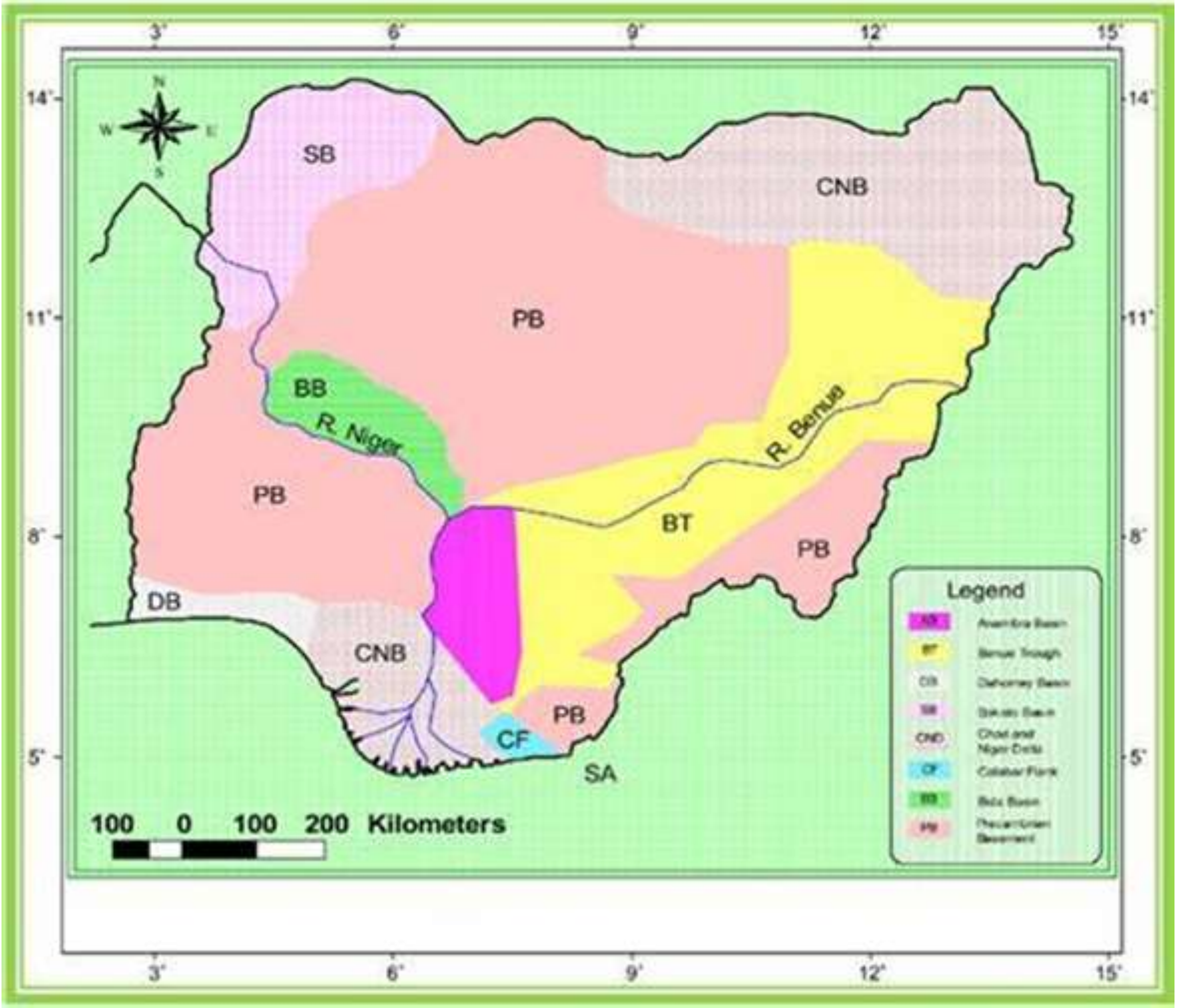


Figure 4.18: Map of Nigeria showing the various drainage basins. (Anambra basin in purple)
Source: Nwajide (1990)

The basin has a well-defined geological chronology of formations (Nwajide, 1990). Various rock types are recorded within these formations. Furthermore, all geological processes within the basin occur within and around the following formation characteristics, listed in upward-younging order, with the Basement Complex as the oldest and the Ogwashi-Asaba Formation as the youngest.

The chronological order of formations is as follows (Figure 4.19):

- Ogwashi-Asaba Formation (Youngest)
- Nanka Formation / Ameki / Nsugbe Sandstone
- Imo Formation
- Nsukka Formation
- Ajali Sandstone
- Mamu Formation

- Owelli Formation
- Awgu Group
- Ezeaku Group
- Asu River Group
- Basement Complex (Oldest)

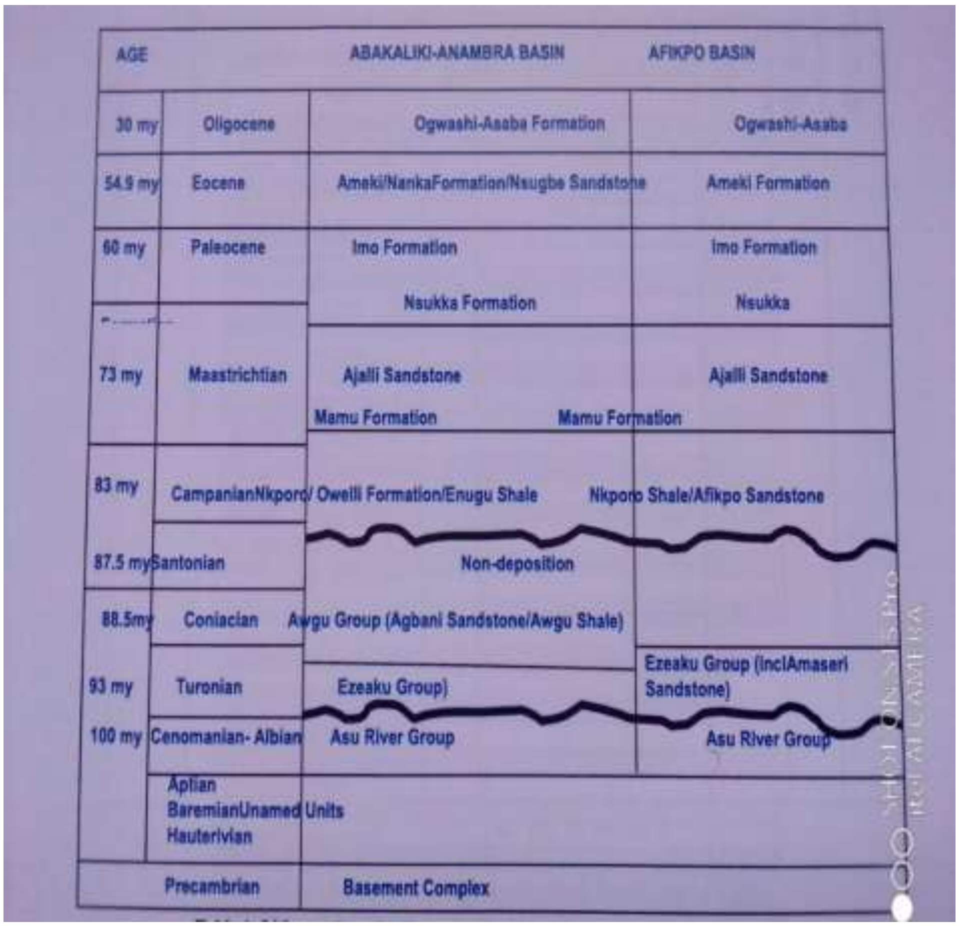


Figure 4.19: Lithostratigraphic Framework of the Anambra Basin (After Nwajide, 1990)

The characteristic lithologies within the project area are further represented in Figure 4.20 below.

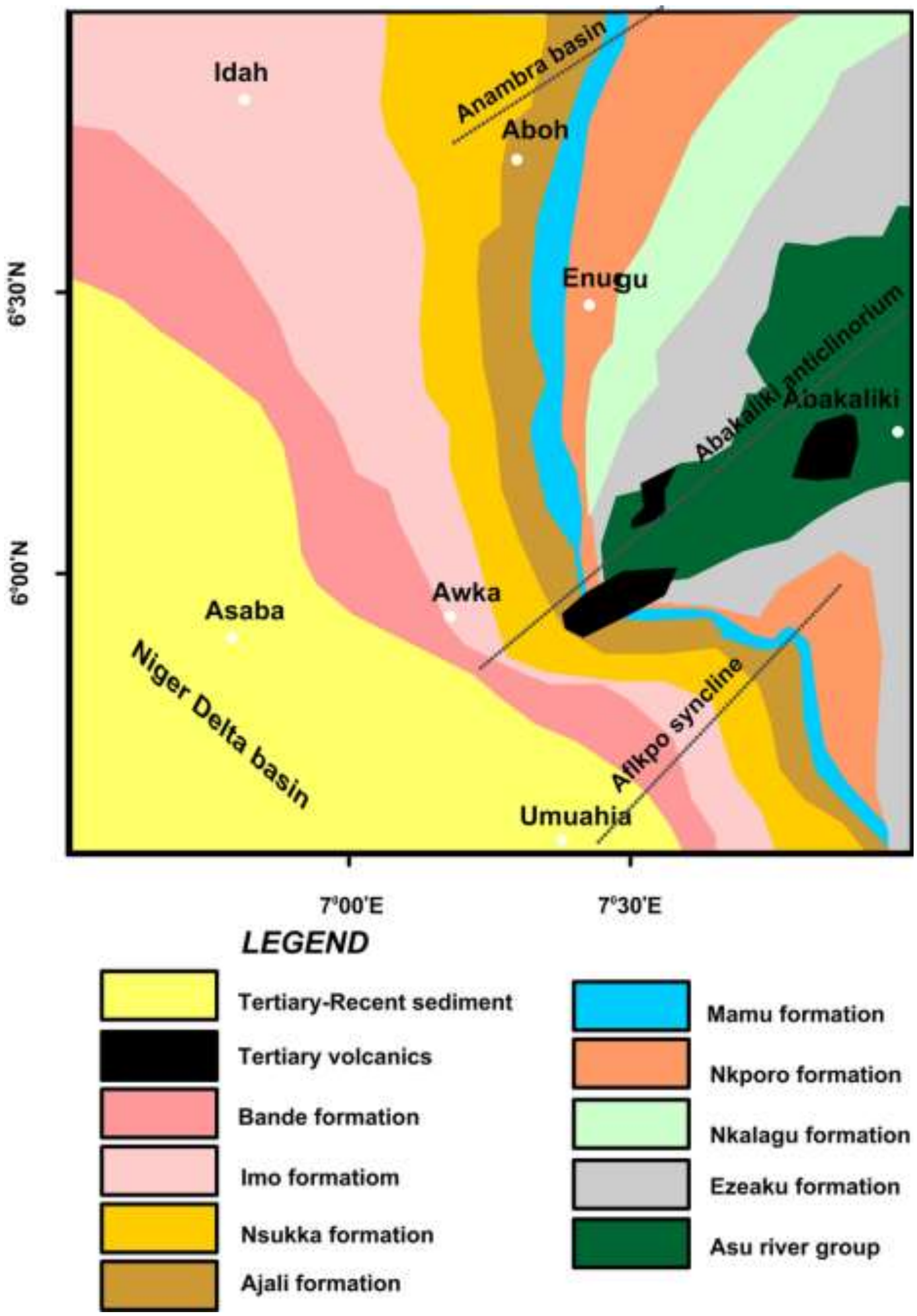


Figure 4.20: Geological Layout of the Various Formations Within the Anambra Basin

Source: Nwajide (1990)

Within Anambra State, various soil and rock types have been studied, leading to the production of a specific geological map for the state, shown in Figure 4.21. This map illustrates the geological units underlying the different parts of the state.

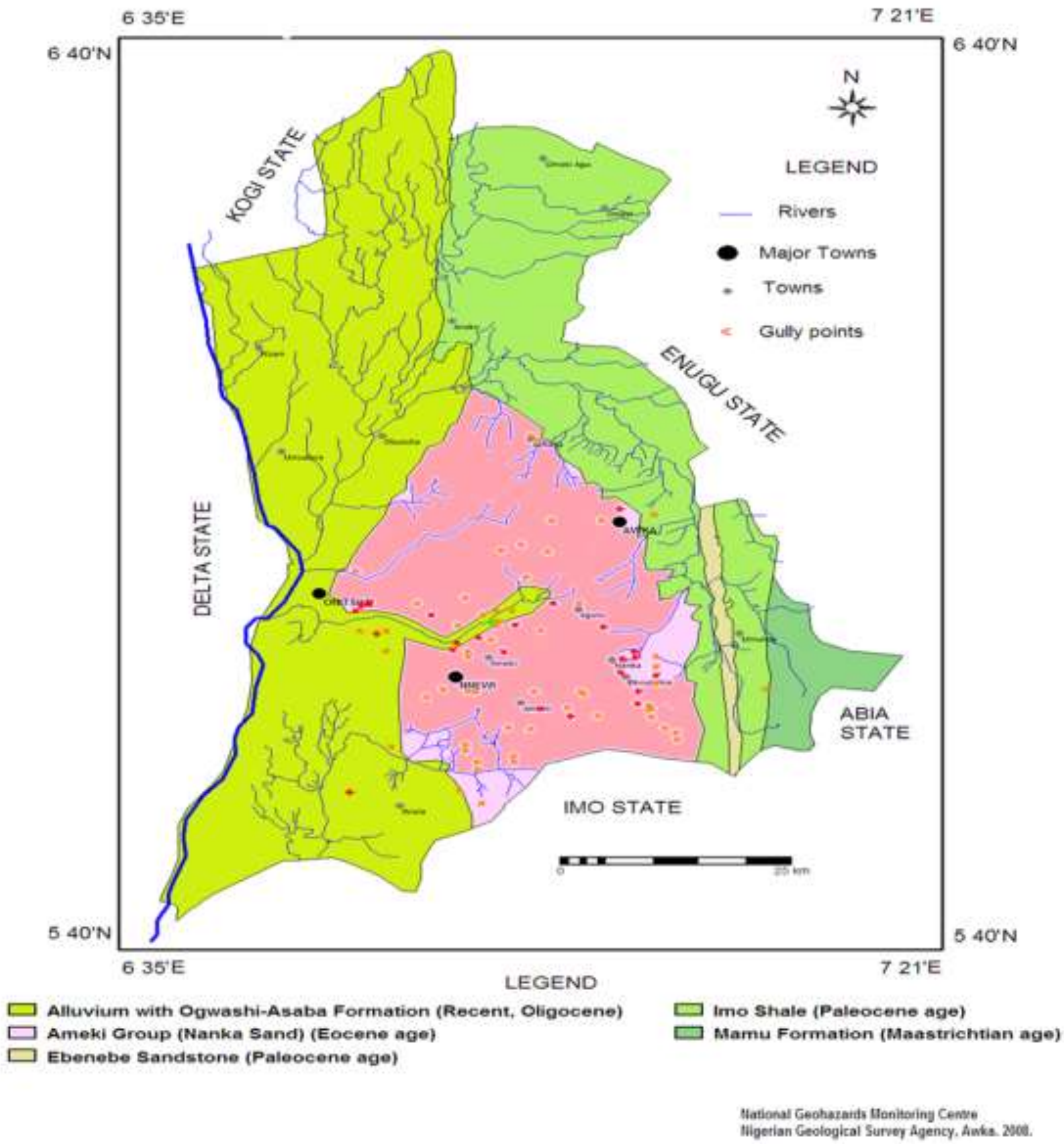


Figure 4.21: Geological and Mineral Resources Map of Anambra State
Source: Onuchukwu (2024)

4.3.6.2 Geology and Hydrogeology of the Project Areas

The following sections present the project areas' geological and hydrogeological information, which is characterised by multiple aquifer layers associated with distinct geological formations, including the Nanka Sands, Imo Shale, and the alluvial deposits in low-lying areas, which support shallow, unconfined aquifers. Each formation's hydrogeological properties significantly influence groundwater availability and quality across the region.

4.3.6.2.1 Geology of Ogboji in Orumba South LGA

Ogboji in the Orumba South Local Government Area is underlain by the Nanka Sands, a key component of the Anambra Basin's Nanka Formation. The Nanka Formation extends beyond Ogboji, covering parts of Agulu, Nanka, Oko, Ekwulobia, Amokpala, and Awgbu. Geologically, these sands are of Eocene age and consist of poorly consolidated, low-cohesive soils. Studies by Okoro *et al*. (2010), Obi and Okekeogbu (2017), and Omonona *et al*. (2016) indicate that this formation, approximately 305 meters thick, is underlain by the Paleocene Imo Shale Formation and overlain by the lignite-clay seams of the Oligocene Ogwashi-Asaba Formation.

The Nanka Sands, which underlie Ogboji, are highly susceptible to erosion, contributing to significant land degradation in the region. These sands are predominantly sandy, interspersed with thin claystone and siltstone bands that retain substantial water content. According to Akpokodje (2001), the mechanical behaviour of sandy soils, such as those in the Nanka Sands, changes significantly with variations in grain size distribution. This can lead to either stable or unstable soil conditions during loading, unloading, and reloading, such as from tectonic activities. The grain size distribution, rather than moisture content alone, plays a critical role in soil stability, making Ogboji particularly vulnerable to erosion.

The susceptibility to erosion is further exacerbated by the hydrogeological and geotechnical properties of the Nanka Sands. High pore water pressures within the formation reduce the effective strength of the unconsolidated coarse sands, leading to intense erosion, mass movements, and sediment removal, especially during the rainy season (Egboka and Okpoko, 1984). These pressures, combined with the region's unique textural properties, drive the genesis and growth of gullies, a major environmental concern in Ogboji.

Moreover, recent studies have highlighted the significance of sulphur and iron geochemistry in the area, with widespread precipitates of iron sulphide, gypsum, and sulphur contributing to the complex erosion dynamics. While the concentration of these elements has not been recently assessed, their presence indicates additional factors influencing the region's geological instability.

The geological context of Ogboji is further complicated by the interplay of these sandy formations with minor claystone and shale layers. While the permeable sands dominate the formation, the less permeable claystone and shale, when saturated, lose shear strength, leading to landslides and other mass movements. This combination of factors—mechanical behaviour, hydrogeology, and geochemistry—makes the Nanka Sands in Ogboji particularly prone to erosion and land degradation, necessitating careful management and mitigation efforts.

- ***Hydrogeology***

The Nanka Sands are notable for their significant water-bearing capacity, with permeable aquifers composed mainly of medium to coarse-grained sands. These sands exhibit high porosity and permeability, allowing for efficient groundwater storage and transmission.

The groundwater table in Ogboji fluctuates seasonally, rising during the rainy season due to surface water infiltration. The presence of thin claystone and siltstone bands within the sands leads to the formation of perched aquifers in certain areas, adding complexity to the groundwater flow dynamics. While these hydrogeological conditions enhance the area's aquiferous nature, they also contribute to its vulnerability to erosion and gully formation, particularly when high pore water pressures reduce soil strength during the rainy season.

4.3.6.2.2 Geology of Ogbunka in Orumba South LGA

Ogbunka, though underlain by the Nanka Sands, generally benefits from stable slope conditions, as noted by Ogbukagu (1976) and highlighted by Onuchukwu (2024). The area's stability is supported by these slope conditions, which mitigate the risk of significant erosion.

However, the presence of interbedded shales in the region contributes to the potential for gullying, particularly due to their tendency to undergo significant volume changes with alternating wetting and drying cycles. This process leads to the contraction of clay and shale materials, forming extensive tension cracks and pressure-release fractures. While this phenomenon is present in Ogbunka, it is not expected to pose a threat to the project or to significantly impact soil stability.

Hydrogeology of Ogbunka

Ogbunka shares its geological foundation with the Nanka Sands but benefits from more stable slope conditions, resulting in different hydrogeological dynamics. The aquifers here consist mainly of permeable sands, which facilitate significant groundwater storage and flow. The interbedded shale layers, though less permeable, create semi-confined aquifers in certain areas.

Groundwater levels in Ogbunka are generally stable, with less seasonal fluctuation compared to Ogboji. The stable slope conditions contribute to reduced groundwater-induced erosion, though localised zones of weakness may exist due to the interbedded shales. Overall, the groundwater resources in Ogbunka are sufficient to meet local demands, with the aquifer system providing a reliable water source for both domestic and agricultural use.

4.3.6.2.3 Geology of Ugbene in Awka North LGA

Ugbene, located in Awka North Local Government Area of Anambra State, features a flat land terrain underlain by Imo Shale and other geological formations. The area includes fine sands mixed with stone and silt, characterised by fine to coarse-grained cross-bedded sandstone with clay drapes. These sandstone formations belong to the subtidal bar facies association and form the basal section of the Nanka Formation, extending into Ebenebe and Ugbene, with similar samples found in Umunya.

The sandstone in this region is noted for its quartz composition, making it mineralogically mature. It contains 90–97% quartz, with a minor amount of rock fragments (2–8%) and near-zero feldspar content, classifying it as quartz-arenite. The framework is composed of over 50% monocrystalline quartz and about 45% polycrystalline quartz.

The sandstone beds range from a few centimetres to meter-scale thickness, featuring unidirectional high-angle cross-beds and trough cross-beds with clay drapes. The clay drapes merge across the cross-beds, and the bed thickness varies from more than 1 cm to about 10 cm intervals. These facies exhibit abundant Ophiomorpha and Chondrite burrows, indicating deposition in an oxic environment.

The sharp base sandy heterolith lithofacies are demarcated by a ferruginous erosional surface, particularly well-developed at Agu-Awka. This detailed geological profile of Ugbene highlights its complex sedimentary history and mineral composition.

Hydrogeology of Ugbene

Ugbene's hydrogeology is influenced by the underlying Imo Shale and Nanka Formation's sandstone layers. The quartz-arenite sandstone is highly permeable, supporting groundwater storage and flow. However, the presence of clay drapes can create semi-confined aquifer conditions, affecting groundwater dynamics.

Groundwater levels in Ugbene are relatively stable, with slow flow rates due to the flat terrain. Seasonal variations in water levels occur during periods of heavy rainfall, but the permeable sandstone allows for adequate recharge. Groundwater quality may be influenced by the ferruginous erosional surfaces within the formation, leading to potential iron-rich mineral accumulation. The well-oxygenated conditions in Ugbene's groundwater are beneficial for maintaining water quality despite the potential for localised contamination.

4.3.6.2.4 Geology of Omor in Ayamelum LGA

Omor is primarily underlain by alluvial deposits, with the Benin and Ogwashi formations present in smaller areas. The Ogwashi Formation is the oldest geological unit in this region, while the alluvial deposits are the youngest. The dominant sediment in Omor is alluvial mud, which is characteristic of the swampy conditions of the area. This contributes to significant sedimentation in surface waters, leading to high levels of pollution.

The predominant soil type in Omor is clay, often referred to geologically as shale. This contrasts with the sandy, highly erodible soils found in Ugbene and other areas. The clay soils in Omor, while less prone to erosion, contribute to increased sedimentation and water pollution.

From a geological standpoint, the alluvial muds and clay soils, coupled with high sedimentation rates, suggest a higher risk of flooding and water pollution, which contrasts with Ugbene’s sandstone formations, which despite their complex sedimentary history, offer relatively more stability with lower erosion rates.

Hydrogeology of Omor

Omor presents a distinct hydrogeological profile due to its alluvial deposits and the presence of the Benin and Ogwashi formations. The area's swampy conditions, combined with alluvial mud sediments, significantly influence its hydrogeology.

The alluvial deposits are highly porous, forming unconfined shallow aquifers that are directly influenced by surface water. The clay-rich soils, while contributing to water retention, limit groundwater movement, resulting in slow recharge and discharge rates. The confined nature of the aquifers in some areas poses challenges for groundwater extraction, potentially limiting well yields.

High sedimentation rates in Omor contribute to water pollution, both in surface waters and within the groundwater system. The area's flood-prone nature further exacerbates these challenges, making groundwater management a critical concern.

4.2.2.3.5 Summary of the Geology of the Project Areas

Table 4.16 provides a summary of the geological and hydrogeological characteristics of the project areas, highlighting the major geological units and their respective lithologies. The table categorises the geological formations present in each location, identifying key characteristics such as erodibility and soil composition. This summary is crucial for understanding the geological context of the project areas, which influences factors such as erosion susceptibility, soil stability, and potential environmental impacts.

Table 4.16: Summary of the Geology and Hydrogeology of the Project Areas

S/N	Project Location	Summary of Geology of the Project Area
1	Ogboji and Ogbunka in Orumba South LGA	♦ The major geological formation is the Nanka Formation with a high erodibility index. ♦ This formation is dominated by highly friable sands with high soil pore water content. ♦ Prolific aquifer with high yield and high recharge potential due to numerous surface water systems ♦ Average depth to water table: 20-40 m in Ogboji and 40 m in Ogbunka ♦ Borehole drill depths: 110-150 m in Ogboji and 200 m in Ogbunka ♦ Suitable for industrial-level boreholes with high expected yield
3	Ugbene in Awka North LGA	♦ Predominantly underlain by the Imo shale formation. Also present are the Ebenebe Sandstone the Imo Formation ♦ The Dominant lithologies are shale and sand; gravel present ♦ Dominant lithology: Nanka Formation ♦ Prolific aquifer with high yield and high recharge potential due to numerous surface water systems ♦ Borehole depths: 6-30 m ♦ Average depth to water table: 11-30 m ♦ Water table depth: 11.2-56.5 m ♦ Aquiferous zones: 6.8-23.3 m thick ♦ 50% confined aquifers, 50% unconfined aquifers ♦ Suitable for industrial-level boreholes with high expected yield

S/N	Project Location	Summary of Geology of the Project Area
4	Omor, Ayamelum LGA	♦ Primarily underlain by alluvium deposits, with smaller areas underlain by the Benin and Ogwashi formations. ♦ The dominant lithology is shale. ♦ Riverine environment with high recharge potential ♦ Average depth to water table: as shallow as 2 m ♦ Borehole depths: 35-50 m ♦ Suitable for industrial-level boreholes with high expected yield

Source: Compiled from the literature cited in this section

4.3.7 Drainage System and Hydrology

Anambra State's drainage system is complex, shaped by its varied topography and numerous water bodies, and situated within the larger Niger River Basin. The major rivers in the state are Rivers Niger and Anambra. Other significant rivers include the Idemili River, Nkisi River, Orashi, Ezu, and Mamu, amongst others. The Omambala River also plays a very significant role within the Anambra North senatorial zone of the State and into Onitsha its main commercial city. It is, however, important to note that most river systems in the project area ultimately join the Ezu River, then into the Omambala River (which most people refer to as "Anambra River" – though riverine communities insist on "Omambala') before discharging into the ocean via the River Niger.

The Niger River forms Anambra's western border and is one of Africa's largest rivers. It serves as a vital source for agriculture, fisheries, and transportation throughout the region. The floodplains along the Niger and its tributaries, while fertile and agriculturally productive, experience seasonal flooding, necessitating robust flood management and erosion control strategies to protect communities and farmlands.

The Anambra River basin is the major drainage system in Anambra State. Regionally speaking, the basin encompasses the Anambra River and its associated drainage systems. A tributary of the River Niger, Anambra River is the most important feeder for the Niger River below Lokoja. The Anambra River flows centrally through the state, crucial in local life. It supports agriculture and fisheries and provides water supply. The river also holds cultural significance before ultimately draining into the Niger. The drainage pattern of the Anambra drainage basin is generally dendritic with tributaries generally in a southerly direction (Nnaji *et al.*, 2023). The dendritic drainage nature of the area signifies a homogeneous underlying material where structural control is lacking. The Anambra River and its tributaries are perennial, resulting in dominant rainforest plants along their banks.

4.3.7.1 Drainage Patterns

Regionally, the drainage pattern of the Anambra River Basin is predominantly dendritic, with tributaries generally flowing in a southerly direction (Nnaji *et al.*, 2023). This pattern indicates a homogeneous underlying material with minimal structural control. The dendritic drainage nature also reflects the elevation gradient across the state: the southern senatorial zone is higher than the northern zone. Water flows downhill towards the lower elevations in the north, towards the Niger River (Ayogu *et al.*, 2019).

The state's topography and the dendritic drainage pattern highlight how elevation differences control water flow. The northern flow direction from the higher southern areas towards the Niger River reinforces the role of elevation models in understanding regional drainage and hydrology (Nnaji *et al.,* 2023).

The floodplains along the Niger River and its tributaries experience significant seasonal flooding, affecting agriculture and local communities. Effective flood management strategies are essential to mitigate these impacts. The perennial rivers and their surrounding rainforest vegetation play a critical role in supporting the region's biodiversity and ecological stability (Ayogu *et al*., 2019).

Figure 4.22 illustrates the typical dendritic drainage pattern within the Anambra Basin.

Figure 4.22: Map showing the dendritic drainage Pattern of the Anambra River Basin

Source: Ayogu *et al*. (2019)

4.3.7.2 Overview of the Local Drainage Systems of Project Locations

4.3.7.2.1 Ogboji, Orumba South LGA

The Ogboji community features a dendritic drainage pattern culminating in Ahomiri. In addition to the Eso (or Eso Ogbo) stream, closest to the project location, several surface waters are found around Ogboji, including Nweze, Ako Okpa, Nkwukwo, and Ngene Ogbo, which all converge into River Ogbo, a tributary to River Otalu (which forms the border with Aguluezechukwu in Aguata LGA) and Ahommiri. Plate 4.7 shows a section of River Eso and the pathway leading to it.

Path to Eso Stream in Ogboji. Notice the undulating erosion-prone terrain

The upstream section of the Eso Stream, flanked by forest vegetation

Ogboji 3 – A closer look at the upstream section of Eso Stream, Notice the water issuing from a man-made pipe. Local says the source is a rock. The section is for domestic use only

Ogboji 4 – Sampling of Eso River

Plate 4.7: Photos showing the slopy part to Eso Stream. Notice the undulating terrain
Source: Anambra SAPZ ESIA Field Data (2024)

4.3.7.2.2 Ogbunka, Orumba South LGA

The drainage system in Ogbunka is primarily influenced by the Mmiri Uruokpukpo River, which flows into the Mmiri Unyo River and subsequently drains into the Imo River. Another notable watercourse in the area is Mmiri Ngele Ojie, which also serves as a tributary to Mmiri Unyo. The landscape around Mmiri Uruokpukpo is characterised by a mix of forested areas and farmlands. The riverbanks are densely vegetated, and the river itself winds through the forest, creating a meandering flow pattern. However, accessibility to several parts of the river is limited, making it challenging to sample it. As depicted in Plate 4.7, the river's sections are visually similar, making them difficult to distinguish from one another.

Sand deposits at near the Mmiri Uruokpukpo River **Upstream of Mmiri Uruokpukpo**

Section of the forested around Mmiri Uruokpukpo **Downstream of Mmiri Uruokpukpo**

Plate 4.8: Photos showing the Sections of Mmiri Uruokpukpo in Ogboji

Source: Anambra SAPZ ESIA Field Data (2024)

4.3.7.2.3 Ugbene, Awka North LGA

In Ugbene, the river drainage system directs flow towards the Ezu River, also known locally as the Nnamuzu River. The Ezu River has tributaries that eventually join the Omambala River, which further flows into the Niger River. Plate 4.9 shows some sections of surface waters in the town.

Ugbene 1 – River Nnamuzu – Avery important source of domestic water for locals

Ugbene 2 – Another section of Nnamuzu River – Not sampled due to accessibility

Ugbene 3 –Nnamuzu River (Right View)

Ugbene 4 – Nnamuzu River (Left View)

Plate 4.9: Photos showing the Sections of the Nnamuzu River in Ugbene

Source: Anambra SAPZ ESIA Field Data (2024)

4.3.7.2.4 Omor, Ayamelum LGA

Omor, a riverine community, is closely situated between the Omambala River and the Niger River. The major river drainage system starts from the Mmiri Otakpu and joins the Okpu River. This system then continues into the Ezu River and eventually flows into the Omambala River. Plate 4.10 is a collage of River Otakpu taken during fieldwork.

Upstream of Mmiri Otakpu in Omor

Omor 2 – Another Section of Mmiri Otakpu

Omor 3 – Sampling of Otakpu River (Midstream)

Downstream of Otakpu River in Omor

Plate 4.10: Photos showing the Sections of the Nnamuzu River in Ugbene
Source: Anambra SAPZ ESIA Field Data (2024)

4.3.7.2.5 Summary of the local hydrology

The hydrology and drainage of the project areas are interconnected with the Ezu River system, the Omambala River system, and the Niger River system. These three river systems are crucial for draining the area and influencing the geochemistry and water resources of the region. Sampling was conducted at the primary tributaries within the immediate project environments.

The physiochemistry reports will reflect data from the primary rivers in the communities of Ogbunka, Ogboji, Ugbene, and Omor.

4.3.8 Soil Study Areas

Soil is the loose material that covers most land surface areas. It consists of inorganic particles and organic matter and provides the structural support and source of water and nutrients to plants and habitats for soil-dwelling organisms. Soil formation is affected by the interplay of these five factors: climate, parent material, climate, topography, relief, time, and organisms inhabiting the area. Each factor's relative influence varies from geographical location to geographical location, but their combined effects generally determine the kind of soil developing in any given place. Soils can be classified using their particle sizes into clay, silt, and sand, which determine their texture (Food and Agricultural Organisation of the United Nations (FAO] n,d.).

In Anambra State, the soil types are deeply influenced by the geology and hydrology of the state. Ayadiuno *et al.* (2022) used topography and the type of parent material from which the soils are derived to discuss the soil types in Anambra State, diving them into soils associated with low wet topography and soils formed on sands and sandstones in the central and the southern part of the State

A. **Soils of the Low Wet Topography (Riverine Alluvium):** These soils dominate the Anambra plains, Niger flood plains, and the Mamu basin, primarily located in the northern, southwestern, and eastern regions of the state. They are characterised by their greyish colour and flat, low-lying nature with slopes less than 5 degrees. The soils have finer textures due to their formation from river deposits, also known as alluvium. Areas with these soil types include Ayamelum, Anambra West, Awka North, Onitsha North, Onitsha South, and Ogbaru Local Government Areas.

B. **Soils on Sands and Sandstones (Hill Slopes):** In contrast to the plains, these soils are found on elevated areas with slopes. They can be further divided into two subgroups: slope wash soils and talus slope soils. Slope wash soils are limited strips that border the plains and are formed by the down-washing of materials from higher slopes. They have a moderate slope angle ranging from 5 to 15 degrees and lie at elevations between 60 and 120 meters above sea level. Locations with these slope wash soils include Anambra East, Idemili South, Oyi, Dunukofia, Awka South, Nnewi North, and Nnewi South Local Government Areas. The origin of talus slope soils is the steeper slopes above the slope wash areas. They are found in Anaocha, Aguata, Orumba North, Orumba South, and Awka South Local Government LGAs. Their origin from weathered rocks (talus) suggests they may have coarser textures compared to the alluvial soils.

4.3.8.1 Soil Characteristics of Omor Project Area

The baseline soil physiochemical properties were determined for the Anambra SAPZ project areas in Ogboji, Ogbunka, Omor, and Ugbene using primary data collected during the rainy season between 9-13 July 2024. The control samples were collected at Igboriam in Anambra East LGA. Dry season soil characteristics were derived from secondary data sourced from secondary data from the 2020 Coscharis Farms Limited's EIA for the Integrated Rice Farm Project and Associated Infrastructure, located in the neighbouring town of Anaku in Ayamelum LGA, Anambra State.

4.3.8.1.1 Soil Physiochemistry

The baseline characteristics of the soil physiochemistry in the Omor project area are shown in Tables 4.17 and 4.18. The baseline was described using primary data collected during the study period in July 2024 (rainy season) and was compared to the dry season secondary data sourced from the Coscharis 2020 EIA for the Integrated Rice Mill Project in Anaku, Ayamelum LGA.

Appearance and Texture

The rainy season soil samples collected in Omor were generally brown in colour but exhibited different shades across different depths and sampling points. In the 0-15 cm layer, the soils were predominantly dark brown, with some samples showing very dark grey hues, indicating a range of organic matter content and soil conditions. In the 15-30 cm layer, the colours ranged from dark brown to reddish brown and dark greyish brown. This variation suggests differences in soil formation processes and moisture levels.

The soil texture also varied across the samples. Most samples from the 0-15 cm depth were classified as loam, which generally supports good drainage and fertility. However, some samples had clay and clay loam textures, which can affect water retention and aeration. The soil texture in the 15-30 cm layer ranged from loam to clay, reflecting variability in soil structure and water-holding capacity.

The control samples consistently exhibited a dark greyish-brown appearance and were uniformly classified as clay, suggesting a more homogeneous soil texture compared to the sampled soils.

The information on the soil appearance and texture was not provided for the dry season sample.

Soil Particle Compositions

The particle size composition of the rainy season soil samples from Omor varied across different depths and showed distinct characteristics compared to the dry season samples from Anaku.

For the 0-15 cm depth during the rainy season, sand content ranged from 22.10% - 47.55% (mean = 34.22%), indicating a mix of sandy and finer particles. Silt content at this depth varied from 24.90% - 39.40% (mean = 34.94%), and clay content ranged from 13.24% - 45.98% (mean = 30.84%), reflecting a balanced distribution of soil particles with a significant presence of clay. In comparison, the dry season samples from Anaku showed a wider range in sand content in the 15 cm depth, ranging from 18.85% - 45.87% (mean = 31.12%). Silt contents were much lower, ranging from 5.82% - 28.01% (mean = 13.97%), while the clay composition was higher than in the rainy season, ranging from 47.18% - 72.72% (mean = 59.28%), suggesting a denser, more compact soil composition at this layer compared to the rainy season samples.

In the 15-30 cm layer in the rainy season, sand content ranged from 22.10% - 40.22% (mean = 28.12%), while silt content varied between 30.90% and 42.36% (mean = 35.79%). The clay content at this depth had a higher mean compared to the top layers (mean = 36.08%; range = 17.42% - 44.60%), indicating an increase in finer particles with depth. In the dry season samples, sand particle compositions ranged from 18.51% - 45.88% (mean = 31.41%), silt from 5.86% - 34.67% (mean = 15.22%), and clay from 40.65% - 74.86% (mean = 56.95%).

The control samples from the rainy season exhibited consistent sand, silt, and clay content across different depths. Sand content was 26.10% in the 0-15 cm layer and 28.80% in the 15-30 cm layer, silt content was 30.10% in the 0-15 cm layer and 31.00% in the 15-30 cm layer, and clay content was 40.20% in the topsoil and 43.80% in the subsoil. This indicates a more homogeneous particle size distribution in the control soils compared to the variability observed in the sampled locations.

Potential of Hydrogen (pH)

The pH levels in the rainy season soil samples from Omor ranged from 5.45 - 6.17 (mean = 5.77) in the 0-15 cm layer and from 5.80 - 6.10 (mean = 5.93) in the 15-30 cm layer, showing a slight increase with depth. In contrast, dry season samples from Anaku had a broader range from 4.86 - 7.65 (mean = 6.48) in the 0-15 cm layer. The control samples showed relatively stable pH values across depths, 6.00 in the 0-15 cm layer and 5.96 in the 15-30 cm layer, indicating a more homogeneous pH profile compared to the variability in the sampled locations.

Moisture Content

Moisture content during the rainy season was higher, ranging from 5.30% - 6.66% (mean = 6.10%) in the top 15 cm layer and from 4.48% - 5.90% (mean = 5.46%) in the 15-30 cm layer. The moisture content in the dry season samples was lower as was expected, ranging from 2.75% - 5.49% (mean = 4.28%) in the top 15 cm layer and from 3.02% - 5.07% (mean = 3.94%) in the 15-30 cm layer. The control samples from the rainy season maintained higher moisture content across both depths, approximately 6.0 % in both layers.

Electrical Conductivity

The EC values in the rainy season samples from Omor ranged from 67.50 - 86.20 µS/cm (mean = 78.92 µS/cm) in the 0-15 cm layer and from 62.70 - 78.90 µS/cm (mean = 72.44 µS/cm) in the 15-30 cm layer. EC was not reported for the dry season samples from Anaku. The rainy season control samples had EC values of 82.20 µS/cm in the 0-15 cm layer and 80.60 µS/cm in the 15-30 cm layer.

Bicarbonates and Chloride

Bicarbonate concentrations in the rainy season samples from Omor, ranging from 0.24 mg/kg - 1.65 mg/kg (mean = 0.87 mg/kg) in the top 15 cm layer from 0.10 mg/kg - 1.08 mg/kg (mean = 0.60 mg/kg) in the 15-30 cm layer. Bicarbonate levels were reported for the dry season samples. The control samples had bicarbonate levels of 1.10 mg/kg in the 0-15 cm layer and 0.90 mg/kg in the 15-30 cm layer.

The chloride concentrations in the rainy season samples ranged from 4.60 - 12.12 mg/kg (mean = 8.56 mg/kg) in the top 15 cm layer and from 3.33 - 13.57 mg/kg (mean = 8.12 mg/kg mg/kg) in the 15-30 cm layer. The dry season samples from Anaku had much higher chloride content, ranging from 9.99 - 28.35 mg/kg (mean = 17.08 mg/kg) in the 0-15 cm layer, and from 8.90 - 26.39 mg/kg (mean = 16.32 mg/kg) in the 15-30 cm layer. Control samples showed chloride contents of 8.98 mg/kg in the 0-15 cm layer and 9.20 mg/kg in the 15-30 cm layer, which were close to the mean observed in the project location.

Total Organic Carbon

The TOC levels were consistently higher in the rainy season samples, with values ranging from 9.50% - 14.29% (mean = 11.40%) in the top 15 cm layer and from 8.34% - 14.56% (mean = 11.38%) in the 15-30 cm layer. Dry season samples showed lower TOC values, ranging from 0.96% - 2.19% (mean = 1.44%) in the 0-15 cm layer and from 0.79% - 2.39% (mean = 1.41%), indicating similar TOC distribution across the two layers. Control samples had TOC levels comparable to the rainy season. The rainy season control samples had total organic carbon of 9.45% in the 0-15 cm layer and 10.00% in the 15-30 cm layer, comparable to those measured for the project area.

Ammonium, Nitrite and Nitrate

NH4-N levels in the rainy season samples ranged from 15.60 - 23.45 mg/kg (mean = 19.79) in the 0-15 cm layer and from 17.77 - 25.30 mg/kg (mean = 21.37) in the 15-30 cm layer. Ammonium was not reported in the dry season samples. The control samples had ammonium levels of 19.32 mg/kg at 0-15 cm and 18.50 mg/kg at 15-30 cm, comparable to the range reported for the project area.

NO_2^- levels in the rainy season samples ranged from 0.01 - 0.08 mg/kg (mean = 0.05) in the 0-15 cm layer and from 0.01 - 0.02 mg/kg (mean = 0.01) in the 15-30 cm layer. Nitrite was also not reported for the dry season samples. The control samples had nitrite levels of 0.01 mg/kg in both layers.

NO_3 levels were higher in the rainy season, ranging from 3.61 mg/kg - 8.53 mg/kg (mean = 7.0 mg/kg) in the 0-15 cm layer, compared to dry season samples with values from 0.28 mg/kg - 1.90 mg/kg (mean = 0.85 mg/kg). The rainy season control samples had nitrate levels of 8.10 mg/kg in the 0-15 cm layer and 9.23 mg/kg in the 15-30 cm layer.

Phosphates and Sulphates

PO_4^{3-} levels in the rainy season samples ranged from 3.33 - 5.93 mg/kg (mean = 4.57) in the 0-15 cm layer and from 3.49 - 6.60 mg/kg (mean = 5.20) in the 15-30 cm layer. The dry season samples had lower phosphate levels, ranging from 0.19 - 1.29 mg/kg (mean = 0.74) in the 0-15 cm layer and from 0.11 - 1.19 mg/kg (mean = 0.61) in the 15-30 cm layer. The control samples had phosphate levels of 4.09 mg/kg at 0-15 cm and 5.26 mg/kg at 15-30 cm, not much different from the levels measured in the project area.

SO_4 concentrations were generally lower in the rainy season, ranging from 2.00 mg/kg - 10.00 mg/kg (mean = 5.60 mg/kg) in the 0-15 cm layer. On the other hand, the dry season concentrations ranged from 7.39 mg/kg - 21.39 mg/kg (mean = 14.54 mg/kg). The control samples had SO4 levels of 7.00 mg/kg in the 0-15 cm layer and 9.00 mg/kg in the 15-30 cm layer.

Total Hydrocarbon

THC levels in the rainy season samples ranged from 1.05 - 3.42 mg/kg (mean = 2.03) in the 0-15 cm layer and from 0.99 - 2.39 mg/kg (mean = 1.64) in the 15-30 cm layer. THC concentrations were not reported in the dry season samples. The control samples had THC levels of 0.99 mg/kg in the 0-15 cm layer and 0.05 mg/kg in the 15-30 layer.

Summary of the Observed Physiochemistry

Overall, the rainy season samples from Omor generally exhibited higher moisture content, total organic carbon, and certain nutrient levels compared to the dry season samples from Anaku. While these differences suggest seasonal variations, the spatial differences between Omor and Anaku, both of which are agricultural areas, also play a significant role in shaping soil characteristics. Agricultural practices, such as crop rotation, irrigation methods, and fertilizer application, can have a profound impact on soil physiochemistry, influencing moisture content, organic carbon levels, and nutrient availability. Differences in these can contribute to the observed variations in soil properties, in addition to the inherent geological formations and land use histories in the areas. The higher clay content observed in deeper layers is more probably a result of geological composition than agricultural practices. The stability seen in control samples reinforces this idea.

Table 4.17: Topsoil Soil Physiochemistry in Omor (Rainy Season) and Anaku (Dry Season)

S/N	Descriptive Statistics	Topsoil (0–15 cm) Omor (Rainy Season)					Topsoil (0–15 cm) Anaku (Dry Season)			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	Sand (%)	22.10	47.55	34.22	10.82	31.405	22.10	40.22	28.12	6.25
2	Silt (%)	24.90	39.40	34.94	5.48	15.2225	30.90	42.36	35.79	4.34
3	Clay (%)	13.24	45.98	30.84	14.06	56.9475	17.42	44.60	36.08	10.03
4	pH	5.45	6.17	5.77	0.25	6.00	4.86	7.65	6.48	1.19
5	Moisture Content (%)	5.30	6.66	6.10	0.45	6.00	2.75	5.49	4.28	1.10
6	EC (µS/cm)	67.50	86.20	78.92	6.63	82.20	ND	ND	ND	ND
7	Bicarbonate (mg/kg)	0.24	1.65	0.87	0.46	1.10	ND	ND	ND	ND
8	Chloride (mg/kg)	4.60	12.12	8.56	2.96	8.98	9.99	28.35	17.08	7.14
9	Total Organic carbon (%)	9.50	14.29	11.40	1.70	9.45	0.96	2.19	1.44	0.46
10	NH4 (mg/kg)	15.60	23.45	19.79	2.64	19.32	ND	ND	ND	ND
11	NO_2 (mg/kg)	0.01	0.08	0.05	0.03	0.01	ND	ND	ND	ND
12	NO_3 (mg/kg)	3.61	8.53	7.00	1.74	8.10	0.28	1.90	0.85	0.64
13	PO_4 (mg/kg)	3.33	5.93	4.57	0.96	4.09	0.19	1.29	0.74	0.46
14	SO_4 (mg/kg)	2.00	10.00	5.60	3.26	7.00	7.39	21.39	14.54	5.60
15	THC (mg/kg)	1.05	3.42	2.03	0.94	0.99	ND	ND	ND	ND

* Control Values not included in calculations; ND: Not Determined

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

Table 4.18: Subsoil Physiochemistry in Omor (Rainy Season) and Anaku (Dry Season)

S/N	Descriptive Statistics	Subsoil (15-30 cm) Omor (Rainy Season)					Subsoil (15-30 cm) Anaku (Dry Season)			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	Sand (%)	26.10	28.80	18.85	45.87	10.19	31.12	10.28	18.51	45.88
2	Silt (%)	30.10	31.00	5.82	28.01	11.75	13.97	9.12	5.86	34.67
3	Clay (%)	43.80	40.20	47.18	72.72	14.00	59.28	11.67	40.65	74.86
4	pH	5.80	6.10	5.93	0.12	5.96	5.73	7.63	6.48	0.77
5	Moisture Content (%)	4.48	5.90	5.46	0.51	5.99	3.02	5.07	3.94	0.79
6	EC (µS/cm)	62.70	78.90	72.44	6.86	80.60	ND	ND	ND	ND
7	Bicarbonate (mg/kg)	0.10	1.08	0.60	0.37	0.90	ND	ND	ND	ND
8	Chloride (mg/kg)	3.33	13.57	8.12	4.15	9.20	8.90	26.39	16.32	7.24
9	Total Organic carbon (%)	8.34	14.56	11.38	2.19	10.00	0.79	2.39	1.41	0.60
10	NH4 (mg/kg)	17.77	25.30	21.37	2.62	18.50	ND	ND	ND	ND
11	NO_2 (mg/kg)	0.01	0.02	0.01	0.00	0.01	ND	ND	ND	ND
12	NO_3 (mg/kg)	3.46	8.08	6.69	1.65	9.23	0.28	1.02	0.61	0.29
13	PO_4 (mg/kg)	3.49	6.60	5.20	1.22	5.26	0.11	1.19	0.61	0.46
14	SO_4 (mg/kg)	3.00	9.00	5.60	2.42	9.00	6.00	20.90	13.38	5.68
15	THC (mg/kg)	0.99	2.39	1.64	0.52	0.05	ND	ND	ND	ND

* Control Values not included in calculations; ND: Not Determined

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

4.3.8.1.2 Soil Exchangeable Cations and Cation Exchange Capacity (CEC)

The analysis of exchangeable cations and CEC in soil samples from Omor during the rainy season and Anaku during the dry season are shown in Tables 4.19 and 4.20. Exchangeable cations refer to positively charged ions loosely bound to soil particles, particularly clay minerals and organic matter (Cornell University Cooperative Extension [CUCE], (2007). These ions can be readily exchanged within the soil solution, impacting soil fertility and nutrient availability for plant growth. Ca, Mg, and K are macronutrients for plants, essential for various physiological and biochemical processes. Ca is crucial for cell wall structure and stability; magnesium is a central component of chlorophyll and vital for photosynthesis. K regulates various metabolic processes, including enzyme activation, water balance, and protein synthesis. Mg, while not a primary macronutrient, can influence soil structure and osmotic balance within plant cells (Maathuis, 2009). The concentration and balance of these exchangeable cations in the soil are indicators of soil health and fertility, affecting plant growth and agricultural productivity. Similarly, the cation exchange capacity (CEC) influences the soil's ability to hold onto essential nutrients and provide a buffer against soil acidification. Soils with a higher clay fraction tend to have a higher CEC.

Exchangeable Potassium (X-K): The rainy season concentrations of X-K ranged from 5.630 - 11.020 Cmol/kg (mean = 7.376 Cmol/kg) in the 0-15 cm layer and from 4.110 - 9.600 Cmol/kg (mean = 6.710 Cmol/kg) in the 15-30 cm layer. In contrast, the dry season samples showed higher levels, ranging from 10.04 - 26.27 Cmol/kg (mean = 19.935 Cmol/kg) in the 0-15 cm layer and from 10.42 - 22.87 Cmol/kg (mean = 16.21 Cmol/kg) in the 15-30 cm layer. The control samples had exchangeable K levels of 8.820 Cmol/kg in the 0-15 cm layer and 8.990 Cmol/kg in the 15-30 cm layer.

Exchangeable Sodium (X-Na): X-Na rainy season concentrations in soil samples ranged from 30.0 - 45.34 Cmol/kg (mean = 37.0 Cmol/kg) in the 0-15 cm layer and from 32.23 - 48.0 Cmol/kg (mean = 41.432 Cmol/kg) in the 15-30 cm layer. The dry season samples had higher levels, ranging from 41.01 - 71.51 Cmol/kg (mean = 54.4725 Cmol/kg) in the 0-15 cm layer, and from 42.19 - 72.56 Cmol/kg (mean = 55.83 Cmol/kg) in the 15-30 cm layer. The control samples had levels of 36.0 Cmol/kg in the 0-15 cm layer and 32.200 Cmol/kg in the 15-30 cm layer

Exchangeable Calcium (X-Ca): Exchangeable calcium concentrations in the rainy season samples ranged from 19.34 - 29.8 Cmol/kg (mean = 25.368 Cmol/kg) in the 0-15 cm layer and from 19.66 - 29.10 Cmol/kg (mean = 23.252 Cmol/kg) in the 15-30 cm layer. The dry season samples showed much lower concentrations, ranging from 0.024 - 3.814 Cmol/kg (mean = 1.833 Cmol/kg) in the 0-15 cm layer, and from 0.094 - 4.162 Cmol/kg (mean = 2.153 Cmol/kg) in the 15-30 cm layer. The levels measured in the control samples were 24.50 Cmol/kg in the 0-15 cm layer and 23.610 Cmol/kg in the 15-30 cm layer.

Exchangeable Magnesium (X-Mg): The levels of exchangeable magnesium measured in the rainy season samples ranged from 11.1 - 15.370 Cmol/kg (mean = 12.598 Cmol/kg) in the 0-15 cm layer and from 10.05 - 15.620 Cmol/kg (mean = 13.350 Cmol/kg) in the 15-30 cm layer. The dry season samples had lower levels, ranging from 0.771 - 3.805 Cmol/kg (mean = 2.3605 Cmol/kg) in the 0-15 cm layer, and from 1.091 - 4.184 Cmol/kg (mean = 2.7395) in the 15-30 cm layer. Control samples had levels of 11.83 Cmol/kg at 0-15 cm layer and 11.5 Cmol/kg at 15-30 cm layer.

Cation Exchange Capacity (CEC): The cation exchange capacity in the rainy season samples ranged from 12.30 - 16.92 Cmol/kg (mean = 14.524 Cmol/kg) in the 0-15 cm layer, and from 9.0 - 16.0 Cmol/kg (mean = 14.374) in the 15-30 cm layer. CEC was not assessed in the dry season samples from Anaku. The control samples had CEC values of 15.30 Cmol/kg in the 0-15 cm layer and 15.97 Cmol/kg in the 15-30 cm layer.

Table 4.19: Topsoil Exchangeable Cations and Heavy Metals in Omor (Rainy Season) and Anaku (Dry Season)

S/N	Descriptive Statistics	**Topsoil (0–15 cm) Omor (Rainy Season)**					**Topsoil (0–15 cm) Anaku (Dry Season)**			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	Exchangeable K+ (Cmol/kg)	5.630	11.020	7.376	2.185	8.820	10.04	26.27	19.935	6.05063
2	Exchangeable Na+ (Cmol/kg)	30.000	45.340	37.000	5.242	36.000	41.01	71.51	54.4725	11.8893
3	Exchangeable Ca+ (Cmol/kg)	19.340	29.800	25.368	3.665	24.500	0.024	3.814	1.833	1.510348
4	Exchangeable Mg+ (Cmol/kg)	11.100	15.370	12.598	1.544	11.830	0.771	3.805	2.3605	1.309399
5	CEC (Cmol/kg)	12.300	16.920	14.524	1.606	15.300	9.000	16.000	14.374	2.713
6	Al (mg/kg)	<0.001	2.680	0.952	1.181	1.830	ND	ND	ND	ND
7	Cd (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Cr (mg/kg)	<0.001	0.030	0.006	0.012	<0.001	<0.001	<0.001	<0.001	<0.001
9	Fe (mg/kg)	276.9	321.9	296.0	14.7	288.7	63.16	121.10	88.60	22.23
10	Pb (mg/kg)	<0.001	1.450	0.580	0.570	0.010	0.08	0.18	0.13	0.05
11	Ni (mg/kg)	<0.001	0.020	0.004	0.008	<0.001	0.01	0.18	0.08	0.07
12	Zn (mg/kg)	2.000	2.990	2.374	0.361	2.530	0.06	0.78	0.44	0.26

*** Control Values not included in calculations; ND: Not Determined**
Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

Table 4.20: Subsoil Exchangeable Cations and Heavy Metals in Omor (Rainy Season) and Anaku (Dry Season)

S/N	Descriptive Statistics	Topsoil (0–15 cm) Omor (Rainy Season)					Topsoil (0–15 cm) Anaku (Dry Season)			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	Exchangeable K+ (Cmol/kg)	4.110	9.600	6.710	2.249	8.990	10.42	22.87	16.21	4.482170233
2	Exchangeable Na+ (Cmol/kg)	32.230	48.000	41.432	7.444	32.200	42.19	72.56	55.83	11.47365461
3	Exchangeable Ca+ (Cmol/kg)	19.660	29.100	23.252	3.593	23.610	0.094	4.162	2.153	1.461069814
4	Exchangeable Mg+ (Cmol/kg)	10.050	15.620	13.350	2.185	11.500	1.091	4.184	2.7395	1.289467041
5	CEC (Cmol/kg)	15.970	ND	ND	ND	ND	ND	ND	ND	ND
6	Al (mg/kg)	<0.001	2.680	0.952	1.181	1.830	ND	ND	ND	ND
7	Cd (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Cr (mg/kg)	<0.001	0.030	0.006	0.012	0.000	<0.001	<0.001	<0.001	<0.001
9	Fe (mg/kg)	276.9	321.9	296.0	14.7	288.7	63.16	121.10	88.60	22.23
10	Pb (mg/kg)	<0.001	1.450	0.580	0.570	0.010	0.08	0.18	0.13	0.05
11	Ni (mg/kg)	<0.001	0.020	0.004	0.008	0.000	0.01	0.18	0.08	0.07
12	Zn (mg/kg)	2.000	2.990	2.374	0.361	2.530	0.06	0.78	0.44	0.26

*** Control Values not included in calculations; ND: Not Determined**

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

4.3.8.1.3 Heavy Metals

The results of the heavy metals analysis of rainy season soil samples from Omor and the dry season soil secondary data from Anaku are shown in Tables 4.17 (topsoil) and 18 (subsoil). The tables reveal distinct differences in their concentrations across depths and seasons

Aluminium: In the rainy season samples, ranged from non-detectable - 2.6 mg/kg (mean = 0.95 mg/) in the top 15 cm layer and also from non-detectable - 2.30 mg/kg (mean = 1.50 mg/kg) in the 15-30 cm layer. Al was not reported for the dry season samples. AL levels in the control were 1.83 mg/kg and 1.40mg/kg, respectively in the topsoil and subsoil. Al can be toxic to plants by inhibiting root growth and reducing nutrient uptake, significantly affecting soil fertility and crop yields (Kochian et al., 2005).

Cadmium: Cd concentrations were below detection levels (BDL) in all samples, indicating no significant presence of this heavy metal in either location during both the rainy and dry seasons.

Chromium: Cr was detected only in one sample OM3 with values of 0.03 mg/kg in the 0-15 cm layer and 0.050 mg/kg (mean = 0.010 mg/kg) in the 15-30 cm depth. Chromium was neither detected in the dry season samples nor the control samples.

Iron: Fe concentrations in the rainy season samples ranged from 276.9 - 321.9 mg/kg (mean = 296.0 mg/kg) in the 0-15 cm layer, and from 278.5 - 304.1 mg/kg (mean = 292.3 mg/kg) in the 15-30 cm layer. In contrast, the dry season samples exhibited much lower Fe levels, ranging from 63.16 mg/kg - 121.10 mg/kg (mean = 88.60 mg/kg) at 0-15 cm depth and 51.86 mg/kg - 104.70 mg/kg (mean = 78.12 mg/kg) at 15-30 cm depth, indicating a significant seasonal and spatial variation in Iron content. The control samples had iron levels of 288.7 mg/kg at 0-15 cm and 292.5 mg/kg at 15-30 cm. Fe is important for the development and function of chlorophyll and a range of enzymes and proteins, however high iron concentrations can affect plant growth and soil microbial activities (Lindsay and Schwab, 1982).

Lead: Pb levels in the rainy season samples ranged from below the detection limit (<0.001) - 1.450 mg/kg (mean = 0.580 mg/kg) in the 0-15 cm layer, and from BDL - 0.890 mg/kg (mean = 0.254 mg/kg) in the 15-30 cm layer. The metal was not detected in OM9 and OM10 topsoil samples and in OM 1 and 4 subsoil samples. In the dry season samples, Pb lead levels ranged from 0.08 - 0.18 mg/kg (mean = 0.13 mg/kg) in the 0-15 cm layer, and from 0.04 - 0.16 mg/kg (mean = 0.103 mg/kg) in the 15-30 cm layer. Control samples had lead levels of 0.010 mg/kg at both depths. Pb is highly toxic and can have severe health impacts, especially on children (Yu et al., 2022). Sources of lead (Pb) include geological origin and various industrial activities. Anthropogenic sources involve many high-temperature processes such as Pb ore smelting, lead-based paint, coal burning, and leaded petrol in automobiles. Pb can be redistributed by atmospheric transport due to its tendency to associate with smaller particle fractions in emissions from high-temperature sources (Steinnes, 2013). Pb levels measured in studies are often higher than the world average of 17 mg/kg, particularly in areas impacted by human activities, as reviewed by Steinnes (2013).

Nickel: Ni was absent in most rainy season samples, except OM3, with concentrations of 0.02 mg/kg in the top 15 cm and 0.06 mg/kg in the 15-30 cm layer. Ni levels in the dry season samples ranged from 0.01 mg/kg - 0.18 mg/kg (mean = 0.08 mg/kg) at 0-15 cm depth and 0.00 mg/kg - 0.14 mg/kg (mean = 0.066 mg/kg) at 15-30 cm depth. The control samples had nickel levels below detection limits. Ni is commonly used in battery manufacturing and a host of other industrial applications. Although naturally occurring the main anthropogenic sources in soils are emissions from metal processing operations and fumes from combustion of coal and oil oil (Gonnelli and Renella, 2013). Like many heavy metals assessed in this study, it is essential for plants and other living organisms but can be toxic at elevated concentrations.

Zinc: Zn levels in the rainy season samples ranged from 2.00 mg/kg - 2.99 mg/kg (mean = 2.37 mg/kg) in the 0-15 cm layer, and from 2.300 - 3.230 mg/kg (mean = 2.674 mg/kg) in the 15-30 cm layer. In the dry season samples, Zn levels ranged from 0.06 - 0.78 mg/kg (mean = 0.44 mg/kg) in the 0-15 cm layer, and from 0.08 - 0.58 mg/kg (mean = 0.348 mg/kg) in the 15-30 cm layer., which were lower than those of the rainy season. The control samples had zinc levels of 2.530 mg/kg at 0-15 cm and 2.700 mg/kg at 15-30 cm. Sources of Zn include geological processes and industrial activities which can lead to localised heavy metal enrichment. Zinc is essential for plant growth but can be toxic at elevated levels (Mertens and Smolders, 2013), however, the values reported in both fields are typical of those found in natural uncontaminated soil (Noulas *et al*., 2018).

The data shows clear seasonal and spatial variations, with Omor's rainy season samples generally exhibiting higher concentrations of heavy metals, particularly Fe, Pb, and Zn, compared to Anaku's dry season samples. While seasonal factors like rainfall can influence the mobility and distribution of heavy metals, the spatial differences between Omor and Anaku, both agricultural areas, play a significant role. These differences could be influenced by varying geological formations, soil composition, and agricultural practices. Additionally, depth plays a role, with deeper layers sometimes exhibiting slightly different metal concentrations compared to surface layers, suggesting that both temporal and geographic factors are crucial in understanding the distribution of heavy metals in the project area.

4.3.8.1.4 Soil Microbiology

The results of the analysis of the microbial community for dry season and rainy seasons are presented in Tables 4.21 and 4.22. Microbial groups investigated include total trophic bacteria and fungi, total coliform counts *Bacillus* spp. and *Pseudomonas aeruginosa*. However, data for *Bacillus* spp. and *P. aeruginosa* in the dry dry season soil samples were not available. The tables reveal notable differences, which may be related to seasonal or spatial variations.

Total Bacterial Count: The TBC in the rainy season samples ranged from 5.500 - 84.000 x 10^4 cfu/g (mean = 41.700 x 104 cfu/g) in the 0-15 cm layer, and from 6.900 - 61.000 x 10^4 cfu/g (mean = 34.580 x 10^4 cfu/g) in the 15-30 cm layer. In contrast, the dry season samples from Anaku showed a much higher total bacterial count, ranging from 1730 - 2870 10^4 cfu/g (mean = 2327.5 x 10^4 cfu/g) in the 0-15 cm layer, and from 1270 - 2419 x 10^4 cfu/g 4 (mean = 1817.5 x

10^4 cfu/g) in the 15-30 cm layer. Control samples had total bacterial counts of 8.800 cfu/g x 10^4 cfu/g in the top 15 cm layer and 0.730 cfu/g x 10^4 cfu/g in the 15-30 layer.

Total Fungal Count: The total fungal count in the rainy season samples ranged from 1.0 - 5.2 x 10^3 cfu/g (mean = 2.88 x 10^3 cfu/g) in the 0-15 cm layer, and from 1.000 - 6.800 x 10^3 cfu/g (mean = 3.226 x 10^3 cfu/g) in the 15-30 cm layer. The dry season samples from Anaku had a wider range, with total fungal counts ranging from 4 - 19 x 10^3 cfu/g (mean = 12.5 x 10^3 cfu/g) in the 0-15 cm layer, and from 4 - 26 x 10^3 cfu/g (mean = 15.5 x 10^3 cfu/g) in the 15-30 cm layer. Control samples had total fungal counts of 1.990 x 10^3 cfu/g in the 0-15 cm layer and 1.0 x 10^3 cfu/g in the 15-30 cm layer.

Total Coliform Count: In the rainy season samples, TCC ranged from 1.1 - 3.0 x 10 cfu/g (mean = 1.70 x 10 cfu/g) in the 0-15 cm layer, and from 1.000 - 3.5 x 10 cfu/g (mean = 1.74 x 10 cfu/g) in the 15-30 cm layer. The dry season samples from Anaku did not have detectable coliform counts (NG). Control samples had total coliform counts of 3.110 x 10 cfu/g in the top 15 cm layer and 2.200 x 10 cfu/g in the 15-30 cm layer.

***Bacillus* spp:** *Bacillus* spp. in the rainy season samples ranged from 0.38 - 0.41 x 10^2 cfu/g (mean = 0.395 x 10^2 cfu/g) in the 0-15 cm layer, and from 0.30 - 4.40 x 10^2 cfu/g (mean = 1.90 x 10^2 cfu/g) in the 15-30 cm layer. The microorganisms were not assessed in the dry season samples. Control samples had Bacillus spp. counts of 3.500 x 10^2 cfu/g in the 0-15 cm layer and 2.10 x 10^2 cfu/g in the 15-30 cm layer.

Pseudomonas aeruginosa: *P. aeruginosa* in the rainy season samples ranged from 0.11 - 1.50 x 10^2 cfu/g (mean = 0.970 x 10^2 cfu/g) in the 0-15 cm layer, and from 0.10 - 1.0 x 10^2 cfu/g (mean = 0.70 x 10^2 cfu/g) in the 15-30 cm layer. *P. aeruginosa* was also not assessed in the dry season samples. The rainy season control samples had no detectable counts of these microorganisms.

To summarise, the observed disparities in microbial populations between Omor (rainy season) and Anaku (dry season) soil samples are likely influenced by a complex interplay of factors, including seasonal variations, local environmental conditions, and land use practices. Although the dry season had significantly higher microbial populations than the rainy season sample, it is essential to acknowledge the potential effects of spatial differences between the two locations. Inferring the seasons to explain the observed disparities should be approached with caution. The unique characteristics of each site, such as soil type, topography, and vegetation cover, can also significantly impact soil microbial communities. Understanding the local environmental context is crucial for assessing the potential impacts of the proposed project and developing effective mitigation strategies.

Table 4.21: Topsoil Microbial Populations in Omor (Rainy Season) and Anaku (Dry Season)

S/N	Descriptive Statistics	Topsoil (0–15 cm) Omor (Rainy Season)					Topsoil (0–15 cm) Anaku (Dry Season)			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	TBC (cfu/g x 10^4)	5.50	84.0	41.7	30.6	8.80	1730.0	2870.0	2327.5	0.544
2	TFC (cfu/g x 10^3)	1.00	5.20	2.880	1.376	1.990	4	19	12.5	6.652
3	TCC (cfu/g x 10_1)	1.10	3.00	1.700	0.707	3.110	NG	NG	NG	NG
4	Bacillus spp. (cfu/g x 10^2)	0.38	0.41	0.395	0.015	3.500	ND	ND	ND	ND
5	Pseudomonas aeruginosa (cfu/g x 102)	0.11	1.50	0.970	0.614	NG	ND	ND	ND	ND

* Control Values not included in calculations; ND: Not Determined; NG: No Growth

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

Table 4.22: Subsoil Microbial Populations in Omor (Rainy Season) and Anaku (Dry Season)

S/N	Descriptive Statistics	Topsoil (0–15 cm) Omor (Rainy Season)					Topsoil (0–15 cm) Anaku (Dry Season)			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	TBC (cfu/g x 10^4)	6.900	61.000	34.580	20.817	0.730	1270.000	2419.000	1817.500	0.548424
2	TFC (cfu/g x 10^3)	1.000	6.800	3.226	1.955	1.000	4	26	15.5	10.52378
3	TCC (cfu/g x 10_1)	1.000	3.500	1.740	0.954	2.200	NG	NG	NG	NG
4	Bacillus spp. (cfu/g x 10^2)	0.300	4.400	1.900	1.791	2.100	ND	ND	ND	ND
5	Pseudomonas aeruginosa (cfu/g x 10^2)	0.100	1.000	0.700	0.424	NG	ND	ND	ND	ND

* Control Values not included in calculations; ND: Not Determined; NG: No Growth

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

4.3.8.2 Soil Characteristics of Ogboji

4.3.8.2.1 Physiochemical Characteristics

Table 4.23 shows the results of the rainy season soil characteristics of the Ogboji projection location, discussed below.

Appearance and Texture

The soil samples across the sampling points, along with a control, show some variations in appearance and texture at different depths. Most locations, particularly OGB1, OGB2, and OGB12 displayed a dark red colour at both 0-15 cm and 15-30 cm depths, indicating similar soil conditions throughout these areas. However, other sites like OGB 3 and OGB 5 exhibited slight variations, with the topsoil being darker or more reddish, suggesting differences in organic content or drainage.

In terms of texture, clay was the predominant soil type across most locations, suggesting high water retention but potentially poor drainage. However, some sites like OGB 3 and OGB 7 show clay loam or loam textures, which are more balanced and favourable for agriculture due to better aeration and drainage.

Particle Size Compositions

The sand content in the soil samples from Ogboji during the rainy season exhibited moderate variability across both depths, ranging from 22.00% - 32.50% (mean = 26.35%) in the top 15 cm layer and from 25.00% - 34.00% (mean = 27.60%) in the 15-30 cm layer, suggesting similar characteristics. In the control, the sand composition was 24.00% for the 0-15 cm depth and 25.00% for the 15-30 cm depth.

Silt content showed higher variability, with a range of 19.60% - 47.64% (mean = 32.38%) in the top 15 cm and 25.35% - 50.10% (mean = 33.15%) in the 15-30 cm. Silt composition in the control samples was 32.90% in the 0-15 cm layer and 36.90% in the 15-30 cm.

Clay content was consistently high across the samples, particularly in the top 15, ranging from 21.99% - to 47.90% (mean = 41.27%). Clay composition in 15-30 cm depth showed a similar trend, varying from 21.00% - 49.11% (mean = 39.25%). Clay also dominated in the control with values of 43.10% in the 0-15 cm layer and 38.10% in the 15-30 cm layer.

Potential of Hydrogen (pH)

The pH ranged from 5.00 - 6.70 (mean = 5.95) in the top 15 cm layer and from 5.50 - 6.44 (mean = 5.95) in the 15-30 cm layer, indicating acidic conditions across all samples Similarly, the pH values of the control samples were 5.50 in the top 15 cm and 5.35 in the 15-30 cm layer.

Moisture Content (%)

Soil moisture content (MC) refers to the amount of water present in the soil, usually expressed as a percentage of the soil's total weight or volume. The MC in the topsoil ranged from 5.11% -

6.70% (mean = 6.16%) and in the subsoil from 5.00% - 6.94% (mean = 6.20%), indicating a fairly uniform MC. The MC in the control was 5.88% in the topsoil and 5.60% in the subsoil.

Electrical Conductivity (EC)

EC measures the ability of the soil to conduct electrical current and is a function of the dissolved ions in the soil. EC values ranged from 115.20 µS/cm - 150.00 µS/cm (mean =132.78 µS/cm in the top 15 cm layer and from 110.20 µS/cm -152.40 µS/cm (mean = 132.79 µS/cm) in the 15-30 cm layer. These values were higher than the 76.20 µS/cm and 79.30 µS/cm measured in the control's 0-15 cm and the 15-30 cm layers, respectively.

Bicarbonate and Chloride

Bicarbonate and chloride are two common anions that play important roles in soil chemistry, influencing plant growth and soil health. Bicarbonate is an important buffer compound in soil management. Its values ranged from 0.01 mg/kg - 2.22 mg/kg (mean = 1.35 mg/kg) in the topsoil and from 0.03 mg/kg - 2.89 mg/kg (mean = 1.34 mg/kg) in the subsoil. The values recorded in the control were higher, being 2.45 mg/kg in the topsoil and 2.63 mg/kg in the subsoil. On the other chloride levels ranged from 10.10 mg/kg - 29.30 mg/k (mean = 21.58 mg/kg) in the topsoil and from 15.10 mg/kg - 32.60 mg/kg (mean = 22.32 mg/kg). Chloride levels in the control samples were 7.77 mg/kg in the top 15 cm layer and 8.30 mg/kg in the 15-30 cm layer. Chloride

Total Organic Carbon (TOC)

Total organic carbon (TOC) ranged from 3.70% - 12.20% (mean = 8.54%) in the topsoil and from 6.02% - 11.50% (mean = 8.96%) in the subsoil, which was higher than in the topsoil. TOC recorded in the control was 8.88% in the top 15 cm and 9.29% in the 15-30 cm. High TOC provides a carbon source for microorganisms and generally indicates a substantial presence of organic matter or slower nitrification processes.

Ammonium, Nitrite and Nitrate

The ammonium content ranged from 4.72 mg/kg - 10.20 mg/kg (mean = 7.93 mg/kg) in the 0-15 cm layer and from 4.41 mg/kg - 10.60 mg/kg (mean = 7.95 mg/kg). The control samples had levels of 17.90 mg/kg in the top 15 cm layer and 15.50 mg/kg in the 15-30 cm layer. The higher ammonium levels in the control samples correlated with their relatively higher TOC concentrations, suggesting localised nutrient enrichment.

Nitrite levels ranged from 0.01 mg/kg - 0.05 mg/kg (mean = 0.04 mg/kg in the top 15 cm and from 0.01 mg/kg - 0.09 mg/kg (mean = 0.04 mg/kg) in the 15 - 30 cm layer. Nitrite levels were very low in the control and were not detected in the topsoil (<0.001 mg/kg) and 0.02 mg/kg in the subsoil layer.

Nitrate levels ranged from 2.05 mg/kg - 11.39 mg/kg (mean = 5.68 mg/kg) in the topsoil and from 2.00 mg/kg - 12.20 mg/kg (mean = 5.75 mg/kg) in the subsoil. Its concentrations in the control samples were 5.44 mg/kg in the top 15 cm layer and 5.67 mg/kg in the 15-30 cm layer. Natural sources of nitrate include biological nitrogen fixation, atmospheric deposition, and nutrient recycling (Cleland and Harpole, 2010), while potential anthropogenic sources in the project area include agricultural practices.

Phosphates and Sulphates

The phosphate content in the soil samples showed high variability, ranging from 1.28 mg/kg - 15.97 mg/kg (mean = 5.77 mg/kg) in the top 15 cm and from 1.10 mg/kg - 12.60 mg/kg (mean = 5.59 mg/kg) in the 15-30 cm layer)> The levels measured in the controls were 7.34 mg/kg in the topsoil and 7.50 mg/kg in the subsoil. Phosphate is often a limiting nutrient in soils, essential for plant growth, particularly for root development and energy transfer.

Sulphate levels ranged from 5.00 mg/kg - 10.03 mg/kg (mean = 7.69 mg/kg) in the topsoil and from 5.50 mg/kg - 9.20 mg/kg (mean = 7.56 mg/kg), showing little variations with depths. Sulphate levels in the control samples were 8.00 mg/kg in the top 15 cm layer and 7.00 mg/kg in the 15-30 cm layer.

Total Hydrocarbon

The soil samples exhibited low to moderate hydrocarbon contamination, with values ranging from 0.80 mg/kg - 3.30 mg/kg (mean = 1.48 mg/kg) in the top 15 cm and from 0.56 mg/kg - 4.90 mg/kg (mean of 1.96 mg/kg) in 15-30 cm layer, suggesting downward movement of hydrocarbon into deeper soil layers. The control concentrations were 1.20 mg/kg in the top 15 cm layer and 1.00 mg/kg in the 15-30 cm.

Table 4.23: Soil Physiochemistry of Ogboji Project Area (Rainy Season; July 2024)

S/N	Parameter	Min *	Max*	Mean	Stdev*	Min*	Max*	Mean*	Stdev*	Control	Control
	Depth	**0-15**	**0-15**	**0-15**	**0-15**	**15-30**	**15-30**	**15-30**	**15-30**	**0-15cm**	**15-30cm**
	Physiochemical										
1	pH	5.00	6.70	5.95	0.49	5.50	6.44	5.95	0.32	5.50	5.35
2	EC (µS/cm)	115.20	150.00	132.78	11.27	110.20	152.40	132.79	12.43	76.20	79.30
3	Moisture Content (%)	5.11	6.70	6.16	0.49	5.00	6.94	6.20	0.53	5.88	5.60
4	Sand (%)	22.00	32.50	26.35	3.52	25.00	34.00	27.60	2.81	24.00	25.00
5	Silt (%)	19.60	47.64	32.38	7.69	25.35	50.10	33.15	7.61	32.90	36.90
6	Clay (%)	21.99	47.90	41.27	7.22	21.00	49.11	39.25	9.59	43.10	38.10
7	NH4-H (mg/kg)	4.72	10.20	7.93	1.74	4.41	10.60	7.95	1.94	17.90	15.50
8	Bicarbonate (mg/kg)	0.01	2.22	1.35	0.69	0.03	2.89	1.34	0.96	2.45	2.63
9	Cl^- (mg/kg)	10.10	29.30	21.58	5.52	15.10	32.60	22.32	4.62	7.77	8.30
10	TOC (%)	3.70	12.20	8.54	2.53	6.02	11.50	8.96	1.44	8.88	9.29
11	NO_2^- (mg/kg)	0.01	0.05	0.04	0.02	0.01	0.09	0.04	0.03	<0.001	0.02
12	NO_3 (mg/kg)	2.05	11.39	5.68	3.60	2.00	12.20	5.75	4.01	5.44	5.67
13	PO_4 (mg/kg)	1.28	15.97	5.77	4.80	1.10	12.60	5.59	4.25	7.34	7.50
14	SO_4 (mg/kg)	5.00	10.03	7.69	1.89	5.50	9.20	7.56	1.41	8.00	7.00
15	THC (mg/kg)	0.80	3.30	1.48	0.78	0.56	4.90	1.96	1.56	1.20	1.00
	Exchangeable Cations										
16	Exchangeable Na+ (Cmol/Kg)	50.84	78.00	65.15	10.15	49.00	70.42	63.09	6.42	34.00	37.56
17	Exchangeable K (Cmol/Kg)	3.10	11.11	7.32	2.81	4.00	12.31	7.94	2.81	7.82	7.90
18	Exchangeable Mg (Cmol/Kg)	6.75	35.60	19.58	10.49	6.00	35.00	20.77	10.32	12.52	12.66
19	Exchangeable Ca (Cmol/Kg)	15.89	40.00	31.55	7.69	19.50	40.55	32.28	6.23	24.40	24.35
20	Cation Exchange Capacity	14.00	24.56	20.12	3.85	14.24	27.00	20.78	4.71	16.34	17.23

S/N	Parameter	Min *	Max*	Mean	Stdev*	Min*	Max*	Mean*	Stdev*	Control	Control
	Depth	**0-15**	**0-15**	**0-15**	**0-15**	**15-30**	**15-30**	**15-30**	**15-30**	**0-15cm**	**15-30cm**
	Heavy Metal										
21	Al (mg/kg)	0.010	2.230	0.773	1.030	0.050	3.010	1.663	1.223	<0.001	<0.001
22	Cd (mg/kg)	0.110	1.090	0.600	0.490	0.010	0.870	0.517	0.367	<0.001	<0.001
23	Cr (mg/kg)	0.020	0.050	0.040	0.013	0.030	0.060	0.047	0.012	<0.001	<0.001
24	Fe (mg/kg)	222.1	322.7	272.2	29.9	238.4	312.3	277.4	25.8	279.4	288.8
25	Pb (mg/kg)	0.260	0.260	0.260	0.000	0.110	0.110	0.110	0.000	<0.001	<0.001
26	Ni (mg/kg)	3.000	3.000	3.000	0.000	3.650	3.650	3.650	0.000	<0.001	<0.001
27	Zn (mg/kg)	0.100	5.970	2.623	2.197	0.020	5.340	2.553	2.020	2.820	2.780

* Control Values not included in calculations

Source: Anambra SAPZ ESIA Field Data (2024)

4.3.8.2.2 Exchangeable Cations (Soil)

The results of the measured exchangeable cations (Ca, Mg, K, Na) measured in the rainy season soil samples are also presented above in Table 4.23.

X-Na ranged from 50.84 -78.00 Cmol/Kg (mean = 65.15 Cmol/Kg) in the top 0-15 cm layer and from 49.00 - 70.42 Cmol/Kg (mean = 63.09 Cmol/Kg) in the 15-30 cm layer. The control values were lower, with 34.00 Cmol/Kg in the 0-15 cm and 37.56 Cmol/Kg in the 15-30 cm.

X-K varied between 3.10 and 11.11 Cmol/Kg (mean = 7.32Cmol/Kg) in the top 15 cm layer and from 4.00 - 12.31 Cmol/Kg (mean = 7.94 Cmol/Kg) in the 15 - 30 cm layer. Control values were 7.82 Cmol/Kg and 7.90 Cmol/Kg in the topsoil and subsoil, respectively.

X-Mg showed a broad range from 6.75 - 35.60 Cmol/Kg (mean = 19.58 Cmol/Kg) in the topsoil and from 6.00 - 35.00 Cmol/Kg (mean = 20.77 Cmol/Kg) in the subsoil. The values measured in the control samples were 12.52 Cmol/Kg in the topsoil and 12.66 Cmol/Kg in the subsoil.

The levels of X-Ca concentrations in the topsoil ranged from 15.89 - 40.00 Cmol/Kg (mean = 31.55 Cmol/Kg) and from 19.50 - 40.55 Cmol/Kg (mean = 32.28 Cmol/Kg) in the subsoil, with control values having values of 24.40 and 24.35 Cmol/Kg for the respective depths.

The CEC varied between 14.00 and 24.56 Cmol/Kg (mean = 20.12) in the 0-15 cm layer and from 14.24 - 27.00 Cmol/Kg (mean = 20.78) in the 15-30 cm layer. Control samples had CEC values of 16.34 Cmol/Kg in the 0-15 cm and 17.23 Cmol/Kg in the 15-30 cm.

4.3.8.2.3 Heavy Metals

The soil samples heavy metal concentrations are shown in Table 4.23.

Al: Al concentrations in the 0-15 cm layer ranged from <0.001 - 2.230 mg/kg (mean = 0.258 mg/kg), while in the 15-30 cm layer, they ranged from <0.001 - 3.010 mg/kg (mean = 0.554). The metal was below the detection limit (<0.001 mg/kg) in most samples, including the control.

Cd: Cd levels ranged from <0.001 - 1.090 mg/kg (mean = 0.133 mg/kg) in the top 15cm layer and <0.001 - 0.870 mg/kg (mean = 0.172 mg/kg) in the 15-30 cm layer. The mean Cd concentration was slightly higher in the deeper layer, with the control samples showing non-detectable levels (<0.001 mg/kg). Cd is a non-essential metal, typically occurring naturally at concentrations of 0.1–1.0 mg/kg (Smolders and Mertens, 2013). It is highly toxic, impacting kidneys and skeletal health, and is classified as a carcinogen. Anthropogenic sources of Cd include metal production, fossil fuel combustion, phosphorus fertilizers, and sewage sludge.

Hexavalent (Cr^{+6}): Cr was detected in low concentrations, ranging from <0.001 - 0.050 mg/kg (mean = 0.022 mg/kg) in the 0-15 cm layer and from <0.001 - 0.060 mg/kg (mean = 0.016 mg/kg) in the 15-30 cm layer. Cr levels were generally low across both layers, with the control samples having non-detectable levels (<0.001 mg/kg). Cr^{+6} is the most toxic form of chromium. It enters the environment from both natural sources and anthropogenic activities such as petroleum refining and chromite ore processing (Saha et al, 2022; Gonnelli and Renella, 2013).

Fe: Fe concentrations were relatively consistent, ranging from 222.1 - 322.7 mg/kg (mean = 272.2 mg/kg) in the 0-15 cm layer and 238.4 - 312.3 mg/kg (mean = 277.4 mg/kg) in the 15-30 cm layer. Fe levels were slightly higher in the deeper layer, with the control samples showing similar values (279.4 and 288.8 mg/kg).

Ni: Ni concentrations ranged from <0.001 - 3.000 mg/kg (mean = 0.333 mg/kg) in the top 15 cm layer and <0.001 - 3.650 mg/kg (mean = 0.406 mg/kg) in the 15-30 cm layer. Ni levels were slightly higher in the deeper layer, with the control samples showing non-detectable levels (<0.001 mg/kg).

PB: Pb was detected at low levels, with concentrations ranging from <0.001 - 0.260 mg/kg (mean = 0.029 mg/kg) in the 0-15 cm layer and <0.001 - 0.110 mg/kg (mean = 0.012) in the 15-30 cm layer. The surface layer had slightly higher Pb concentrations, while the control samples showed non-detectable levels (<0.001 mg/kg).

Zn: Zn concentrations ranged from <0.001 - 5.970 mg/kg (mean = 2.331 mg/kg) in the top layer and <0.001 - 5.340 mg/kg (mean = 2.269 mg/kg) in the sublayer. The mean Zn concentrations were similar between the two layers, with control values (2.820 and 2.780 mg/kg) slightly higher than the means observed in the sampled locations.

4.3.8.2.4 Soil Microbiology

The results of the analysis of the microbial community for dry season and rainy seasons are presented in Table 4.24. Microbial groups investigated included total bacteria (TBC) and total fungi (TFC), total coliform count (TCC), *Bacillus* spp., and *Pseudomonas aeruginosa*.

TBC: TBC measures the overall bacteria present in a given sample. In the topsoil, the TBC ranged from 0.69 - 7.0 x 10^5 Cfu/g (mean = 2.8 x 10^5) and from 0.3 - 5.2 x 10^5 Cfu/g (mean = 1.9 x 10^5 Cfu/g) in the subsoil. The TBC in the control samples was significantly lower, with values of 0.55 x 10^5 Cfu/g in the topsoil and 0.6 x 10^5 Cfu/g in the subsoil.

TFC: TFC measures all fungi communities in the soil samples. In the topsoil, TFC counts ranged from 0.155 - 9.4 x 10^3 Cfu/g (mean = 3.7 x 10^3 Cfu/g) and from 0.1 - 7.1 x 10^3 Cfu/g (mean = 1.8 x 10^3 Cfu/g). The control levels were much lower, with values of 0.32 x 10^3 Cfu/g in the topsoil and 0.192 x 10^3 Cfu/g in the subsoil, reflecting less fungal presence in the control areas compared to the sampled sites.

TCC: TCC values ranged from 1.9 - 36.9 x 10^3 Cfu/g (mean = 12.7 x 10^3 10^5 Cfu/g) in the top 15 cm layer and from 0.2 - 26.5 x 10^3 Cfu/g (mean = 5.7 x 10^3 Cfu/g) in the 15-30 cm layer. Control samples also had lower counts with values of 2.4 x 10^3 Cfu/g in the top 15 cm layer and 1.1 x 10^3 Cfu/g in the 15-30 cm layer.

***Bacillus spp.*:** *Bacillus* bacteria are endospore-forming aerobic or facultatively anaerobic bacteria that are important for nutrient recycling. Their measured concentrations ranged from 0 - 8.9 Cfu/g (mean = 2.5 Cfu/g) in the top 15 cm layer and from 0 - 9.0 Cfu/g (mean = 3.7 Cfu/g) in the 15-30 cm layer. The control concentrations were 0.22 Cfu/g and 12 Cfu/g, respectively in the topsoil and subsoil.

Pseudomonas aeruginosa*: *P. aeruginosa is known to degrade pollutants, including hydrocarbon and heavy metals. The measured level in the topsoil ranged from non-detectable - 53.0 Cfu/g (mean = 7.3 cfu/g). It was absent in the subsoil. The control showed significantly higher values, with 10.1 Cfu/g in the topsoil and 121 Cfu/g in the subsoil.

In summary, the microbial counts in the sampled areas are generally higher than in the control, except for *Bacillus* spp. in the subsoil and Pseudomonas aeruginosa, which showed elevated levels in the control.

Table 4.24: Topsoil Microbiology Populations Counts in Ogboji (Rainy Season. July 2024)

Parameter	**Min ***	**Max ***	**Mean ***	**Stdev ***	**Min ***	**Max ***	**Mean ***	**Stdev ***	**Control**	**Control**
Depth	0-15	0-15	0-15	0-15	15-30	15-30	15-30	15-30	0-15cm	15-30cm
TBC (Cfu/g x 10^5)	0.69	7.00	3.03	1.80	0.30	5.20	1.92	1.68	0.55	0.60
TFC (Cfu/g x 10^3)	0.16	9.40	3.71	3.57	0.13	7.05	1.78	2.75	0.32	0.19
TCC (Cfu/g x 10^3)	1.90	36.90	12.74	14.24	0.22	26.50	5.69	7.84	2.40	1.10
Bacillus spp. (Cfu/ml)	1.80	8.90	5.53	2.52	4.00	9.00	6.71	1.94	0.22	12.00
Pseudomonas aeruginosa	13	53	33	20	NG	NG	NG	NG	10.1	121

* Control Values not included in calculations

Source: Anambra SAPZ ESIA Field Data (2024)

4.3.8.1 Soil Characteristics of Ogbunka Project Area

4.3.8.1.1 Physiochemical

Table 4.25 shows the results of the physiochemical characteristics of soil samples from the Ogbunka project area.

Appearance and Texture: The soil appearance varied from dark brown to dark reddish brown and red, indicating differences in organic matter content and possibly mineral composition. The texture predominantly consists of loam, which is generally good for plant growth due to its balanced mixture of sand, silt, and clay. However, OGK2 and the control samples show clay and clay loam textures, which can affect drainage and root penetration.

Particle Size Compositions: The particle size composition of the soil samples from 0-15 cm and 15-30 cm layers showed variations in the proportions of sand, silt, and clay, as discussed below:

- **Sand**: The sand content in the 0-15 cm layer ranged from 26.10% - 37.81% (mean = 31.30%) and from 28.0% - 37.85% (mean = 31.28%) in the 15-30 cm layer, indicating a relatively consistent sand fraction across both layers, with slightly higher variation in the upper layer. The sand compositions in the control samples in the 0-15 cm and 15-30 cm layers were 24.0% and 25.0%, respectively.
- **Silt**: content in the top 15 cm layer ranged from 12.19% - 56.10% (mean = 43.49%) and from 10.0% - 60.0% (mean = 45.57%). In the control samples, silt content was 32.90% in the top 15 cm layer and 36.90% in the 15-30 cm layer. The sampled soils exhibited higher variability and overall higher silt content compared to the controls, indicating a finer texture and possibly more fertile soil in the sampled areas.
- **Clay:** Clay content in the 0-15 cm layer ranged from 10.90% - 50.00% (mean = 25.21%) and from 10.00% - 52.15% (mean = 23.15%). The control samples have higher clay content, with 43.10% in the 0-15 cm layer and 38.10% in the 15-30 cm layer. The significantly higher clay content in the controls suggests heavier, more compact soil, which contrasts with the lower clay content and more loamy texture of the sampled soils.

These results suggest that the soil is predominantly sandy loam to loam in texture, with considerable variability in silt and clay content. The differences between the two layers are not pronounced, although the control sample indicates a significantly higher clay content, likely due to different soil genesis between the project area and control

pH: T The soil samples exhibited acidic pH, with the 0-15 cm layer having pH ranging from 4.77 - 5.25 (mean = 5.00). In the 15-30 cm layer, the pH ranged from 4.58 - 5.34 (mean = 4.90). The control soils had higher pH values of 5.50 and 5.35 in the 0-15 cm and 15-30 cm layers, respectively, which were less acidic than those of the project area.

Moisture Content: MC in the 0-15 cm layer ranged from 26.10% - 37.81% (mean = 31.30%). In the 15-30 cm layer, it ranged from 28.00% - 37.85% (mean = 31.28%). The control samples had lower moisture content, with 24.00% and 25.00%, indicating that the sampled soils retained more moisture.

Electrical Conductivity: The EC values in the 0-15 cm layer ranged from 5.90 - 7.20 µS/cm (mean = 6.69 µS/cm) and from 6.00 - 7.20 µS/cm (mean = 6.54 µS/cm) in the 15-30 cm layer. The control samples had lower EC values, being 5.88 µS/cm and 5.60 µS/cm in the top 15 cm and 15-30 cm layers, respectively.

Bicarbonate and Chloride: Bicarbonate concentrations in the 0-15 cm layer ranged from 0.06 - 0.92 mg/kg (mean = 0.49 mg/kg); while in the 15-30 cm layer, its concentrations from 0.06 - 0.55 mg/kg (mean = 0.36 mg/kg). These are much lower than the levels recorded in control samples, with concentrations of 2.45 mg/kg in the topsoil and 2.63 mg/kg in the subsoil. On the other hand, chloride$^-$ levels in the 0-15 cm layer ranged from 5.50 - 18.00 mg/kg (mean = 9.95 mg/kg) and from 2.60 - 12.53 mg/kg (mean = 7.87 mg/kg) in the 15-30 cm layer. The control samples had comparable chloride levels of 7.77 mg/kg and 8.30 mg/kg.

Total Organic Carbon: TOC levels in the 0-15 cm layer ranged from 6.30% - 14.50% (mean = 9.40%), while its levels in the 15-30 cm layer ranged from 7.10% - 13.40% (mean = 10.13%). The concentrations in the control samples were 8.88% in the top 15 cm and 9.29% in the 15-30 cm, indicating comparable organic carbon content between the sampled and control soils.

Ammonium, Nitrite and Nitrate

- Ammonium: The concentration of NH_4-N in the top 15 cm layer ranged from 4.13 - 12.50 mg/kg (mean = 7.23 mg/kg) and from 5.22 - 18.10 mg/kg (mean = 9.08 mg/kg) in the 15-30 cm layer. The control samples had higher concentrations of NH4-N, with values of 17.90 mg/kg and 15.50 mg/kg in the topsoil and subsoil, respectively.
- Nitrite*:* NO_2^- levels in the top 15 cm layer ranged from 0.09 - 0.18 mg/kg (mean = 0.14 mg/kg) and from 0.02 - 0.11 mg/kg (mean = 0.07 mg/kg) in the 15-30 cm layer. NO_2^- concentrations were lower in the control samples, which were below the detectable limit in the topsoil and 0.02 mg/kg in the subsoil.
- Nitrate***:*** NO_3^- levels in the 0-15 cm layer ranged from 4.00 - 16.72 mg/kg (mean = 10.43 mg/kg). In the 15-30 cm layer, it ranged from 2.49 - 18.30 mg/kg (mean = 9.43 mg/kg). The control samples had nitrate levels of 5.44 mg/kg and 5.67 mg/kg.

Phosphates and Sulphates

- **Phosphate:** PO_4^{3-} levels in the 0-15 cm layer ranged from 2.20 - 9.73 mg/kg (mean = 7.14 mg/kg) and from 1.44 - 9.31 mg/kg (mean = 5.57 mg/kg) in the 15-30 cm layer. The control samples had comparable phosphate levels of 7.34 mg/kg and 7.50 mg/kg in the topsoil and subsoil respectively.

- **Sulphate:** SO_4 levels in the 0-15 cm layer ranged from 3.00 - 10.00 mg/kg (mean = 6.08 mg/kg), while in the 15-30 cm layer, it ranged from 1.00 - 9.00 mg/kg (mean = 6.26 mg/kg). The control samples had sulphate levels of 8.00 mg/kg (topsoil) and 7.00 mg/kg (subsoil).

Total Hydrocarbon: THC had wide variations in both soil layers. In the 0-15 cm layer, it ranged from 0.01 - 8.11 mg/kg (mean = 2.83 mg/kg) and from 0.01 - 8.60 mg/kg (mean = 3.08 mg/kg) in the 15-30 cm layer. The control samples had lower THC levels of 1.20 mg/kg and 1.00 mg/kg in the topsoil and subsoil, respectively.

Table 4.25: Soil Physiochemistry of Ogbunka Project Area (July 2024, Rainy Season)

S/N	Parameter	Min*	Max*	Mean*	Stdev*	Min*	Max*	Mean*	Stdev*	Control	Control
	Depth	0-15	0-15	0-15	0-15	15-30	15-30	15-30	15-30	0-15cm	15-30cm
	Physiochemical										
1	pH	5.00	6.70	5.95	0.49	5.50	6.44	5.95	0.32	5.50	5.35
2	EC (µS/cm)	115.20	150.00	132.78	11.27	110.20	152.40	132.79	12.43	76.20	79.30
3	Moisture Content (%)	5.11	6.70	6.16	0.49	5.00	6.94	6.20	0.53	5.88	5.60
4	Sand (%)	22.00	32.50	26.35	3.52	25.00	34.00	27.60	2.81	24.00	25.00
5	Silt (%)	19.60	47.64	32.38	7.69	25.35	50.10	33.15	7.61	32.90	36.90
6	Clay (%)	21.99	47.90	41.27	7.22	21.00	49.11	39.25	9.59	43.10	38.10
7	NH4-H (mg/kg)	4.72	10.20	7.93	1.74	4.41	10.60	7.95	1.94	17.90	15.50
8	TOC (%)	3.70	12.20	8.54	2.53	6.02	11.50	8.96	1.44	8.88	9.29
9	THC (mg/kg)	0.80	3.30	1.48	0.78	0.56	4.90	1.96	1.56	1.20	1.00
10	Bicarbonate (mg/kg)	0.01	2.22	1.35	0.69	0.03	2.89	1.34	0.96	2.45	2.63
11	Cl- (mg/kg)	10.10	29.30	21.58	5.52	15.10	32.60	22.32	4.62	7.77	8.30
12	NO2- (mg/kg)	0.01	0.05	0.04	0.02	0.01	0.09	0.04	0.03	<0.001	0.02
13	NO3 (mg/kg)	2.05	11.39	5.68	3.60	2.00	12.20	5.75	4.01	5.44	5.67
14	PO4 (mg/kg)	1.28	15.97	5.77	4.80	1.10	12.60	5.59	4.25	7.34	7.50
15	SO4 (mg/kg)	5.00	10.03	7.69	1.89	5.50	9.20	7.56	1.41	8.00	7.00
	Exchangeable Cations										
16	Exchangeable Na+ (Cmol/Kg)	50.84	78.00	65.15	10.15	49.00	70.42	63.09	6.42	34.00	37.56
17	Exchangeable K (Cmol/Kg)	3.10	11.11	7.32	2.81	4.00	12.31	7.94	2.81	7.82	7.90
18	Exchangeable Mg (Cmol/Kg)	6.75	35.60	19.58	10.49	6.00	35.00	20.77	10.32	12.52	12.66
19	Exchangeable Ca (Cmol/Kg)	15.89	40.00	31.55	7.69	19.50	40.55	32.28	6.23	24.40	24.35
20	Cation Exchange Capacity	14.00	24.56	20.12	3.85	14.24	27.00	20.78	4.71	16.34	17.23

S/N	Parameter	Min*	Max*	Mean*	Stdev*	Min*	Max*	Mean*	Stdev*	Control	Control
	Depth	**0-15**	**0-15**	**0-15**	**0-15**	**15-30**	**15-30**	**15-30**	**15-30**	**0-15cm**	**15-30cm**
	Heavy Metal										
21	Al (mg/kg)	<0.001	4.870	0.888	1.782	<0.001	3.110	0.562	1.142	<0.001	<0.001
22	Cd (mg/kg)	<0.001	<0.001	<0.001	0.000	0.000	<0.001	<0.001	0.000	<0.001	<0.001
	Cr (mg/kg)	<0.001	1.000	0.005	0.011	<0.001	0.010	0.002	0.004	<0.001	<0.001
24	Fe (mg/kg)	248.0	272.5	292.9	49.1	202.8	366.2	276.4	48.8	279.4	288.8
25	Pb (mg/kg)	<0.001	2.200	0.367	0.820	<0.001	1.010	0.168	0.376	<0.001	<0.001
26	Ni (mg/kg)	<0.001	<0.001	<0.001	0.000	0.000	<0.001	<0.001	0.000	<0.001	<0.001
27	Zn (mg/kg)	3.330	5.450	4.645	0.720	4.020	6.220	4.938	0.852	2.820	2.780

2.2 Exchangeable Cations (Soil)

X-Na (Cmol/Kg): Values in the 0-15 cm layer ranged from 32.51 - 72.45 (mean = 44.67) and from 32.50 - 66.66 (mean = 42.03) in the 15-30 cm layer. The control samples had values of 34.00 in the 0-15 cm layer and 37.56 in the 15-30 cm layer.

X-K (Cmol/Kg): In the 0-15 cm layer, exchangeable K values ranged from 5.00 - 9.51 (mean = 7.27), while in the 15-30 cm layer, they ranged from 5.25 - 8.92 (mean = 6.65). Control values were 7.82 in the 0-15 cm layer and 7.90 in the 15-30 cm layer.

X-Mg (Cmol/Kg): Concentrations ranged from 9.82 - 15.26 (mean = 12.14) in the 0-15 cm layer and from 11.00 - 15.20 (mean = 13.00) in the 15-30 cm layer. The control values were 12.52 in the 0-15 cm layer and 12.66 in the 15-30 cm layer.

X-Ca (Cmol/Kg): The 0-15 cm layer had values ranging from 19.47 - 32.00 (mean = 24.40), and the 15-30 cm layer ranged from 24.24 - 34.90 (mean = 28.22). The control values were 24.40 in the 0-15 cm layer and 24.35 in the 15-30 cm layer.

CEC (Cmol/Kg): Values ranged from 20.24 - 36.98 (mean = 26.51) in the 0-15 cm layer and from 15.60 - 26.80 (mean = 23.03) in the 15-30 cm layer. The control samples had values of 16.34 in the 0-15 cm layer and 17.23 in the 15-30 cm layer.

4.3.8.1.3 Heavy Metals

Among the heavy metals assessed during the study, Cd and Ni were below the equipment detection limits, while Cr and Pb were detected in two samples. Al was present in most samples with concentrations ranging from <0.001 - 4.87 mg/kg (mean = 0.888 mg/kg) in the top 15 cm layer and from <0.001 - 3.11 mg/kg (mean = 0.562 mg/kg). Al was below detection limits in both soil depths in the control.

Cr was detected in the top layer of OGK1 at a concentration of 0.03 mg/kg and in the 15-30 cm layer of OGK5, with a concentration of 0.01 mg/kg. Fe was present in measurable concentrations in all samples, with values ranging from 248.0 - 272.5 mg/kg (mean = 292.9 mg/kg) in the top 15 cm layer and from 202.8 - 366.2 mg/kg (mean = 276.4 mg/kg) in the 15-30 cm layer. The control samples had Fe concentrations of 279.4 mg/kg in the topsoil and 288.8 mg/kg in the subsoil, which were comparable to those of the project area.

Pb occurred only in the sublayer of OGK4 with a concentration of 1.01 mg/kg and in the top layer of OGK5 with a concentration of 2.2 mg/kg. The control samples showed Pb levels below detection limits. Zn concentrations in the topsoil ranged from 3.33 - 5.45 mg/kg (mean = 4.645 mg/kg) and from 4.020 - 6.220 mg/kg (mean = 4.938 mg/kg) in the subsoil. The control samples had Zn concentrations of 2.820 mg/kg in the topsoil and 2.780 mg/kg.

4.3.8.1.4 Microbiology

The results of the microorganisms in the soil samples are presented in Table 4.26.

Total Bacteria Count (Cfu/g x 10^5): TBC in the 0-15 cm layer ranged from 0.69 - 7.00 (mean = 3.03) and from 0.30 - 5.20 (mean = 1.92) in the 15-30 cm layer. The control samples had values of 0.55 in the 0-15 cm layer and 0.60 in the 15-30 cm layer.

Toral Bacteria Count (Cfu/g x 10^3): TFC Concentrations ranged from 0.16 - 9.40 (mean = 3.71) in the 0-15 cm layer and from 0.13 - 7.05 (mean = 1.78) in the 15-30 cm layer. Control values were 0.32 in the 0-15 cm layer and 0.19 in the 15-30 cm layer.

Total Coliform Count (Cfu/g x $10^{3)}$: TCC values ranged from 1.90 - 36.90 (mean = 12.74) in the 0-15 cm layer and from 0.22 - 26.50 (mean = 5.69) in the 15-30 cm layer. The control samples had values of 2.40 in the 0-15 cm layer and 1.10 in the 15-30 cm layer.

Bacillus spp. (Cfu/g): In the 0-15 cm layer, *Bacillus* values ranged from 1.80 - 8.90 (mean = 5.53), while in the 15-30 cm layer, they ranged from 4.00 - 9.00 (mean = 6.71). Control values were 0.22 in the 0-15 cm layer and 12.00 in the 15-30 cm layer.

Pseudomonas aeruginosa (Cfu/g): The 0-15 cm layer had values ranging from 13 - 53 (mean = 33), while the bacteria were not detected in the 15-30 cm layer. The control samples had values of 10.1 in the 0-15 cm layer and 121 in the 15-30 cm layer.

Table 4.26: Soil Microbiology of Ogbunka Project Area (July 2024, Rainy Season)

S/N	Parameter	Min*	Max*	Mean*	Stdev*	Min*	Max*	Mean*	Stdev*	Control	Control
	Depth	0-15	0-15	0-15	0-15	15-30	15-30	15-30	15-30	0-15cm	15-30cm
1	TBC (Cfu/g x 10^5)	0.69	7.00	3.03	1.80	0.30	5.20	1.92	1.68	0.55	0.60
2	TFC (Cfu/g x 10^3)	0.16	9.40	3.71	3.57	0.13	7.05	1.78	2.75	0.32	0.19
3	TCC (Cfu/g x 10^3)	1.90	36.90	12.74	14.24	0.22	26.50	5.69	7.84	2.40	1.10
4	Bacillus spp. (Cfu/g)	1.80	8.90	5.53	2.52	4.00	9.00	6.71	1.94	0.22	12.00
5	Pseudomonas aeruginosa (Cfu/g)	13	53	33	20	NG	NG	NG	NG	10.1	121

* Control Values not included in calculations

Sources: Anambra SAPZ ESIA Data (2024)

*

4.3.8.4 Soil Characteristics of Ugbene Project Area

The rainy season baseline soil characteristics used primary data from the soil analysis collected during the field study. The data was compared to the secondary data obtained from the 2020 EIA for Coscharis Farms Limited Rice Processing facility in Igboariam, located within the project's area of influence. The control was also collected from Igboariam.

Physiochemistry

Tables 4.27 (topsoil: 0-15 cm layer) and 4.28 (subsoil: 15-30 cm layer) show the results of soil physiochemistry, which are described in the following subsections.

Appearance and Texture

The Ugbene soil samples primarily exhibited several shades of brown, with subtle variations across the sampling points. Some samples exhibited yellowish brown to dark brown colour, e.g. UGB1. while in some locations, the colour deepens to very dark grey, e.g. UGB6. This variation in colour intensity reflects differences in organic matter content and moisture but remains within the brown spectrum.

In terms of texture, sand, loam and clay soils were represented. Sandy soils suggest areas with good drainage but may have lower nutrient retention. Loam soils indicated a more balanced mix of sand, silt, and clay, which can support better plant growth. Deeper layers tend to have a heavier texture, with loam and clay appearing in one instance, indicating higher water retention but potentially less efficient drainage. The control samples, in contrast, consistently show a clay texture throughout, paired with a dark greyish-brown colour. Overall, the Ugbene soils demonstrate a complex profile shaped by variations in organic matter, moisture, and underlying geological factors.

Particle Size Compositions

- The sand content in the rainy season samples from Ugbene ranged from 23.7% to 55.66% (mean = 37.16%) in the top 15 cm and increased slightly in the 15-30 cm depth, where it ranged from 25.1% - 59.72% (mean = 47.95%). In contrast, the dry season samples from Igboariam exhibited lower sand content, ranging from 19.51% - 39.2% (mean = 30.43%) in the top 15 cm and 19.17% - 38.42% (mean = 30.04%) in the 15-30 cm depth.
- Silt content in the rainy season samples ranged from 26.7% - 55% (mean = 40.94%) in the topsoil and 27.26% - 53% (mean = 35.10%) in the deeper layers. In the dry season samples, silt content was significantly lower, ranging from 5.94% - 16.1% (mean = 10.58%) in the top 15 cm and 5.82% - 14.81% (mean = 9.97%) in the 15-30 cm layer.
- Clay content in the rainy season samples ranged from 13.73% - 50% (mean = 21.97%) in the upper layer, with a slightly lower range of 10.03% - 40% (mean = 16.95%) in the 15-30 cm depth. The dry season samples, on the other hand, showed much higher clay content, with the top layer ranging from 50.83% - 66.52% (mean = 59.65%) and deeper

layers ranging from 50.15% - 66.82% (mean = 58.81%).

In general, the rainy season's soil samples were more sand- and silt-dominated, particularly in the surface layers, reflecting better drainage but potentially lower nutrient retention. The dry season's soil samples, with their higher clay content, indicated greater water retention potential and less efficient drainage, potentially impacting agricultural productivity differently depending on crop requirements. Crops requiring well-drained soil might perform better in Ugbene, while those needing more consistent moisture might thrive in Igboariam.

Potential of Hydrogen (pH)

The soil pH in the rainy season samples ranged from 5.77 - 6.90 (mean = 6.26) in the top 15 cm and from 5.22 - 6.50 (mean = 5.84) in the 15-30 cm depth. The deeper layers were slightly more acidic. In the dry season, pH ranged from 6.18 - 7.55 (mean = 6.80) across both depths, indicating more alkaline conditions. The control sample had a pH of about 6.0 in both layers.

Moisture Content

Rainy season moisture content (MC) ranged from 4.9% - 6.02% (mean = 5.61%) in the top 15 cm and from 4.21% - 5.82% (mean = 5.17%) in the 15-30 cm depth. In the dry season, MC was lower, ranging from 2.64% - 4.26% (mean = 3.34%) across both depths, reflecting the expected seasonal decrease.

Electrical Conductivity (EC)

During the rainy season, EC values ranged from 25.4 - 42.34 µS/cm (mean = 32.11) in the top 15 cm and from 19.3 - 40.06 µS/cm (mean = 30.68) in the 15-30 cm layer, indicating moderate salinity levels. The control sample had a significantly higher EC of 82.2 µS/cm in the topsoil and 80.6 µS/cm in the subsoil.

Bicarbonate and chloride

- **Bicarbonates (HCO_3^-):** Rainy season samples showed HCO_3^- levels ranging from 0.1 - 0.89 mg/kg (mean = 0.50 mg/kg) in the topsoil and from 0.03 - 0.99 mg/kg (mean = 0.51 mg/kg) in the 15-30 cm layer. Data for bicarbonate in the dry season was not available, and the control sample had higher levels, with 1.1 mg/kg in the topsoil and 0.8 mg/kg in the subsoil. The control's elevated bicarbonate levels suggest a difference in soil composition or environmental factors compared to the sampled areas.
- **Chloride$^-$:** Cl^- levels in the rainy season samples ranged from 4.09 - 11.11 mg/kg (mean = 6.67 mg/kg). During the dry season, chloride levels increased significantly, ranging from 10.79 - 39 mg/kg (mean = 23.02 mg/kg). The control sample showed a chloride level of 8.98 mg/kg in the 0-15 cm layer and 9.2 mg/kg in the 15-30 cm layer.

Total Organic Carbon (TOC):

The TOC levels measured in the rainy season samples ranged from 1.8% - 5.6% (mean = 4.0%) in the top 15 cm and from 1.46% - 5.83% (mean = 3.57%) in the 15-30 cm depth. TOC was notably lower in the dry season samples, ranging from 0.88% - 2.83% (mean = 1.99%) in the topsoil and from 1.09% - 2.61% (mean = 1.90%) in the subsoil. The control samples had much higher TOC levels, with 9.45% in the topsoil and 10.0 mg/kg in the subsoil. The reduced TOC during the dry season indicates a lower organic matter content, which may be due to seasonal decomposition or lower organic inputs.

Ammonium, Nitrite and Nitrate

- These compounds represent major nitrogen sources for plants. NH_4-N levels in the rainy season samples ranged from 2.56 - 9.1 mg/kg (mean = 5.28) in the top 15 cm layer and from 2.7 - 12.1 mg/kg (mean = 5.89) in the 15-30 cm layer. The data for ammonium levels was not available for the dry season samples. In contrast, the control samples had ammonium concentrations of around 6 mg/kg in both soil layers.
- NO_2^- levels were consistently below the detection limit (<0.001) in the rainy season samples, and no data was available for the dry season. The control samples showed nitrite levels of 0.01 mg/kg in both top and subsoil.
- NO_3 levels in the rainy season ranged from 1.22 - 6.42 mg/kg (mean = 4.47) in the top 15 cm layer and from 1.4 - 5.55 mg/kg (mean = 4.05) in the 15-30 cm layer. In the dry season, nitrate levels were much lower, ranging from 0.189 - 0.94 mg/kg (mean = 0.60) in the top 15 cm layer and from 0.16 - 0.74 mg/kg (mean = 0.49) in the 15-30 cm layer, indicating a significant decrease compared to the rainy season.

Phosphates and Nitrates

PO_4^{3-} and SO_4 are also macronutrients required by plants. PO_4^{3-} concentrations in the rainy season samples ranged from 1.0 - 4.1 mg/kg (mean = 1.82) in the 0-15 cm layer and from 1.16 - 5.82 mg/kg (mean = 2.75 mg/g) in the 15-30 cm layer. The concentrations measured in the dry season samples ranged from 0.79 - 1.39 (mean = 1.02 mg/kg in the topsoil and 0.58 - 1.21 mg/kg (mean = 0.90 mg/kg) in the subsoil. PO4 levels in the control samples were 4.09 mg/kg and 5.26 mg/kg in the topsoil and subsoil, respectively.

SO_4 levels in the rainy season soil samples ranged from 4.63 - 7.3 mg/kg (mean = 6.09) in the 0-15 cm layer and from 1.99 - 8.52 mg/kg (mean = 5.46 mg/kg) in the 15-30 cm soil samples. On the other hand, the SO4 levels measured in the dry season samples ranged from 9.89 - 20.28 (mean = 15.73) in the 0-15 cm layer and 5.30 - 20.00 mg/kg (mean = 13.70 mg/kg) in the 5-30 cm layer. The levels measured in the control samples were 7.00 in the 0-15 cm layer and 9.00 mg/kg in the 15-30 cm layer.

Table 4.27: Topsoil Soil Physiochemistry in Ugbene (Rainy Season) and Anaku (Dry Season)

S/N	Descriptive Statistics	Topsoil (0–15 cm) Omor (Rainy Season)					Topsoil (0–15 cm) Anaku (Dry Season)			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	Sand (%)	23.7	55.66	37.16	12.78	26.10	19.51	39.20	30.43	8.17
2	Silt (%)	26.7	55.00	40.94	11.60	30.10	5.94	16.10	10.58	4.57
3	Clay (%)	13.73	50.00	21.97	12.71	43.80	50.83	66.52	59.65	6.96
4	pH	5.77	6.90	6.26	0.47	6.00	5.89	7.46	6.59	0.68
5	EC (µS/cm)	25.4	42.34	32.11	5.87	82.20	ND	ND	ND	ND
6	Moisture Content (%)	4.9	6.02	5.61	0.35	6.00	2.65	4.63	3.59	0.85
7	NH4-H (mg/kg)	2.56	9.10	5.28	2.67	19.32	ND	ND	ND	ND
8	TOC (%)	1.8	5.60	4.00	1.53	9.45	0.88	2.83	1.99	0.77
9	Bicarbonate (mg/kg)	0.1	0.89	0.50	0.40	1.10	ND	ND	ND	ND
10	Cl- (mg/kg)	4.09	11.11	6.67	2.22	8.98	10.79	39.00	23.02	11.71
11	NO2- (mg/kg)	0	<0.001	<0.001	0.00	0.01	ND	ND	ND	ND
12	NO3 (mg/kg)	1.22	6.42	4.47	1.85	8.10	0.19	0.94	0.60	0.34
13	PO4 (mg/kg)	1.00	4.10	1.82	1.06	4.09	0.79	1.39	1.02	0.24
14	SO4 (mg/kg)	4.63	7.30	6.09	0.95	7.00	9.89	20.28	15.73	3.80
15	THC (mg/kg)	0.07	2.53	1.53	1.04	0.99	ND	ND	ND	ND

* Control Values not included in calculations; ND: Not Determined

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

Table 4.28: Subsoil Physiochemistry in Ugbene (Rainy Season) and Anaku (Dry Season)

S/N	Descriptive Statistics	**Subsoil (15-30 cm) Omor (Rainy Season)**					**Subsoil (15-30 cm) Anaku (Dry Season)**			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	Sand (%)	25.10	59.72	47.95	14.37	28.80	19.17	38.42	30.04	7.90
2	Silt (%)	27.26	53.00	35.10	8.35	31.00	5.82	14.81	9.97	4.17
3	Clay (%)	10.03	40.00	16.95	10.52	40.20	50.15	66.82	58.81	7.94
4	pH	5.22	6.50	5.84	0.52	5.96	6.18	7.55	6.80	0.51
5	EC (µS/cm)	19.30	40.06	30.68	7.60	80.60	ND	ND	ND	ND
6	Moisture Content (%)	4.21	5.82	5.17	0.57	5.99	2.64	4.26	3.34	0.68
7	NH4-H (mg/kg)	2.70	12.10	5.89	3.44	18.50	ND	ND	ND	ND
8	TOC (%)	1.46	5.83	3.57	1.47	10.00	1.09	2.61	1.90	0.63
9	Bicarbonate (mg/kg)	0.03	0.99	0.51	0.48	0.90	ND	ND	ND	ND
10	Cl- (mg/kg)	3.76	8.39	6.07	1.75	9.20	12.00	33.00	19.56	8.20
11	NO2- (mg/kg)	<0.001	<0.001	<0.001	0.00	0.01	ND	ND	ND	ND
12	NO3 (mg/kg)	1.40	5.55	4.05	1.49	9.23	0.16	0.74	0.49	0.25
13	PO4 (mg/kg)	1.16	5.82	2.75	1.74	5.26	0.58	1.21	0.90	0.26
14	SO4 (mg/kg)	1.99	8.52	5.46	1.93	9.00	5.30	20.00	13.70	5.40
15	THC (mg/kg)	0.13	3.68	1.54	1.21	0.05	ND	ND	ND	ND

* Control Values not included in calculations; ND: Not Determined

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

Phosphates and Nitrates

PO_4^{3-} and SO_4 are also macronutrients required by plants. PO_4^{3-} concentrations in the rainy season samples ranged from 1.0 - 4.1 mg/kg (mean = 1.82) in the 0-15 cm layer and from 1.16 - 5.82 mg/kg (mean = 2.75 mg/g) in the 15-30 cm layer. The concentrations measured in the dry season samples ranged from 0.79 - 1.39 (mean = 1.02 mg/kg in the topsoil and 0.58 - 1.21 mg/kg (mean = 0.90 mg/kg) in the subsoil. PO4 levels in the control samples were 4.09 mg/kg and 5.26 mg/kg in the topsoil and subsoil, respectively.

SO_4 levels in the rainy season soil samples ranged from 4.63 - 7.3 mg/kg (mean = 6.09) in the 0-15 cm layer and from 1.99 - 8.52 mg/kg (mean = 5.46 mg/kg) in the 15-30 cm soil samples.

On the other hand, the SO4 levels measured in the dry season samples ranged from 9.89 - 20.28 (mean = 15.73) in the 0-15 cm layer and 5.30 - 20.00 mg/kg (mean = 13.70 mg/kg) in the 5-30 cm layer. The levels measured in the control samples were 7.00 in the 0-15 cm layer and 9.00 mg/kg in the 15-30 cm layer.

Total Hydrocarbon Content (THC):

The concentrations of THC in the rainy season sample's top 15 cm layer ranged from 0.07 - 2.53 mg/kg (mean = 1.53 mg/kg), while in the 15-30 cm, the TOC levels ranged from 0.13 - 3.68 mg/kg (mean = 1.544 mg/kg). THC data for the dry season was not provided. In the control samples, THC levels were 0.99 mg/kg in the topsoil and 10.0 mg/kg in the subsoil. The presence of THC in the rainy season samples suggests potential hydrocarbon pollution, possibly due - runoff or other environmental factors

Exchangeable Cations and Cation Exchange Capacity (CEC) in Soil Samples

Tables 4.29 and 4.30 show the results of the exchangeable cations and CEC used to describe the baseline levels for these soil parameters. The results are discussed below.

X-Na concentrations in the rainy season samples ranged from ranged from 19.50 - 40.21 Cmol/Kg (mean = 29.52) in the 0-15 cm layer and from 21.11 - 41.0Cmol/Kg (mean = 28.102) in the 15-30 cm layer. X-Na levels in the dry season sample were significantly higher, ranging from 41.01 - 71.51 Cmol/Kg (mean = 54.698) in the 0-15 cm layer and from 42.200 - 72.560 Cmol/Kg (mean = 56.438) in the 15-30 cm layer. The control samples had concentrations of 36.0 Cmol/Kg in the topsoil and 32.20 Cmol/Kg in the subsoil.

X-K concentrations during the rainy season ranged from 2.95 - 5.67 Cmol/Kg (mean = 4.262) in the 0-15 cm layer and from 1.110 - 5.90 Cmol/Kg (mean = 3.433) in the 15-30 cm layer. In the dry season, X-K levels were also higher, ranging from 12.68 - 28.500 Cmol/Kg (mean = 21.140) in the 0-15 cm layer and from 6.593 - 22.630 Cmol/Kg (mean = 15.696) in the 15-30 cm layer. The control samples had X-K levels of 8.82 Cmol/Kg in the 0-15 cm layer and 8.99 Cmol/Kg in the 15-30 cm layer.

X-Mg concentrations in the rainy season samples ranged from 2.77 - 22.20 Cmol/Kg (mean = 10.620) in the 0-15 cm layer and from 2.90 - 20.0 Cmol/Kg (mean = 9.730) in the 15-30 cm layer. On the other hand, the concentrations of X-Mg in the dry season samples ranged from 1.17 - 4.010 Cmol/Kg (mean = 2.773) in the 0-15 cm layer and from 1.37 - 3.957 Cmol/Kg (mean = 2.672) in the 15-30 cm layer. The control samples had X-Mg levels of 11.830 Cmol/Kg in the topsoil and 11.500 Cmol/Kg in the subsoil.

The measured concentrations of X-Ca in the rainy season samples ranged from 5.80 - 36.50 Cmol/Kg (mean = 23.185) in the 0-15 cm layer and from 6.930 - 35.010 Cmol/Kg (mean = 24.327) in the 15-30 cm layer. In the dry season samples, X-Ca levels ranged from 0.105 - 4.173 Cmol/Kg (mean = 1.747) in the 0-15 cm layer and from 0.050 - 1.558 Cmol/Kg (mean = 0.782) in the 15-30 cm layer. The control samples had X-Ca levels of 24.50 Cmol/Kg in the topsoil and 23.610 Cmol/Kg in the subsoil.

Cation exchange capacity (CEC) during the rainy season ranged from 10.550 - 16.730 Cmol/Kg (mean = 13.560) in the 0-15 cm layer and from 11.620 - 18.900 Cmol/Kg (mean = 14.673) in the 15-30 cm layer. Data for CEC during the dry season was not provided, but the control samples had CEC levels of 15.30 Cmol/Kg in the 0-15 cm layer and 15.97 Cmol/Kg in the 15-30 cm layer.

Heavy Metals

The results of the heavy metals for the rainy and dry season samples are also shown in Tables 4.29 and 4.30 and discussed below.

Among the heavy metals assessed during the study, both Cd and Cr were below the equipment detection (<0.001 mg/kg) in both the rainy and dry season samples. In the case of Al, the heavy metals were below the equipment detection limit in most rainy season samples except UGB4, which had Al levels of 0.95 mg/kg in the topsoil and 0.73 mg. kg in the subsoil. Al was not assessed for the dry season samples. In the rainy season control samples, their concentrations were 1.83 mg/kg and 1.4 mg/kg in the topsoil and subsoil, respectively.

Pb and Ni were also not detected in the rainy season samples; however, the control samples showed Pb levels of 0.010 mg/kg in both the topsoil and subsoil, indicating minimal localised presence of the metal at that location. Both Pb Ni were present in measurable quantities in the dry season samples, with Pb having concentrations of 0.084 - 0.183 mg/kg (mean = 0.137 mg/kg) in the 0-15 cm layer and from 0.056 - 0.120 mg/kg (mean = 0.087 mg/kg) in the 15-30 cm layer. Ni levels in the dry season samples ranged from 0.039 - 0.080 mg/kg (mean = 0.055 mg/kg) in the 0-15 cm layer and from 0.013 - 0.060 mg/kg (mean = 0.035 mg/kg) in the 15-30 cm layer. Unlike Pb, Ni concentrations were below the detection limit in the control samples.

Table 4.29: Topsoil Exchangeable Cations and Heavy Metals in Ugbene (Rainy Season) and Igboariam (Dry Season)

S/N	Descriptive Statistics	**Topsoil (0–15 cm) Omor (Rainy Season)**					**Topsoil (0–15 cm) Anaku (Dry Season)**			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	Exchangeable K+ (Cmol/kg)	5.630	11.020	7.376	2.185	8.820	10.04	26.27	19.935	6.05063
2	Exchangeable Na+ (Cmol/kg)	30.000	45.340	37.000	5.242	36.000	41.01	71.51	54.4725	11.8893
3	Exchangeable Ca+ (Cmol/kg)	19.340	29.800	25.368	3.665	24.500	0.024	3.814	1.833	1.510348
4	Exchangeable Mg+ (Cmol/kg)	11.100	15.370	12.598	1.544	11.830	0.771	3.805	2.3605	1.309399
5	CEC (Cmol/kg)	12.300	16.920	14.524	1.606	15.300	9.000	16.000	14.374	2.713
6	Al (mg/kg)	<0.001	0.950	0.158	0.354	1.830	NA	NA	NA	NA
7	Cd (mg/kg)	<0.001	<0.001	<0.001	0.000	<0.001	<0.001	<0.001	<0.001	<0.001
8	Cr (mg/kg)	<0.001	<0.001	<0.001	0.000	<0.001	<0.001	<0.001	<0.001	<0.001
9	Fe (mg/kg)	95.750	187.800	116.045	32.654	288.700	63.038	111.500	84.177	20.356
10	Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001	0.010	0.084	0.183	0.137	0.045
11	Ni (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	0.039	0.080	0.055	0.017
12	Zn (mg/kg)	2.100	10.300	6.592	2.638	2.530	0.002	0.560	0.347	0.210

*** Control Values not included in calculations; ND: Not Determined**

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

Table 4.30: Subsoil Exchangeable Cations and Heavy Metals in Ugbene (Rainy Season) and Igboariam (Dry Season)

S/N	Descriptive Statistics	Topsoil (0–15 cm) Omor (Rainy Season)					Topsoil (0–15 cm) Anaku (Dry Season)			
		Min*	Max*	Mean*	Stdev*	Control	Min	Max	Mean	Stdev
1	Exchangeable K+ (Cmol/kg)	4.110	9.600	6.710	2.249	8.990	10.42	22.87	16.21	4.482170233
2	Exchangeable Na+ (Cmol/kg)	32.230	48.000	41.432	7.444	32.200	42.19	72.56	55.83	11.47365461
3	Exchangeable Ca+ (Cmol/kg)	19.660	29.100	23.252	3.593	23.610	0.094	4.162	2.153	1.461069814
4	Exchangeable Mg+ (Cmol/kg)	10.050	15.620	13.350	2.185	11.500	1.091	4.184	2.7395	1.289467041
5	CEC (Cmol/kg)	15.970	ND	ND	ND	ND	ND	ND	ND	ND
6	Al (mg/kg)	<0.001	0.730	0.122	0.272	1.400	NA	NA	NA	NA
7	Cd (mg/kg)	<0.001	<0.001	<0.001	0.000	<0.001	<0.001	<0.001	<0.001	<0.001
8	Cr (mg/kg)	<0.001	<0.001	<0.001	0.000	<0.001	<0.001	<0.001	<0.001	<0.001
9	Fe (mg/kg)	96.660	141.830	114.328	18.030	292.500	51.220	117.400	74.583	26.799
10	Pb (mg/kg)	<0.001	<0.001	<0.001	0.000	0.010	0.056	0.120	0.087	0.025
11	Ni (mg/kg)	<0.001	<0.001	<0.001	0.000	<0.001	0.013	0.060	0.035	0.019
12	Zn (mg/kg)	2.370	8.560	5.727	2.374	2.700	0.117	0.740	0.376	0.230

*** Control Values not included in calculations; ND: Not Determined**

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

Fe was one of the two metals (with Zn) among the heavy metals studied that were present in measurable concentrations in all samples. Its concentrations in the rainy season samples ranged from 95.75 - 187.80 mg/kg (mean = 116.045 mg/kg) in the 0-15 cm layer and from 96.660 - 141.830 mg/kg (mean = 114.328 mg/kg) in the 15-30 cm layer. In the dry season samples, Fe levels ranged from 63.038 - 111.500 mg/kg (mean = 84.177 mg/kg) in the 0-15 cm layer and from 51.220 - 117.400 mg/kg (mean = 74.583 mg/kg) in the 15-30 cm layer. These values were lower than those for the rainy season. On the other hand, the control samples had significantly higher Fe levels than both the rainy and dry seasons samples, with values of 288.700 mg/kg in the topsoil and 292.500 mg/kg in the subsoil.

Zinc (Zn) concentrations were higher in the rainy season samples compared to the dry season samples, with values from 2.100 - 10.30 mg/kg (mean = 6.592 mg/kg) in the 0-15 cm layer and from 2.370 - 8.560 mg/kg (mean = 5.727 mg/kg) in the 15-30 cm layer. In the dry season, Zn levels ranged from 0.002 - 0.560 mg/kg (mean = 0.347 mg/kg) in the 0-15 cm layer and from 0.117 - 0.740 mg/kg (mean = 0.376 mg/kg) in the 15-30 cm layer. The control samples had Zn levels of 2.530 mg/kg in the topsoil and 2.700 mg/kg in the subsoil, which were within the range measured in the sampled stations.

The concentrations of heavy metals varied significantly across seasons and soil depths. Cadmium and chromium were below detection limits in all samples, while aluminium was detected only in one rainy season sample and was not assessed during the dry season. Iron and zinc were consistently present, with higher concentrations observed during the rainy season, whereas lead and nickel, absent in the rainy season, were detected in measurable quantities during the dry season. The control samples generally exhibited higher metal concentrations than the project area samples. These variations likely reflect the influence of seasonality, parent material, and land use on the baseline soil conditions in the project area.

Soil Microbiology

The microbiological parameters analysed during the study include total bacterial count (TBC), total fungal count (TFC), total coliform count (TCC), *Bacillus* spp. and *Pseudomonas aeruginosa*, with the results presented in Tables 4.31 and 4.32, and discussed below.

Total Bacterial Count (TBC): TBC in the rainy season samples ranged from 2.22×10^4 - 8.06×10^5 Cfu/g (mean = of 3.41×10^5 Cfu/g) in the top 0-15 cm layer and from 1.02×10^4 Cfu/g to 4.10×10^5 Cfu/g (mean = 1.49×10^5 Cfu/g). The control samples showed TBC values of 8.80×10^4 Cfu/g and 7.30×10^4 Cfu/g in the topsoil and subsoil, respectively.

In contrast, during the dry season, TBC levels were significantly higher, with values ranging from 1.49×10^7 Cfu/g to 2.87×10^7 Cfu/g (mean = 2.13×10^7 Cfu/g) in the 0-15 cm layer and from 1.28×10^7 Cfu/g to 2.41×10^7 Cfu/g (mean = 1.77×10^7 Cfu/g) in the 15-30 cm layer. These elevated levels during the dry season cannot easily be explained by the difference between organic matter content, which was comparable between the rainy and dry season samples, as shown in Table 4.31. Furthermore, TBC measures all forms of bacteria in the soil, including autotrophic bacteria.

Total Fungal Count (TFC): The measured concentrations of TFC in the 0-15 cm layer of rainy season samples ranged from 1.10×10^2 to 6.11×10^3 Cfu/g (mean = 3.78×10^3 Cfu/g), and a lower range of 1.00×10^2 to 4.80×10^3 Cfu/g (mean = 2.68×10^3 Cfu/g) in the 15-30 cm layer. The control samples exhibited TFC values of 1.99×10^2 Cfu/g and 1.00×10^3 Cfu/g in the topsoil and subsoil, respectively.TFC concentrations in the dry season samples were significantly higher than those of rainy season concentrations with counts ranging from 8.00×10^3 - 1.90×10^4 Cfu/g (mean = 1.30×10^4 Cfu/g) in the 0-15 cm layer and from 4.00×10^3 Cfu/g to 2.60×10^4 Cfu/g (mean = 1.50×10^4 Cfu/g) in the 15-30 cm layer.

Total Coliform Count (TCC): TCC levels in the rainy season samples had values from 1.50×10^2 - 7.90×10^2 Cfu/g (mean = 3.90×10^2 Cfu/g) in the top 15 cm layer and from 1.10×10^2 Cfu/g - 5.60×10^2 Cfu/g (mean = 2.50×10^2 Cfu/g) in the 15-30 cm layer. The control samples had TCC values of 3.11×10^2 Cfu/g and 2.20×10^2 Cfu/g in the topsoil and subsoil, respectively. TCC data was not provided for the dry season samples.

***Bacillus* spp.**: *Bacillus* spp. occurred in low numbers during the rainy season, with counts ranging from 3.2×10^2 - 5.2 Cfu/g (mean = 4.2×10^2 Cfu/g) in the 0-15 cm layer and from 1.5 Cfu/g - 8.8×10^2 Cfu/g (mean = 5.15×10^2 Cfu/g) in the 15-30 cm layer. The control samples showed lower values of 3.5 Cfu/g and 2.1 Cfu/g in the topsoil and subsoil, respectively. *Bacillus* spp. were not assessed in the dry season samples.

Pseudomonas aeruginosa: *Pseudomonas aeruginosa* was not detected in the rainy season samples and the control samples. The parameter was not assessed in the dry season samples., indicating the absence or extremely low levels of this bacterial species in the soil across all seasons and depths.

Summary

In summary, the microbial population in the soil samples exhibited distinct seasonal and depth-related variations, with lower microbial counts generally observed in the rainy season and a significant increase in TBC and TFC during the dry season. These variations may be influenced by changes in soil conditions that favour microbial proliferation during the dry season. However, spatial differences between locations, such as Ugbene and Igboarim, suggest that localised rather than seasonality alone may play a more crucial role in determining the microbial communities observed between the two locations.

Table 4.31: Topsoil Microbial Populations in Ugbene (Rainy Season) and Igboariam (Dry Season)

S/N	Descriptive Statistics	Topsoil (0–15 cm) Omor (Rainy Season)					Topsoil (0–15 cm) Anaku (Dry Season)			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	TBC (Cfu/g x 10^5)	0.222	8.060	3.412	3.317	0.880	1490.0	2870.0	2130.0	0.6
2	TFC (Cfu/g x 10^3)	0.110	6.110	3.778	2.228	0.199	8.000	19.000	13.000	4.301
3	TCC (Cfu/g x 10^3)	0.15	0.79	0.39	0.23	0.311	NG	NG	NG	NG
4	*Bacillus* spp. (Cfu/g x 10^2)	3.2	5.2	4.2	1	3.5	ND	ND	ND	ND
5	*Pseudomonas aeruginosa*	NG	NG	NG	NG	NG	ND	ND	ND	ND

* Control Values not included in calculations; ND: Not Determined; NG: No Growth

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

Table 4.32: Subsoil Microbial Populations in Ugbene (Rainy Season) and Igboariam (Dry Season)

S/N	Descriptive Statistics	Topsoil (0–15 cm) Omor (Rainy Season)					Topsoil (0–15 cm) Anaku (Dry Season)			
		Min*	**Max***	**Mean***	**Stdev***	**Control**	**Min**	**Max**	**Mean**	**Stdev**
1	TBC (Cfu/g x 10^5)	0.102	4.100	1.488	1.634	0.730	1280.0	2410.0	1767.5	0.5
2	TFC (Cfu/g x 10^3)	0.100	4.800	2.680	1.602	1.000	4.000	26.000	15.000	11.000
3	TCC (Cfu/g x 10^3)	0.11	0.56	0.25	0.15	0.22	NG	NG	NG	NG
4	*Bacillus* spp. (Cfu/g x 10^2)	1.5	8.8	5.15	3.65	2.1	ND	ND	ND	ND
5	*Pseudomonas aeruginosa*	NG	NG	NG	NG	NG	ND	ND	ND	ND

* Control Values not included in calculations; ND: Not Determined; NG: No Growth

Sources: Anambra SAPZ ESIA Field Data (2024) (Rainy Dry Season); Coscharis Farms Limited (2020) (Dry Season)

4.2.9 Groundwater Characteristics

4.2.9.2 Groundwater Characteristics of Omor Project Area

The baseline groundwater characteristics at Omor were established using primary data for the rainy season, which was compared to the dry season secondary data sourced from the previously approved EIA for Coscharis Farms Limited at Anaku, Ayamelum LGA. The groundwater samples from Omor were collected from one borehole (GW2) and two wells (GW1 and GW3). The wells were covered; however, it was not unlikely that rainwater might have mixed with the water within them.

The results are presented in Table 4.33. Comparing them against NESREA's Highest Desirable Level for potable groundwater and WHO Guideline Values (GV), where available, provides a comprehensive understanding of the water quality and potential implications for public health and environmental management.

Physiochemistry

Appearance: The groundwater appearance of rainy season samples ranges from 2 - 20 TCU (mean = 9 TCU), with GW1 and GW2 having a colour appearance of 2 TCU and 5 TCU, respectively, which complied with NESREA's desirable limit, while GW3 had 20 TCU, exceeded NESREA's desirable limit but within the 50 permissible limits for potable groundwater. Colour appearance was not reported for the dry season samples.

Potential of Hydrogen (pH): The pH in the rainy season samples ranged from 6.3 - 7.7 (mean = 7.1), within the NESREA standard range of 7.0-8.5. However, during the dry season, the pH values were lower, ranging from 5.89 - 6.89 (mean = 6.42) and below the desirable limit for domestic use.

Conductivity and Total Dissolved Solids (TDS): Conductivity in the rainy season varied from 50 - 640 µS/cm (mean = 146.7 µS/cm). The conductivity values in the dry samples ranged from 35 - 867 µS/cm (mean = averaging 335.5 µS/cm), indicating higher mineral content in the dry season samples. Similarly, total dissolved solids (TDS) were lower in the rainy season ranging from 30 - 320 mg/L (mean = 141.88 mg/L), while in the dry season samples, the range was from 17 - 433 mg/L (mean = 167.8 mg/L. The higher values in the dry season suggest more concentrated mineral contents, which could affect water taste and long-term usage.

Total Hardness (TH): The total hardness of groundwater in the rainy season samples varied significantly, with values ranging from 0.001 - 234.6 mg/L (mean = 104.87 mg/L). This range is outside NESREA's desirable limit of 100 mg/L but within the Permissible Limit of 500 mg/L. The maximum concentration was recorded in GW3. In the dry season samples, TH ranged from 76 - 242.8 mg/L (mean = 132.45 mg/L).

Total Alkalinity (mg/L) & Bicarbonate (mg/L): Total alkalinity during the rainy season samples ranged from 40 - 188 mg/L (mean = 110.87 mg/L). Bicarbonate levels ranged from 0.07

- 1.1 mg/L (mean = 0.59 mg/L. These values suggest moderate buffering capacity in the samples, which helps maintain pH stability.

Data for the dry season was not available for these two parameters.

Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO): COD levels in the rainy season samples ranged from 6.5 - 11.2 mg/L (mean = 8.23 mg/L). In contrast, COD was much higher in the dry season samples, ranging from 30.71 - 54.72 mg/L (mean 39.28 mg/L). DO during the rainy season ranged from 56.8% to 66.7% (mean = 61.8%. On the other hand, DO concentrations in the dry season samples ranged from 3.5 mg/L - to 4.8 mg/L (mean = 4.17 mg/L). However, it is difficult to make a direct comparison of the DO of dry and rainy season samples due to the differences in the units used.

Nutrients: Nitrogen, Nitrates, and Nitrites: The total nitrogen levels in the rainy season samples ranged from 0.02 - 0.28 mg/L (mean = 0.15 mg/L.), while nitrate levels ranged from 0.31 - 1.66 mg/L (mean = 1.14 mg/L), well below the NESREA standard of 45 mg/L and WHO guideline of 50 mg/L. Nitrite concentrations were also very low, ranging from 04 - 0.42 mg/L (mean = 0.23 mg/L), below the NESREA standard of 0.5 mg/L and WHO guideline of 3 mg/L. Data for total nitrogen and nitrite were not available for the dry season samples; however, nitrate levels in these samples were below detection limits.

Phosphates and Sulphates: Phosphate levels in the rainy season samples ranged from 0.1 - 1.87 mg/L (mean = 0.74 mg/L). Lower levels of phosphate were measured In the dry season samples, with a range of 0.1 - 1.87 (mean =0.74 mg/L). On the other hand, sulphate levels in the rainy season range from 2 - 3 mg/L (mean = 2.5 mg/L), while no data is available for the dry season.

Total Organic Carbon (TOC): TOC concentrations in the rainy season samples ranged from 0.01 - 1.89 mg/L (mean = 1.07 mg/L. Higher TOC values were recorded in the well samples (GW1 and GW3). The presence of TOC suggests some level of organic pollution, which can contribute to oxygen depletion and impact water quality. No data was available for the dry season.

Chloride (Cl-), Calcium (Ca), Magnesium (Mg): In the rainy season samples, Cl- levels ranged from 31.29 - 47.58 mg/L (mean = 37.95 mg/L), Ca from 0.3 - 1 mg/L (mean = 0.609 mg/L) and Mg from 0 - 56.76 mg/L (mean = 25.357). All three minerals were within their respective recommended standards. The concentrations of these minerals measured in the dry season samples were lower than their respective rainy season parameter and also complied with regulatory standards. Cl- ranged from 6.99 - 55.98 mg/L (mean = 26.1 mg/L), Ca from 0.56 - 8.23 mg/L (mean = 4.32 mg/L) and Mg from 0.53 - 0.93 mg/L (mean = 0.77 mg/L)

Heavy Metals

The concentration of Al measured in the rainy season ranged from 0.2 - 0.64 (mean = 0.407 mg/L). Al was not measured in the dry season samples. Cd levels in the rainy season samples ranged from 0.008 - 0.1 mg/L (mean = 0.069 mg/L). These values are higher than the WHO GV of 0.003 mg/L for Cd. On the other hand, Cd was detection limits in the dry season samples.

The rainy season levels of chromium (Cr) ranged from 0.01 - 0.03 mg/L (mean = 0.023 mg/L). The levels were below the WHO GV of 0.05 mg/L. Cr was below detection limits in the dry season. Iron (Fe) levels in the rainy season samples ranged from 0.02 - 0.05 mg/L (mean = 0.033 mg/L), below the NESREA standard of 0.1 mg/L. Fe was below detection limits in the dry season. On the other hand, nickel (Ni) levels in the rainy season samples ranged from 0.021 - 0.087 mg/L (mean = 0.057 mg/L). Ni level in GW3 (0.087 mg/L) exceeded WHO GV values in GW of 0.07 mg/L. Ni was below the detection limits in the dry season samples.

The rainy season levels of lead (Pb) ranged from 0 - 0.006 mg/L (mean = 0.003 mg/L). Pb was below detection limits in the dry season. WHO GV for Pb is 0.001mg/L and was exceeded in GW 1 (0.006 mg/L) and GW 3 (0.003 mg/L).

Zn levels in the rainy season ranged from 0.001 - 0.002 mg/L (mean = 0.001 mg/L), while the dry season levels ranged from 0.072 - 0.588 mg/L (mean = 0.3895 mg/L). All measured Zn levels were within NESREA regulatory standards.

In summary, Cd (all samples), Ni (GWs) and Pb (GW1 and GW2) levels were exceeded in the rainy season samples, while other parameters were within regulatory guidelines. In the rainy season, Ni levels exceeded the WHO GV of 0.05 mg/L in GW1 and GW3. Ni was below detection limits in the dry season.

Table 4.33: Characteristics of Groundwater from Omor (Rainy Season) and Anaku (Dry Season)

S/N	Parameter	Rainy Season						Dry Season			NESREA† Standard	WHO GV
		GW1	GW2	GW3	Mean	Stdev	Control	Min	Max	Mean		
	Physiochemical											
1	Appearance (TCU)	2	5	20	9.00	7.87	10.00	1	1	1	5	
2	pH	7.7	6.3	7.3	7.1	0.5888	4.7	5.89	6.89	6.42	7.0-8.5	
3	Conductivity (µS/cm)	640	50	180	290	253.1	58.9	35	867	335.5	NS	
4	TDS (mg/L)	320	30	90	146.7	125.0	25.50	17	433	167.8	NS	
5	Temperature (°C)	27.5	27.3	27.4	27.40	0.08	27.60	29.4	32.3	30.68	NS	
6	Salinity (ppt)	1.24	0.98	0.37	0.86	0.36	1.11	0.02	0.37	0.14625	NS	
7	Total Hardness (mg/L)	234.6	0.001	80	104.87	97.38	0.00	76	242.8	132.45	100	
8	Total Alkalinity (mg/L)	104.6	40	188	110.87	60.58	62.60	ND	ND	ND	NS	
9	Bicarbonate (mg/L)	1.1	<0.001	0.07	0.59	0.52	<0.001	ND	ND	ND	NS	
10	COD (mg/L)	7	11.2	6.5	8.23	2.11	19.20	30.71	54.72	39.28	NS	
11	DO (%)	66.7		56.8	61.8	5.0	58.9	3.5	4.8	4.175	NS	
12	Total Nitrogen (mg/L)	0.02	<0.001	0.28	0.15	0.13	1.92	ND	ND	ND	NS	
13	NO_3 (mg/L)	1.457	0.309	1.663	1.14	0.60	0.59	0	0	0	45	50
14	NO_2^- (mg/L)	0.226	0.038	0.416	0.23	0.15	0.07	ND	ND	ND	0.5	3
15	PO_4 (mg/L)	0.1	0.25	1.87	0.74	0.80	0.33	0	0.096	0.029	NS	
16	SO_4^{2-} (mg/L)	3	2	<0.001	2.50	0.50	1.00	0	0	0	200	
17	TOC (mg/L)	1.31	0.01	1.89	1.07	0.79	<0.001	ND	ND	ND	NS	
18	Total Chloride (mg/L)	47.58	31.29	34.98	37.95	6.97	37.98	6.99	55.98	26.1	200	
19	Ca (mg/L)	1	0.3	0.526	0.609	0.292	1.450	0.56	8.23	4.32	75	
20	Mg (mg/L)	56.76	0	19.31	25.357	23.563	0.000	0.53	0.93	0.77	30	
21	**Heavy Metal**											
22	Al (mg/L)	0.64	0.2	0.38	0.407	0.181	0.020	ND	ND	ND	ND	
23	Cd(mg/L)	0.1	0.008	0.1	0.069	0.043	0.901	BDL	BDL	BDL	NS	0.003
24	Cr (mg/L)	0.01	0.03	0.03	0.023	0.009	<0.001	BDL	BDL	BDL	NS	0.05
25	Fe (mg/L)	0.03	0.05	0.02	0.033	0.012	0.010	BDL	BDL	BDL	0.1	
	Ni (mg/L)	0.064	0.021	0.087	0.057	0.027	0.066	BDL	BDL	BDL	NS	0.07
26	Pb (mg/L)	0.006	0	0.003	0.003	0.002	0.004	BDL	BDL	BDL	NS	0.01

S/N	Parameter	Rainy Season						Dry Season			NESREA† Standard	WHO GV
		GW1	GW2	GW3	Mean	Stdev	Control	Min	Max	Mean		
27	Zn (mg/L)	0.001	0.001	0.002	0.001	0.000	0.001	0.072	0.588	0.3895	5.0	
	Microbiology										NS	
28	Total Coliform Count (Cfu/ml x10^1)	6.0	NG	70.0	38.0	32.0	4.0	ND	ND	ND	10	
29	Total Bacteria Count (Cfu/ml x10^2)	0.4	1.0	33.0	11.5	15.2	40.0	0.1	0.4	0.24	NS	
30	Faecal Coliform (Cfu/ml x 10^1)	NG	NG	2	0.666	9.428	NG	0	0	0	0	
31	*Bacillus* spp. (Cfu/ml)	NG	NG	1.0	1.0	0.0	NG	ND	ND	ND	NS	
32	*Pseudomonas aeruginosa* (Cfu/ml)	NG	NG	NG	0.0	0.0	NG	ND	ND	ND	NS	
33	Total Fungi Count (Cfu/ml x10^1)	35.0	3.0	1.0	13.0	15.6	NG	0	0	0	NS	

†: Highest Desirable Limit; BDL: Below Equipment Detection Limit; ND: Not Determined; NG: No Growth; NS: Not Specified

Source: Anambra SAPZ ESIA Field Data (2024)

Microbiology

The total coliform counts (TCC) in the rainy season samples ranged from 6 - 70 Cfu/ml (mean = 38 Cfu/ml). TCC exceeded NESREA's limits of 10 Cfu/ml in GW3 (70 Cfu/ml) but not in GW1 (6 Cfu/ml) and GW2 (0 Cfu/ml). Coliforms were absent in the dry season samples.

Total Bacteria Count (Cfu/ml): The total bacteria count in the rainy season ranged from 0.4 - 33 Cfu/ml (mean = 11.5 Cfu/ml), while in the dry season, the counts were significantly lower, ranging from 0.1 - 0.4 Cfu/ml (mean = 0.24 Cfu/ml). The high TBC was counted in GW3, while GW1 and GW2 had TCC of 4 and 10, respectively. The GW3's high bacterial count suggests greater microbial activity and potential contamination.

Faecal Coliform (Cfu/ml): Faecal coliforms were not detected in the rainy season samples of GW1 and GW2. However faecal coliform count of 20 Cfu/ml was observed in GW3, which exceeded the zero NESREA's recommendations.

Bacillus spp., *Pseudomonas aeruginosa* and Total Fungi Counts: One count of *Bacillus* spp. was recorded in the rainy season samples of GW3, with no growth recorded in GW1 and GW2. No growth of *P. aeruginosa* was recorded, while TFC counts of 350, 30 and 10 were recorded in GW1, GW2 and GW3, respectively. These three parameters were not determined in the dry season samples.

In summary, the data indicates GW3 was highly impacted by organic matter and microbial growth, rendering it unfit for domestic consumption.

4.2.9.2 Groundwater Characteristics of Ogboji Project Area

Table 4.34 shows the results of the general physiochemistry of the groundwater samples, discussed below.

Physiochemistry

Appearance and Colour: The water sample and control appeared clear, with a measured True Colour Unit (TCU) of 5, meeting NESREA's highest desirable limits for domestic groundwater. This clarity is an indicator of good water quality, and both samples maintained this standard.

Potential of Hydrogen (pH): The groundwater sample exhibited a pH of 7.6, placing it slightly on the alkaline side and is within the NESREA standard range of 7.0-8.5. In contrast, the control sample had a lower pH of 4.7, indicating more acidity and possibly influenced by environmental factors or contamination.

Conductivity and Total Dissolved Solids (TDS): Conductivity in the groundwater was measured at 30 μS/cm, significantly lower than the control sample's 350 μS/cm. This low conductivity suggests a lower concentration of dissolved ions in the groundwater, which typically reflects better water quality. TDS) in the groundwater were also much lower at 16.93 mg/L compared to the control sample's 185.7 mg/L. Although NESREA does not specify a standard for TDS, lower values generally indicate fewer dissolved substances, which is beneficial for drinking water.

Total Hardness (TH): TH in the groundwater was found to be 0 mg/L, indicating very soft water. While soft water reduces scaling in pipes and appliances, it may also be more corrosive and less effective in providing essential minerals like calcium and magnesium. In contrast, the control sample had a total hardness of 102.6 mg/L, slightly exceeding the NESREA standard of 100 mg/L.

Total Alkalinity: The groundwater's total alkalinity was measured at 72.6 mg/L, slightly lower than the control sample's 90 mg/L. Although there are no specified NESREA standards for alkalinity, this measure reflects the water's ability to neutralise acids, and lower values in the groundwater could make it more susceptible to acidic inputs.

Bicarbonates: Both the groundwater and control samples had bicarbonate levels below 0.001 mg/L. Bicarbonates act as buffers in water, helping to maintain a stable pH by neutralising both acids and bases.

Chemical Oxygen Demand (COD): The COD of the groundwater was higher at 22.3 mg/L compared to the control sample's 18.3 mg/L. Higher COD values can indicate the presence of organic pollutants.

Table 4.34: Groundwater of Ogboji (Rainy Season, July 2024)

S/N	PARAMETER	GW	GW Control	NESREA† Limit	WHO GV
1	Appearance (TCU)	5.0	5.0	5.0	
2	pH	7.6	4.7	7.0-8.5	
3	Conductivity (µS/cm)	30	350	NS	
4	TDS (mg/L)	16.93	185.7	NS	
5	Temperature (°C)	27.7	27.7	NS	
6	Salinity (mg/L)	1.58	1.21	NS	
7	Total Hardness (mg/L)	0.0	102.6	100	
8	Total Alkalinity (mg/L)	72.6	90	NS	
9	Bicarbonate (mg/L)	<0.001	<0.001	NS	
10	COD (mg/L)	22.3	18.3	NS	
11	DO (%)	ND	58.9	NS	
12	NO_3 (mg/L)	0.18	1.807	45	50
13	NO_2^- (mg/L)	0.039	0.052	0.5	3.0
14	Total Nitrogen (mg/L)	<0.001	<0.001	NS	
15	PO_4 (mg/L)	3.5	4.1	NS	
16	SO_4 (mg/L)	2.0	5.0	200	
17	Total Chloride (mg/L)	52.58	61.28	NS	
18	Ca (mg/L)	0.2	1.04	75	
19	Mg (mg/L)	0	24.67	30	
20	TOC (mg/L)	<0.001	<0.001	NS	
	Heavy Metal				
21	Al (mg/L)	0.45	0.6	NS	
22	Cd (mg/L)	0.001	0.01	NS	0.003
23	Cr (mg/L)	0.04	0.02	NS	0.05
24	Fe (mg/L)	1.0	0.02	0.1	
25	Ni (mg/L)	0.071	0.051	NS	0.07
26	Pb (mg/L)	0.006	0.008	NS	0.01
27	Zn (mg/L)	0	0	5.0	

S/N	PARAMETER	GW	GW Control	NESREA† Limit	WHO GV
	Microbiology				
28	TCC (Cfu/ml)	1 x 10^1	2 x 10^1	10	
29	TotaTBC(Cfu/ml)	2 x 10^2	1.5 x 10^2	NS	
30	Faecal Coliform (Cfu/ml)	NG	NG	0	
31	*Bacillus* spp. (Cfu/ml)	NG	NG	NS	
32	*Pseudomonas aeruginosa* (Cfu/ml)	NG	NG	NS	
33	TFC (Cfu/ml)	NG	NG	NS	

†: Highest Desirable Limit; ND: Not Determined; NG: No Growth; NS: Not Specified; GV: Guideline Value
Source: Anambra SAPZ ESIA Field Data (2024)

Heavy Metals

In terms of heavy metals, the groundwater's aluminium level was lower than that of the control sample, but both were within typical environmental ranges. Cd levels were low at 0.001 mg/L, significantly lower than the control sample's 0.01 mg/L. These values are lower than the WHO guideline value (GV) of 0.003 for Cd. Cd is highly toxic, and even small amounts can accumulate in the body, leading to serious health effects, including kidney damage and bone fragility. The chromium level measured in the groundwater sample was higher than the control sample's 0.02 mg/L and within the WHO GV value of 0.05 for this metal.

The groundwater sample exhibited an iron (Fe) concentration of 1.0 mg/L, significantly higher than the control sample's 0.02 mg/L and exceeding the NESREA desirable standard of 0.1 mg/. However, it meets the permissible standard. This elevated iron level likely originates from natural sources such as the weathering of iron-bearing minerals. However, according to WHO (2022), Fe does not pose a health concern at the levels found in drinking water.

Lead (Pb) was present at a concentration of 0.006 mg/L in the groundwater, slightly lower than the control sample's 0.008 mg/L, with both values being below the WHO GV of 0.01 mg/L for lead. The nickel (Ni) concentration in the sample was 0.071 mg/L, and just about the WHO GV value of 0.7 mg/L. The concentration of Ni measured in the control sample was 0.051 mg/L.

Zinc (Zn) was not detected in either the groundwater or the control sample, complying with the NESREA standard of 5.0 mg/L. Zn is an essential trace element, and its absence suggests no significant sources for the metal in the area.

Microbiology Parameters

Microbiological analysis revealed that the groundwater had a total coliform count of 1 x 10^1 Cfu/ml, which, while above NESREA's desirable groundwater limit, still meets the highest permissible limits. The control sample had a higher total coliform count of 2 x 10^1 Cfu/ml. The groundwater also had a higher total bacterium count at 2 x 10^2 Cfu/ml compared to the control sample's 1.5 x 10^2 Cfu/ml, suggesting potential organic pollution. However, no faecal coliforms were detected in either the groundwater or control samples, indicating the absence of significant contamination from human or animal waste. Additionally, Bacillus spp. and Pseudomonas aeruginosa were not detected in both groundwater and control samples, further indicating no contamination by these bacteria.

Overall, the groundwater sample meets several key water quality standards but shows certain areas of concern, such as higher COD and increased microbial counts.

4.2.8.2 Groundwater Characteristics of Ogbunka Project Area

Table 4.35 shows the results of the laboratory analysis of two borehole water samples collected from around Ogbunka to establish the baseline groundwater characteristics of the project area. The results are discussed below.

Appearance and pH

Both boreholes exhibited a clear appearance with a True Colour Unit (TCU) of 5, meeting the NESREA standard of 5 TCU. The pH levels were slightly acidic, with GW1 at 6.3 and GW2 at 6.4, averaging 6.35. These values fall below the NESREA standard range of 7.0-8.5, indicating slightly acidic conditions.

Conductivity and Total Dissolved Solids (TDS)

The conductivity of GW1 was 30 µS/cm, while GW2 was 40 µS/cm (mean = 35 µS/cm). TDS levels were 10 mg/L for GW1 and 20 mg/L for GW2 (mean = 15 mg/L). Both parameters were within acceptable ranges, although no specific standards are provided by NESREA or WHO.

Total Hardness and Alkalinity

Total hardness, which is often associated with calcium and magnesium content, was not detected in both samples, with values of 0 mg/L in each sample, indicating very soft water. The total alkalinity values varied between GW1 at 50.6 mg/L and GW2 at 27.2 mg/L (mean = mean of 38.9 mg/L), indicating the water's low capacity to neutralise acid. This is further supported by the minimal bicarbonate levels, with GW1 showing less than 0.001 mg/L and GW2 at 0.03 mg/L, averaging 0.03 mg/L.

Bicarbonate and Chemical Oxygen Demand (COD)

Bicarbonate levels were below detection limit (<0.001 mg/L) in GW1 and 0.03 mg/L in GW2 (mean = 0.015 mg/L). COD levels were 19.2 mg/L in GW1 and 21 mg/L in GW2 (mean = 20.1 mg/L), indicating the presence of organic matter.

Nitrates, Nitrite, and Total Nitrogen

Nitrate levels were 0.636 mg/L in GW1 and 0.396 mg/L in GW2 (mean = 0.516 mg/L), well below the NESREA standard of 45 mg/L and WHO guideline of 50 mg/L. Nitrite levels were 0.035 mg/L in GW1 and 0.026 mg/L in GW2 (mean = 0.0305 mg/L), which was also below the NESREA standard of 0.5 mg/L and WHO guideline of 3 mg/L. Total nitrogen was significantly higher in GW1 at 2.35 mg/L compared to 0.1 mg/L in GW2 (mean = 1.225 mg/L).

Phosphates and Sulphates

PO4- levels were somewhat elevated, with GW1 at 2.22 mg/L and GW2 at 3.6 mg/L, (mean = 2.91 mg/L). However, SO4- levels are low, with GW1 having concentrations of 1 mg/L and GW2 6 mg/L (mean = 3.5 mg/L), which were well below the NESREA limit of 200 mg/L.

Chlorides, Calcium and Magnesium

The total chloride levels were 39.98 mg/L in GW1 and 37.58 mg/L in GW2 (mean = 38.78 mg/L), which was well below NESREA's 200 mg/L standards for this mineral. Ca and Mg concentrations were extremely low, with calcium having levels of 0.1 mg/L in GW1 and 0.26 mg/L in GW2 (mean = 0.18 mg/L below the NESREA standard of 75 mg/L. Mg was not detected in any of the samples; hence the NESREA standard of 30 mg/L for the mineral.

Total Organic Carbon (TOC). TOC, an indicator of organic matter, showed slight variation, with GW1 at 0.01 mg/L and GW2 at 0.3 mg/L (mean = 0.155 mg/L).

Table 4.35: Characteristics of Groundwater from Ogbunka (Rainy Season)

S/N	PARAMETER	GW1	GW2	Mean	NESREA†	WHO GV
	Physiochemical					
1	Appearance (TCU)	5	5	5	5	
2	pH	6.3	6.4	6.35	7.0-8.5	
3	Conductivity (µS/cm)	30	40	35	NS	
4	TDS (mg/L)	10	20	15	NS	
5	Temperature (°C)	27.5	27.5	27.5	NS	
6	Salinity (ppt)	1	0.78	0.89	NS	
7	Total Hardness (mg/L)	0	0	0	100	
8	Total Alkalinity (mg/L)	50.6	27.2	38.9	NS	
9	Bicarbonate (mg/L)	<0.001	0.03	0.015	NS	
10	COD (mg/L)	19.2	21	20.1	NS	
11	NO_3 (mg/L)	0.636	0.396	0.516	45	50
12	NO_2^- (mg/L)	0.035	0.026	0.0305	0.5	3
13	Total Nitrogen (mg/L)	2.35	0.1	1.225	NS	
14	PO_4 (mg/L)	2.22	3.6	2.91	NS	
15	SO_4 (mg/L)	1	6	3.5	200	
16	Total Chloride (mg/L)	39.98	37.58	38.78	200	
17	Ca (mg/L)	0.1	0.26	0.18	75	
18	Mg (mg/L)	0	0	0	30	
19	TOC (mg/L)	0.01	0.3	0.155	NS	
	Heavy Metals					
24	Al (mg/L)	1	0.2	0.6	NS	
25	Cd (mg/L)	0.057	0.001	0.029	NS	0.003
23	Cr (mg/L)	<0.001	0.01	0.01	NS	0.05
20	Fe (mg/L)	0.04	0.03	0.035	0.1	

S/N	PARAMETER	GW1	GW2	Mean	NESREA†	WHO GV
22	Ni (mg/L)	0.001	0	0.0005	NS	0.07
21	Pb (mg/L)	0	0.008	0.004	NS	0.01
26	Zn (mg/L)	0	0	0	5.0	
	Microbiology					
27	Total Coliform Count (Cfu/ml x 10^2)	2.4	12	7.2		
28	Total Bacteria Count (Cfu/ml x 10^2)	3	15.8	9.4	0.1	
29	Fecal Coliform (Cfu/ml x 10^2)	NG	3.6	1.8	0	
30	*Bacillus* spp. (Cfu/ml)	NG	NG	NG	NS	
31	Pseudomonas *aeruginosa* (Cfu/ml)	NG	NG	NG	NS	
32	Total Fungi Count (Cfu/ml)	NG	NG	NG	NS	

†: Highest Desirable Limit; BDL: Below Equipment Detection Limit; ND: Not Determined; NG: No Growth; NS: Not Specified

Source: Anambra SAPZ ESIA Field Data (2024)

Heavy Metals

All levels were relatively high in GW1 at 1 mg/L compared to 0.2 mg/L in GW2 (mean = 0.6 mg/L). The measured Cd levels in the GW1 sample were 0.057 mg/L, which exceeded the WHO GV of 0.003. In contrast, Cd levels in GW1 were 0.001 mg/L, below the GV for Cd. The measured Cr levels were within safe limits, with GW1 having Cd concentrations below the equipment detection limit of 0.001 and GW2 having values of 0.01 mg/L

Fe concentrations were low, with values of 0.04 mg/L measured in GW1 and 003 in GW2 (mean = 0.035 mg/L), below the NESREA limits of 0.1 mg/L. Ni levels were minimal at 0.001 in GW1 and 0.0 in GW2, well within the WHO guideline of 0.07 mg/L. In contrast, Pb levels were elevated in GW2 at 0.008 mg/L, compared to 0 mg/L in GW1, and exceeded the WHO GV of 0.001 mg/L. Zn was not detected in both samples.

Microbiology

The measured TCC was 2.4 Cfu/ml x 10^2in GW1 and 12 Cfu/ml x 10^2 in GW2 (mean 7.2 Cfu/ml x 10^2), well above the NESREA standard of 10 Cfu/ml. TBC levels were 3 Cfu/ml x 10^2 in GW1 and 15.8 Cfu/ml x 10^2 in GW2, averaging 9.4 Cfu/ml x 10^2. Faecal coliform showed no growth (NG) in GW1 but counts of 3.5 x 10^2 were measured in GW2*. P. aeruginosa* and fungi showed no growth in the samples.

To conclude, while most chemical parameters of the groundwater fall within acceptable limits, the elevated Cd, pH, and microbial contamination, indicate potential health risks if the water is consumed untreated. Appropriate treatment measures, such as filtration and disinfection, are essential to ensure that the water remains safe for domestic use.

4.2.10 Surface Water

The surface waters studied are the closest to the project areas and include Rivers Otakpu and Nnamuzu in Omor and Ugbene, respectively, Eso Stream in Ogboji and River Uruokpukpo in Ogbunka. These were studied during the rainy season during the ESIA fieldwork.

4.2.10.1 Omor and Ugbene Surface Waters

Otakpu River in Omor and River Nnamuzu in Ugbene are tributaries of River Ezu, which flows into River Omambala and is part of the Anambra River Basin. Rainy season water samples were collected from three locations along Otakpu River: OMSW1 (upstream), OMSW2 (midstream), and OMSW3 (downstream). Similarly, samples from River Nnamuzu were taken at UGBSW1 (upstream), UGBSW2 (midstream), and UGBSW3 (downstream). Additionally, a control sample was collected from a pool of water located 100 meters from OMSW1. The analysis results were used to establish baseline surface water characteristics for the rainy season and were compared to dry season samples obtained from the Coscharis Farms Limited 2020 EIA study, which examined the surface water of Ezu River, the parent water body of Otakpu and Nnamuzu Rivers. The results are presented in Table 4.36 and discussed below.

Physiochemistry

Appearance (TCU)

- Otakpu River: The range was 20.0 to 25.0 TCU across SW1 to SW3.
- Nnamuzu River: The range was 25.0 to 30.0 TCU across SW1 to SW3.
- Ezu River (Dry Season): The range was 3.7 to 5.0 TCU.

The results indicate that both Omor and Nnamuzu Rivers showed higher turbidity levels during the rainy season, likely due to increased runoff. Ezu River, sampled during the dry season, has significantly lower turbidity, indicating clearer water, which is expected when there is less runoff influence.

Potential of Hydrogen:

- Otakpu River: pH ranged from 6.5 to 6.6.
- Nnamuzu River: pH ranged from 6.2 to 6.7.
- Ezu River (Dry Season): pH ranged from 5.5 to 6.5.

The pH levels in Otakpu and Nnamuzu Rivers were relatively stable and slightly acidic during the rainy season. The Ezu River data, collected during the dry season, exhibited a wider variability with slightly lower pH values, which may indicate seasonal acidity changes or local sources influencing the pH of the water.

Conductivity (µS/cm):

- Otakpu River: The range was 60.0 to 200.0 µS/cm.
- Nnamuzu River: The range was 20.0 to 60.0 µS/cm.
- Ezu River (Dry Season): Conductivity was not detected.

Otakpu River displays higher conductivity compared to Nnamuzu River during the rainy season, possibly due to higher dissolved solids and minerals. Conductivity data was not available for the Ezu River.

Total Dissolved Solids (TDS) (mg/L):

- Otakpu River: The range was 24.2 to 24.4 mg/L.
- Nnamuzu River: The range was 10 to 30 g/L.
- Ezu River (Dry Season): The range was 11.0 to 14.0 mg/L.

TDS levels in Omor and Nnamuzu Rivers during the rainy season varied, with River Nnamuzu showing broader fluctuations. The Ezu River data in the dry season had a narrower range and values, indicating stable water quality with fewer dissolved solids compared to rainy season samples.

Temperature (°C):

- Otakpu River: The range was 27.4 to 27.6°C.
- Nnamuzu River: Consistent at 27.7°C.
- Ezu River (Dry Season): The range was 29.0 to 29.3°C.

The dry season in the Ezu River corresponded with slightly higher temperatures, reflecting seasonal warmth. Omor and Nnamuzu Rivers, sampled in the rainy season, showed relatively stable and cooler temperatures.

Salinity (ppt):

- Otakpu River: The range was 9.9 to 10.7 mg/L.
- Nnamuzu River: The range was 12.3 to 15.5 mg/L.
- Ezu River (Dry Season): Was not assessed.

Salinity was higher in the Nnamuzu River than in the Otakpu River during the rainy season. Salinity data was not available for the Ezu River.

Total Hardness (mg/L):

- Otakpu River: Not detected.
- Nnamuzu River: The range was 0.0 to 102.0 mg/L.
- Ezu River (Dry Season): The range was 76.8 to 82.9 mg/L.

Hardness was detected only in Rivers Nnamuzu and Ezu, with the highest range measured in River Nnamuzu during the rainy season.

Nutrients (Nitrate, Nitrite, Total Nitrogen, Phosphate, Sulphate):

- Omor and Nnamuzu Rivers had relatively higher nitrogen and phosphate levels during the rainy season.
- Ezu River in the dry season generally showed lower concentrations for these parameters.

Rainy season samples from the Otakpu and Nnamuzu Rivers were richer in nutrients, likely due to agricultural runoff. Ezu River's nutrient concentrations were less, reflecting lower runoff and potential dilution during the dry season.

Heavy Metals

Aluminium: The rainy season Al concentrations were notably high in River Otakpu, ranging from 2.400 mg/L - 3.190 mg/L (mean = 2.713 mg/L), while in River Nnamuzu, Al levels varied from 1.120 mg/L - 1.610 mg/L (mean = 1.310 mg/L). These levels exceeded the NESREA limit of 0.2 mg/L. In contrast, Al was below detectable levels in the Ezu River during the dry season.

Cadmium: Cd levels in River Otakpu ranged from 0.002 mg/L - 0.015 mg/L (mean = 0.011 mg/L), while River Nnamuzu showed Cd concentrations between 0.009 mg/L and 0.072 mg/L (mean = 0.035 mg/L). Except for OMSW1, recorded Cd values exceeded NESREA's ambient standard of 0.005mn/L for Cd. However, OMSWI Cd was not detectable in the Ezu River during the dry season.

Chromium: The measured Cr levels in River Otakpu were between 0.010 mg/L and 0.030 mg/L (mean = 0.023 mg/L), while River Nnamuzu's Cr levels ranged from not detected in UGBSW1 - 0.020 mg/L in UGBSW2 and UGBSW3. These concentrations exceeded NESREA's ambient standard of 0.001 mg/L for hexavalent Cr. The Ezu River again showed no detectable levels during the dry season.

Iron: Fe concentrations in the rainy season samples in River Otakpu ranged from 0.020 mg/L - 0.810 mg/L, with a mean value of 0.307 mg/L, while in samples River Nnamuzu, Fe levels varied from 0.070 mg/L - 1.000 mg/L (mean = 0.393 mg/L). In the dry season sample from Ezu River, the Ezu River concentrations of Fe were significantly higher, ranging from 1.3 mg/L - 2.6 mg/L (mean = 1.9 mg/L). These concentrations were higher than NESREA's limit of 0.05 mg/L for Fe. However, Fe levels in OMSW1 and OMSW3 were within NESREA's limits.

Lead: Pb levels in both River Otakpu and River Nnamuzu were relatively low, with a maximum concentration of 0.009 mg/L in River Otakpu and 0.003 mg/L in River Nnamuzu. In contrast, Pb was below detectable levels in the Ezu River during the dry season, indicating minimal contamination across all sites, with Rivers Otakpu and Nnamuzu remaining within safe limits.

Nickle: Ni concentrations in River Otakpu ranged from 0.064 mg/L to 0.086 mg/L (mean = 0.076 mg/L), while those recorded in River Nnamuzu were between 0.071 mg/L and 0.090 mg/L (mean = 0.079 mg/L). These levels were higher than NESREA's ambient standard of 0.01 mg/L. Ni concentrations were below the detection limit in the Ezu River.

Zinc: Zn concentrations were minimal across both River Otakpu and River Nnamuzu, with a maximum of 0.010 mg/L in River Otakpu and undetectable levels in River Nnamuzu, mirroring the undetectable levels observed in the Ezu River during the dry season. All Zn levels were within safe limits according to NESREA standards.

Overall, the data shows elevated concentrations of some heavy metals, including Al, Cd, Cr, Fe and Ni exceeding NESREA limits. In contrast, the Ezu River during the dry season generally exhibits lower concentrations of these metals, except for iron.

Microbiological Parameters

Total Coliform Count, Total Bacterial Count and Total Fungal Count

- Otakpu and Nnamuzu Rivers showed varied bacterial and fungal counts during the rainy season.

- Ezu River, sampled in the dry season, did not show detectable microbial activity, possibly due to less favourable conditions for microbial growth.

Rainy season conditions in the Otakpu and Nnamuzu Rivers supported higher microbial presence, driven by nutrient-rich runoff. Ezu River's dry season sample showed minimal microbial activity, possibly due to the reduced influx of organic material.

Overall Assessment

Otakpu and Nnamuzu Rivers exhibited more variability and higher concentrations across most parameters compared to the Ezu River, highlighting the impact of the rainy season. In contrast, the dry season Ezu River data generally exhibited more stable and conservative values, reflecting the lower runoff, dilution, and seasonal changes in water quality associated with the dry season. This is likely due to increased runoff, erosion, and potential pollution inputs during this period. While seasonal influence was clearly observed, it is essential to also account for the spatial disparities among these rivers—such as differences in land use, watershed characteristics, and proximity to pollution sources—which likely contributed to the observed differences in water quality.

Table 4.36: Surface Water Physiochemistry in Rivers Otakpu (Omor) and Nnamuzu (Ugbene) (Rainy Season) and River Ezu (Anaku) (Dry Season)

S/N	Season	Rainy Season													Dry Season						NESREA limits†
	Surface Water	Otakpu River						Nnamuzu River							Ezu River						
	Parameter	SW 1	SW 2	SW 3	Min	Max	Mean	SW1	SW 2	SW 3	Min	Max	Mean	Control	SW 1	SW 2	SW 3	Min	Max	Mean	
1	Appearance (TCU)	20.0	25.0	20.0	20.0	25.0	21.7	30.0	25.0	25.0	25.0	30.0	26.7	10.0	5.0	3.7	4.6	3.7	5.0	4.4	NS
2	pH	6.6.	6.6	6.5	6.5	6.6	6.6	6.2	6.7	6.7	6.2	6.7	6.5	5.6	6.5	5.9	5.5	5.5	6.5	6.0	6.5-8.5
3	Conductivity (µS/cm)	200	130	60	60	200	130	60	20	20	20	60	33.3	60	ND	ND	ND	ND	ND	ND	ND
4	TDS (mg/L)	90	60	30	30	90	60	30	10	10	10	30	16.7	30	11.0	14.0	11.0	11.0	14.0	12.0	NS
5	Temperature (°C)	27.4	27.6	27.6	27.4	27.6	27.5	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.0	29.1	29.3	29.0	29.3	29.1	NS
6	Salinity (mg/L)	10.7	10.0	9.9	9.9	10.7	10.2	12.3	15.5	14.4	12.3	15.5	14.1	15.2	0.0	0.0	0.0	0.0	0.0	0.0	NS
7	Total Hardness (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	102.0	100.0	0.0	0.0	102.0	67.3	0.0	76.8	78.0	82.9	76.8	82.9	79.2	NS
8	Total Alkalinity (mg/L)	60.0	57.2	57.2	57.2	60.0	58.1	92.6	97.4	42.6	42.6	97.4	77.5	50.0	ND	ND	ND	ND	ND	ND	NS
9	Bicarbonate (mg/L)	8.5	3.7	4.1	3.7	8.5	5.4	2.2	3.1	2.9	2.2	3.1	2.7	12.0	ND	ND	ND	ND	ND	ND	NS
10	COD (mg/L)	12.0	6.8	17.3	6.8	17.3	12.0	15.2	16.2	12.3	12.3	16.2	14.6	34.2	27.9	21.5	30.6	21.5	30.6	26.7	NS
11	DO (%)	58.8	68.8	68.8	58.8	68.8	65.5	ND	ND	ND	ND	ND	ND	33.7	4.5	5.0	4.8	4.5	5.0	4.8	6.0*
12	Nitrate (NO3)	0.7	0.6	0.5	0.5	0.7	0.6	1.2	1.1	0.4	0.4	1.2	0.9	0.3	0.1	0.1	0.3	0.1	0.3	0.2	9.1
13	Nitrite (NO2-)	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.3	0.1	0.0	ND	ND	ND	ND	ND	ND	0.0
14	Total Nitrogen (N)	3.0	2.0	4.1	2.0	4.1	3.0	5.0	4.4	6.7	4.4	6.7	5.4	6.9	ND	ND	ND	ND	ND	ND	ND
15	PO_4^{3-} (mg/L)	4.5	6.6	6.6	4.5	6.6	5.9	4.2	5.1	4.6	4.2	5.1	4.6	7.4	0.3	0.2	0.2	0.2	0.3	0.3	3.5
16	Sulphate (SO42-)	40.0	24.0	32.0	24.0	40.0	32.0	19.0	17.9	18.0	17.9	19.0	18.3	35.0	12.8	35.7	31.7	12.8	35.7	26.7	100.0

S/N	Season	Rainy Season													Dry Season						NESREA limits†
	Surface Water	Otakpu River						Nnamuzu River							Ezu River						
	Parameter	SW 1	SW 2	SW 3	Min	Max	Mean	SW1	SW 2	SW 3	Min	Max	Mean	Control	SW 1	SW 2	SW 3	Min	Max	Mean	
17	Total Chloride	52.3	33.6	42.3	33.6	52.3	42.7	138.2	53.6	47.6	47.6	138.2	79.8	37.6	7.6	7.9	9.0	7.6	9.0	8.2	300.0
18	Ca (mg/L)	0.5	0.1	0.5	0.1	0.5	0.4	1.8	0.8	0.5	0.5	1.8	1.0	1.7	0.2	0.3	0.3	0.2	0.3	0.3	180.0
19	Mg (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	24.2	24.1	0.0	0.0	24.2	16.1	0.0	0.1	0.1	0.2	0.1	0.2	0.1	40.0
20	TOC	0.8	0.5	1.0	0.5	1.0	0.7	0.7	0.1	0.9	0.1	0.9	0.6	1.0	ND	ND	ND	ND	ND	ND	ND
	Heavy Metals																				
21	Fe (mg/L)	0.020	0.810	0.090	0.020	0.810	0.307	0.070	1.000	0.110	0.070	1.000	0.393	0.090	2.6	1.9	1.3	1.3	2.6	1.9	0.05
22	Pb (mg/L)	0.000	0.006	0.009	0.000	0.009	0.005	0.000	0.000	0.003	0.000	0.003	0.001	0.001	BDL	BDL	BDL	BDL	BDL	BDL	0.01
23	Ni (mg/L)	0.064	0.086	0.079	0.064	0.086	0.076	0.071	0.090	0.075	0.071	0.090	0.079	0.081	BDL	BDL	BDL	BDL	BDL	BDL	0.01
24	Cr (mg/L)	0.010	0.030	0.030	0.010	0.030	0.023	<0.001	0.020	0.020	0.020	0.020	0.01	0.320	BDL	BDL	BDL	BDL	BDL	BDL	0.01
25	Al (mg/L)	2.550	3.190	2.400	2.400	3.190	2.713	1.120	1.610	1.200	1.120	1.610	1.310	1.200	BDL	BDL	BDL	BDL	BDL	BDL	0.2
26	Cd (mg/L)	0.015	0.002	0.015	0.002	0.015	0.011	0.072	0.025	0.009	0.009	0.072	0.035	0.011	BDL	BDL	BDL	BDL	BDL	BDL	0.005
27	Zn (mg/L)	0.010	0.000	0.000	0.000	0.010	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	BDL	BDL	BDL	BDL	BDL	BDL	0.01
	Microbiology																				
28	TCC (Cfu/ml x 10^2)	1.0	5.0	1.5	1.0	5.0	2.5	0.5	NG	2.0	0.5	2.0	1.3	2.5	ND	ND	ND	ND	ND	ND	10.0
29	TBC (Cfu/ml x 10^2)	28.0	30.0	45.0	28.0	45.0	34.3	36.0	0.8	0.1	0.1	36.0	12.3	11.2	ND	ND	ND	ND	ND	ND	NS
30	TFC (Cfu/ml x 10^1)	NG	2.0	NG	2.0	2.0	2.0	2.0	2.0	NG	2.0	2.0	2.0	3.0	ND	ND	ND	ND	ND	ND	NS
31	Pseudomonas aeruginosa	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	ND	ND	ND	ND	ND	ND	NS
32	Faecal Coliform	NG	NG	NG	NG	NG	NG	3.0	NG	NG	NG	NG	NG	50.0	ND	ND	ND	ND	ND	ND	NS

S/N	Season	Rainy Season													Dry Season						NESREA limits†
	Surface Water	Otakpu River						Nnamuzu River							Ezu River						
	Parameter	SW 1	SW 2	SW 3	Min	Max	Mean	SW1	SW 2	SW 3	Min	Max	Mean	Control	SW 1	SW 2	SW 3	Min	Max	Mean	
33	Bacillus spp.	2.0	4.0	1.0	NG	NG	2.3	NG	1.0	3.0	NG	NG	2.0	8.0	ND	ND	ND	ND	ND	ND	NS

†: Fisheries & Recreation Quality Standard Criteria; ND: Not Determined; NG: No Growth; NS: Not Specified

Source: Anambra SAPZ ESIA Field Data (2024)

4.2.1.0.2 Ogboji Surface Water

Surface water samples were collected from the upstream (SW1) and midstream (SW2) sections of Eso Stream to assess the water quality characteristics of the project area. Unfortunately, the downstream section could not be sampled due to difficult terrain and security concerns, as the narrow stream winds through an undulating, forested region. The results of the water analysis are presented in Table 4.37.

Physical and Chemical Parameters

Potential of Hydrogen: The pH of the two water samples was 5.7 and 6.6, respectively for SW1 and SW2, with an average of 6.15, which falls slightly below the NESREA standard range of 6.5-8.5.

Total Dissolved Solids (TDS) and Conductivity: The TDS measured in the water samples were 10 mg/L for SW1 and SW2 (mean = 10 mg/L), with conductivity values of 20 µS/cm for SW1 and SW2 (mean = 10 µS/cm). These values indicate limited mineralisation and minimal input from external sources.

Salinity: The salinity levels were 12.23 mg/L for SW1 and 13.54 mg/L for SW2 (mean = 12.885 mg/L), indicating moderate salinity levels.

Total Hardness: No hardness was detected in the samples, indicating very soft water.

Alkalinity: The measured alkalinity levels in the water samples were 75.2 mg/L for SW1 and 60.0 mg/L for SW2, averaging 67.6 mg/L and showing moderate buffering capacity.

Total Chloride: The chloride concentrations were 42.28 mg/L in SW1 and 42.58 mg/L in SW2, with a mean value of 42.43 mg/L, well below the NESREA guideline of 300 mg/L for surface water.

Calcium: Ca levels were 1.2 mg/L in SW1 and 1.47 mg/L in SW2, with a mean concentration of 1.335 mg/L, which were also lower than the NESREA limit of 180 mg/L.

Magnesium: Mg was not detected in either SW1 or SW2, with concentrations recorded as 0 mg/L.

Total Organic Carbon: The TOC levels were 0.9 mg/L in SW1 and 0.19 mg/L in SW2, averaging 0.545 mg/L.

Nutrients:

- Nutrient levels in the water samples revealed nitrate concentrations of 0.3 mg/L for SW1 and 0.38 mg/L for SW2, with a mean of 0.34 mg/L. Nitrite levels were 0.042 mg/L for SW1 and 0.078 mg/L for SW2, averaging 0.06 mg/L. Total nitrogen was measured at 2.77 mg/L for SW1 and 5.3 mg/L for SW2, with a mean of 4.035 mg/L. These results suggest higher nutrient levels in the midstream section (SW2), which is more shaded by forest trees compared to the more exposed upstream section (SW1).
- The concentrations of phosphate were 5.55 mg/L in SW1 and 6.85 mg/L in SW2, with a mean of 6.20 mg/L. These values exceed NESREA's guideline of 3.5 mg/L for surface water used in fisheries and recreational activities. The minimal presence of pollution

sources suggests that the elevated phosphate levels may be attributed to natural sources.

Table 4.37: Surface Water Quality of Eso Stream, Ogboji (Rainy Season)

S/N	Parameters	SW1	SW2	Mean	NESREA†
1	Appearance (TCU)	10	25	17.5	NS
2	pH	5.7	6.6	6.15	6.5-8.5
3	Conductivity (µS/cm)	20	20	20	
4	TDS (mg/L)	10	10	10	NS
5	Temperature (°C)	27.7	27.2	27.45	NS
6	Salinity (mg/L)	13.54	12.23	12.885	NS
7	Total Hardness	0	0	0	NS
8	Total Alkalinity	75.2	60	67.6	NS
9	Bicarbonate	10.1	7	8.55	NS
10	COD (mg/L)	23.7	20.3	22	NS
11	DO (%)	33.4	33.7	33.55	6.0*
12	NO_3 (mg/L)	0.3	0.38	0.34	9.1
13	NO_2 (mg/L)	0.042	0.078	0.06	0.02
14	Total N (mg/L)	2.77	5.3	4.035	ND
15	PO_4^{3-} (mg/L)	5.55	6.85	6.2	3.5
16	SO_4^{2-} (mg/L)	12	18	15	100
17	Total Chloride	42.28	42.58	42.43	300
18	Ca (mg/L)	1.2	1.47	1.335	180
19	Mg (mg/L)	0	0	0	40
20	TOC (mg/L)	0.9	0.19	0.545	ND
	Heavy Metals				
21	Fe	0.62	0.08	0.35	0.05
22	Pb (mg/L)	0.001	0.002	0.0015	0.01
23	Ni (Ni)	0.064	0.087	0.0755	0.01
24	Cr (mg/L)	0.33	1	0.665	0.001
25	Al (mg/L)	1.12	1.61	1.365	0.2
26	Cd (mg/L)	0.0159	0.026	0.02095	0.005
27	Zn	0	0	0	0.01
	Microbial Parameters				
28	TCC (Cfu/ml x 10^2)	4.5	3	3.75	10
29	TBC (Cfu/ml x 10^2)	15	8	11.5	NS
30	TFC (Cfu/ml x 10^1)	NG	3	3	0
31	Bacillus spp.	NG	5	5	NS
32	Faecal Count	NG	20	20	NS
33	Pseudomonas aeruginosa	NG	NG	NG	NS

†: Fisheries & Recreation Quality Standard Criteria; NG: No Growth; NS: Not Specified; Source: Anambra SAPZ ESIA Field Data (2024)

Heavy Metals

- Fe concentrations were 0.62 mg/L in SW1 and 0.08 mg/L in SW2, with a mean value of 0.35 mg/L, exceeding the NESREA guideline of 0.05 mg/L.
- The levels of Pb were 0.001 mg/L in SW1 and 0.002 mg/L in SW2, with a mean concentration of 0.0015 mg/L, which were well below the NESREA limit of 0.01 mg/L, suggesting minimal Pb contamination.
- Ni concentrations were 0.064 mg/L in SW1 and 0.087 mg/L in SW2, with a mean of 0.0755 mg/L. These levels exceeded the NESREA limit of 0.01 mg/L, indicating elevated Ni levels.
- The measured Cr levels were 0.33 mg/L in SW1 and 1.0 mg/L in SW2, with a mean of 0.665 mg/L, which were also above the NESREA guideline of 0.001 mg/L for fisheries and recreational use of surface water.
- Al levels were 1.12 mg/L in SW1 and 1.61 mg/L in SW2, with a mean concentration of 1.365 mg/L, which were significantly higher than the NESREA limit of 0.2 mg/L
- Cd was found at concentrations of 0.0159 mg/L in SW1 and 0.026 mg/L in SW2, with a mean of 0.02095 mg/L. These levels exceeded the NESREA guideline of 0.005 mg/L, indicating a considerable risk of contamination.
- Zinc (Zn): Zinc was not detected in either SW1 or SW2, with concentrations recorded as 0 mg/L. This is below the NESREA limit of 0.01 mg/L.

the elevated concentrations of heavy metals, particularly Pb, Ni, Cr, Al, and Cd, are concerning. The proximity of SW1 to the water source may contribute to higher metal loads, likely from natural geological sources. These elevated metal levels pose risks not only to aquatic life but also to the local community that depends on this water for domestic use. It is crucial to investigate the sources of these metals further and to implement measures to mitigate potential impacts on both the environment and public health.

Microbiology

Total Coliform Count: The TCC values were 4.5 x 10^2 cfu/ml in SW1 and 3 x 10^2 cfu/ml in SW2, with a mean of 3.75 x 10^2 cfu/ml. These values are significantly higher than the NESREA guideline of 10 indicating that coliform levels are outside acceptable limits.

Total Bacterial Count: TBC was recorded at 15 x 10^2 cfu/ml in SW1 and 8 x 10^2 cfu/ml in SW2, with a mean of 11.5 x 10^2 cfu/ml. The NESREA guideline for TBC is not specified (NS), so a direct comparison is not available. However, the variation between the samples and the relatively higher count in SW1 suggest localised bacterial activity or contamination sources.

Total Fungal Count: TFC was not detected in SW1 but was 3 x 10^1 cfu/ml in SW2, suggesting fungal contamination might be limited or variable.

Bacillus spp.: Bacillus spp. were not detected in SW1 but were present at 5 x 10^1 cfu/ml in SW2.

Faecal Count: Faecal counts were not detected in SW1 but were 20 x 10^1 cfu/ml in SW2. This value is above the NESREA guideline of 0, suggesting potential faecal contamination in SW2.

***Pseudomonas aeruginosa*:** This pathogen was not detected in either sample.

Overall Assessment

The surface water is generally within acceptable limits for several parameters but shows concerning levels of certain heavy metals and microbial contaminants. These issues need to be addressed, as the water is a domestic source for the local community.

4.2.1.0.2 Ogbunka Surface Water

Surface water samples were collected from the upstream (SW1) midstream (SW2) and downstream (SW3) sections of River Uruokpukpo in Ogbunka, a tributary to River Unyo, which joins Imo River. The results of the water analysis are presented in Table 4.38.

Physiochemical

Appearance (TCU): The water appearance, as measured in True Color Units (TCU), ranged from 20 TCU in SW1 and SW2 to 35 TCU in SW3, with a mean value of 25.00 TCU, suggesting SW3 is more turbid compared to the upstream and midstream of the water.

Potential of Hydrogen: The pH values were consistent across all samples, at 6.8 for SW1, SW2, and SW3, which was within the NESREA standard range of 6.5-8.5.

Conductivity and Total Dissolved Solids: The conductivity was uniform across all samples at 20 µS/cm. This low conductivity indicates low levels of dissolved ions, typical for water with minimal anthropogenic influence. In the same manner, the measure TDS was uniform at 19 mg/L for all stations. The levels are consistent with the measured low conductivity values.

Total Hardness: TH was recorded as 0 mg/L across all samples, indicating that the water is extremely soft with no measurable concentrations of calcium or magnesium.

Total Alkalinity and Bicarbonates: Total alkalinity varied widely across the stations, with values of 17.2 mg/L in SW1, 74.6 mg/L in SW2, and 36 mg/L in SW3, averaging 42.60 mg/L. Bicarbonate concentrations were 3.2 mg/L for SW1, 1.92 mg/L for SW2, and 1.16 mg/L for SW3, with a mean value of 2.09 mg/L. Bicarbonate is a significant component of alkalinity, and its lower concentrations in SW2 and SW3 indicate reduced buffering capacity compared to SW1. However, the HCO3 levels did not directly correlate with total alkalinity, suggesting that other ions were contributing to the water's buffering capacity. Despite SW2 having the highest total alkalinity, its bicarbonate concentration was lower than SW1, which had the lowest alkalinity but the highest bicarbonate level. This indicates that factors beyond bicarbonate, such as other alkaline compounds, influenced the overall alkalinity in the samples.

Chemical Oxygen Demand: The COD levels were 18.6 mg/L in SW1, 15.3 mg/L in SW2, and 19.9 mg/L in SW3, with a mean value of 17.93 mg/L. COD is an indicator of the oxygen demand required to chemically oxidise organic and inorganic matter in the water, reflecting the degree of pollution by these substances.

Total Organic Carbon: TOC levels were 0.09 mg/L for SW1, 1.05 mg/L for SW2, and 0.11 mg/L for SW3, with a mean value of 0.417 mg/L, indicating differing amounts of organic material in the water.

Total Chloride: The total chloride concentrations were 31.29 mg/L for SW1, 34.98 mg/L for SW2, and 31.29 mg/L for SW3, with a mean value of 32.52 mg/L. These values are far below the NESREA standard of 300 mg/L.

Calcium: Ca levels were recorded at 0.08 mg/L for SW1, 0.026 mg/L for SW2, and 0.126 mg/L for SW3, with a mean of 0.08 mg/L, with all values well below the NESREA standard of 180 mg/L.

Magnesium: The measured Mg level was 0 mg/L across all samples (SW1, SW2, SW3). The absence of magnesium suggests that the water is very soft, with minimal contributions from geological formations containing magnesium.

Nutrients

- The nitrate levels in the water samples were 0.479 mg/L for SW1, 0.425 mg/L for SW2, and 0.449 mg/L for SW3, with a mean value of 0.45 mg/L. These values are well below the NESREA standard of 9.10 mg/L, indicating minimal nitrate contamination.
- Nitrite: NO_2^- levels were recorded at 0.024 mg/L for SW1, 0.012 mg/L for SW2, and 0.045 mg/L for SW3, with a mean of 0.03 mg/L. The observed levels were in SW2 and slightly exceeded the NESREA standard of 0.02 mg/L for fisheries and recreational surface water use. The nitrite distribution also suggests the potential for localised impacts on water quality.
- Total Nitrogen: Total N concentrations were 1.5 mg/L for SW1, 3.62 mg/L for SW2, and 2.66 mg/L for SW3, with a mean value of 2.59 mg/L, reflecting differences in N input and removal across the sampling stations.
- Phosphate (PO_4^{3-}): Phosphate concentrations were measured at 5.5 mg/L for SW1, 5.12 mg/L for SW2, and 3.98 mg/L for SW3, with a mean of 4.87 mg/L. These values exceed the NESREA standard of 3.50 mg/L for surface water.
- Sulphate: The measured SO_4^{2-}concentrations were 12.66 mg/L for SW1, 12.3 mg/L for SW2, and 17 mg/L for SW3, with a mean of 13.99 mg/L. These values are well below the NESREA standard of 100.00 mg/L.

Table 4.38: Surface Water Quality of River Uruokpukpo, Ogbunka (Rainy Season)

S/N	PARAMETER	SW1	SW2	SW3	Min	Max	Mean	Stdev	NESREA†
1	Appearance (TCU)	20	20	35	20	35	25.00	7.07	NS
2	pH	6.8	6.8	6.8	6.8	6.8	6.8	0.0	6.5-8.5
3	Conductivity (µS/cm)	20	20	20	20	20	20	0.0	NS
4	TDS (mg/L)	10	10	10	10	10	10	0.0	NS
5	Temperature (°C)	27.6	27.6	27.6	27.6	27.6	27.60	0.00	NS
6	Salinity (ppt)	13.4	15.38	11.7	11.7	15.38	13.49	1.50	NS
7	Total Hardness (mg/L)	0	0	0	0	0	0.00	0.00	NS
8	Total Alkalinity (mg/L)	17.2	74.6	36	17.2	74.6	42.60	23.89	NS
9	Bicarbonate (mg/L)	3.2	1.92	1.16	1.16	3.2	2.09	0.84	NS
10	COD (mg/L)	18.6	15.3	19.9	15.3	19.9	17.93	1.94	NS
11	DO (%)	ND	ND	ND	ND	ND	ND	ND	6.0*
12	Nitrate (NO_3)	0.479	0.425	0.449	0.425	0.479	0.45	0.02	9.10
13	Nitrite (NO_2^-)	0.024	0.012	0.045	0.012	0.045	0.03	0.01	0.02
14	Total Nitrogen (N)	1.5	3.62	2.66	1.5	3.62	2.59	0.87	ND
15	PO_4 (mg/L)	5.5	5.12	3.98	3.98	5.5	4.87	0.65	3.50
16	Sulphate (SO_4^{2-})	12.66	12.3	17	12.3	17	13.99	2.14	100.00
17	Total Chloride	31.29	34.98	31.29	31.29	34.98	32.52	1.74	300
18	Ca (mg/L)	0.08	0.026	0.126	0.026	0.126	0.08	0.04	180
19	Mg (mg/L)	0	0	0	0	0	0	0	40
20	TOC (mg/L)	0.09	1.05	0.11	0.09	1.05	0.417	0.448	ND

	Heavy Metals								
25	Al (mg/L)	2.55	1	5	1	5	2.850	1.647	0.2
26	Cd (mg/L)	0.01	0.0011	0.0019	0.0011	0.01	0.004	0.004	0.005
24	Cr (mg/L)	<0.001	0.01	<0.001	0.01	0.01	0.010	0.000	0.001
21	Fe (mg/L)	1.05	1.03	1	1	1.05	1.027	0.021	0.05
23	Ni (mg/L)	0.001	0	0.011	0	0.011	0.004	0.005	0.01
22	Pb (mg/L)	0.001	0	0	0	0.001	0.000	0.000	0.01
27	Zn(mg/L)	0	0	0	0.0	0.0	0.00	0.00	0.01
	Microbiology								
28	Total Coliform Count (Cfu/ml x 10^2)	2.5	5.9	0.3	0.3	5.9	2.90	2.30	0.3
29	Total Bacteria Count (Cfu/ml x 10^2)	3.6	8	10	3.6	3.6	4.2	229	NS
30	Fecal Coliform (Cfu/ml x 10^1)	1	6	NG	1	6	2.33	26.2	0
31	*Bacillus* spp.	3	1	5	1.0	5.0	3.0	1.6	NS
32	Total Fungi Count	NG	NG	NG	NG	NG	NG	0	NG
33	*Pseudomonas aeruginosa*	NG	NG	NG	NG	NG	NG	0	NG

†: Fisheries & Recreation Quality Standard Criteria; NG: No Growth; NS: Not Specified

Source: Anambra SAPZ ESIA Field Data (2024)

Heavy Metals

- **Aluminium**: Al concentrations in the water samples were 2.55 mg/l in SW1, 1.0 mg/l in SW2 and 5.0 mg/L in SW3, averaging 2.85 mg/L and significantly exceeding the NESREA standard of 0.2 mg/L. This suggests a significant presence of aluminium in the water body, potentially from natural or anthropogenic sources.
- **Cadmium:** Cd levels were low, ranging from 0.0011 mg/L in SW2 to 0.01 mg/L in SW1, with a mean value of 0.004 mg/L. Although these values are within the NESREA standard of 0.005 mg/L, the presence of cadmium remains concerning due to its toxicity and potential to bioaccumulate in aquatic organisms.
- **Chromium:** Cr was below the detection limit in SW1 and SW3 but was measured at 0.01 mg/L in SW2, which was elevated above NESREA's standard of 0.001 mg/L. It also suggests localised contamination sources.
- **Iron:** Fe concentrations were relatively consistent across the samples, with values of 1.05 mg/L in SW1, 1.03 mg/L in SW2, and 1.0 mg/L in SW3, resulting in a mean of 1.027 mg/L. These levels are significantly above the NESREA standard of 0.05 mg/L for fisheries and recreational surface water use, indicating possible contamination from natural or anthropogenic sources.
- **Nickel:** Ni levels varied slightly, with 0.001 mg/L in SW1, non-detectable levels (0 mg/L) in SW2, and 0.011 mg/L in SW3, with a mean concentration of 0.004 mg/L. These values are within the NESREA standard of 0.01 mg/L.
- **Lead:** Pb concentrations were very low, with a value of 0.001 mg/L detected in SW1 and non-detectable levels (0 mg/L) in SW2 and SW3. These values are well within the NESREA standard of 0.01 mg/L. However, the presence of lead is still concerning due to its high toxicity, even at low concentrations.
- **Zinc (Zn):** Zinc was not detected in any of the samples (0 mg/L across all stations). While zinc is an essential trace element for living organisms, it can become toxic at higher concentrations.

In summary, the heavy metal profile of River Uruokpukpo reveals elevated levels of Al, Fe,) in all samples, with chromium Cr also elevated in SW2, indicating contamination sources for these metals. The presence of Ni and Pb at low levels is concerning due to their high toxicity. Further investigation is required to implement management measures to mitigate risks to the aquatic environment and the community dependent on the river for domestic use.

Microbiology

Total Coliform Count: The TCC varied significantly, with values of 2.5×10^2 Cfu/ml in SW1, 5.9×10^2 Cfu/ml in SW2, and 0.3×10^2 Cfu/ml in SW3, averaging 2.90×10^2 Cfu/ml. This variation indicates different levels of contamination across the sampling stations.

Total Bacteria Count: TBC ranged from 3.6 x 10^2 Cfu/ml in SW1 to 10 x 10^2 Cfu/ml in SW3, with an average of 4.20 x 10^2 Cfu/ml. SW3 showed the highest bacterial load, suggesting greater contamination or organic matter support for bacterial growth.

Faecal Coliform Count: Detected FCC levels varied, with 1 x 10^1 Cfu/ml in SW1, 6 x 10^1 Cfu/ml in SW2, and none in SW3, averaging 2.33 x 10^1 Cfu/ml. The presence of faecal coliforms, especially in SW2, is concerning for potential pathogenic contamination.

***Bacillus* spp.:** *Bacillus* spp. were present in all stations, with counts of 3 Cfu/ml in SW1, 1 Cfu/ml in SW2, and 5 Cfu/ml in SW3, averaging 3.00 Cfu/ml. This indicates some variation in distribution but generally low levels.

Total Fungi Count and *Pseudomonas aeruginosa*: Neither total fungi count nor Pseudomonas aeruginosa were detected at any station, suggesting minimal sources or unsuitable conditions for their growth.

4.2.11 Sediment Studies

Table 4.39 shows the results of sediment samples obtained in one location in Eso River in Ogboji (OGBSED1, upstream) and three locations in River Uruokpukpo in Ogbunka (OGKSED1, OGKSED2 and OGKSED3) corresponding to the upstream, midstream and downstream of the water body. The results are discussed below.

4.2.11.1 Physiochemistry

Appearance and Texture

The sediment from the Eso River in Ogboji appeared red in colour, while those from River Uruokpukpo in Ogbunka showed a transition from very dark grey upstream, dark brown midstream and reddish brown downstream, indicating differences in organic matter and iron oxide contents. In terms of texture, Eso River sediment was predominantly loam, while those from River Uruokpukpo were sandy loam, suggesting Eso has more clay or silt continents than the samples from River Uruokpukpo.

Sediment Particle Compositions

The sediment sample from the Eso River consisted of 46.30% sand, 28.62% silt, and 25.08% clay, resulting in a relatively well-balanced sediment with a significant proportion of finer particles (silt and clay) alongside sand.

In contrast, the sediment samples from River Uruokpukpo showed a higher sand content across all locations, ranging from 60.20% - 67.38% (mean =.62.68%), indicating coarser sediment and hence more permeable than the sediment from Eso River.

The silt content in River Uruokpukpo sediments ranged from 21.89 % - 29.44% (mean = 25.75%). High silt content tends to increase cohesion and reduce permeability, which may help in stabilising the sediment *in-situ*. On the other hand, clay contents in the sediment

Clay contents in Uruokpukpo sediments were lower than in the Eso River, ranging from 10.36% - 13.62% (mean = 11.57 %).

Potential of Hydrogen (pH)

The sediment sample from Eso River had a pH of 5.99, indicating slightly acidic conditions. The pH from those of River Uruokpukpo samples was comparable and ranged from 5.98 to 6.04 (mean 6.01), also indicating acidic conditions.

Electrical conductivity (EC)

EC measures the sediment's ability to conduct electrical current. The Eso sediment had an EC of 59.40 µS/cm, while those from River Uruokpukpo exhibited a range from 55.55 µS/cm - 65.60 µS/cm (mean = 59.66 µS/cm). The mean EC value was comparable to the EC measured at ESo River. Higher EC values are indicative of a higher presence of dissolved salts or minerals.

Bicarbonates and Chloride

Bicarbonate levels were low across all samples, with River Eso and OGKSED3 (River Umuokpukpo) having 0.02 mg/kg and OGKSED1. The HCO3 levels in OGKSED2 and OGKSED3 were 0.01 mg/kg, respectively. The low bicarbonate content suggests limited buffering capacity in these sediments, which might influence their response to acidic or basic inputs.

Chloride content, indicative of salinity, was higher in Eso River (16.30 mg/kg) compared to the Ogbunka samples, which had Cl- concentrations ranging from 9.35 mg/kg (OGKSED3) - 12.45 mg/kg (mean =10.67 mg/kg).

Total Organic Carbon (TOC)

TOC is an indicator of the amount of organic matter, which appeared relatively high in all samples, suggesting a significant input of organic material. TOC measured in Eso River sediment was 15.60% TOC, while the percentage of TOC in River Uruokpukpo samples ranged from 13.70% - 15.20% (mean = 14.60%).

Nutrients

Nutrient indicators such as ammonium, nitrite, nitrate, phosphate, and sulphate varied across the samples. Nitrate levels were low in all sediments, with values of 0.16 mg/kg measured in Eso River's samples, while the range in Uruokpukpo sediment samples ranged from 0.11 mg/kg to 0.34 mg/kg (mean = 0.22 mg/kg).

Ammonium levels in the sediment are another important indicator of nitrogen availability, which is crucial for microbial growth in the sediment. NH4-N level in the ESo River was 0.39 mg/kg, whereas the concentrations measured in River Uruokpukpo ranged from 0.22 mg/kg - 1.00 mg/kg (mean = 0.59 mg/kg). On the other hand, nitrite levels were below equipment detection in all samples.

Phosphate concentrations were higher, with 0.59 mg/kg measured in Eso River, whereas those in River Uruokpukpo sediment ranged from 0.62 mg/kg - 0.90 mg/kg (mean = 0.76 mg/kg).

Sulphate levels were relatively consistent, with Eso River samples having SO4 concentration of 1.80 mg/kg and Ogbunka samples ranging from 1.09 mg/kg (OGKSED2) to 1.30 mg/kg (mean = 1.20 mg/kg).

Total Hydrocarbon (THC)

THC measures hydrocarbon contamination in the sediments. THC measured in River Eso was 2.77 mg/kg, while those measured in the River Uruokpukpo ranged from 1.34 mg/kg - 3.20 mg/kg (mean = 2.45 mg/kg).

Heavy Metals

Among the assessed heavy metals, Cd, Cr, Pb and Ni were below the equipment detection limit (<0.001), whereas Al, Fe and Zn were available at quantifiable levels. The concentration of Al measured in Eso River was 0.05 mg/kg, while in River Umuokpukpo, Al concentration was below the detection limit in OGKSED2 but occurred at concentrations of 0.02 mg/kg and 0.03 mg/kg in OGKSED1 and OGKSED3, respectively.

Fe concentration in Eso Rive was 02.11 mg/kg, whereas its concentration in River Uruokpukpo samples ranged from 73.60 mg/kg - 111.29 mg/kg (mean = 93.56 mg/kg). Fe is an essential element for many biological processes, but its elevated levels could influence the sediment's chemical properties, particularly under anaerobic conditions, leading to the formation of iron sulfides or other compounds.

Zinc concentrations show more variation among the samples, with sediment samples from ESo River having Fe concentrations of 0.67 mg/kg, while the concentrations in River Uruokpukpo ranged from 0.02 mg/kg - 0.92 mg/kg (mean = 0.43 mg/kg). Zn is an essential trace element but can become toxic at higher concentrations.

Table 4.39: Sediment Characteristics of Eso (Ogboji) and Uruokpukpo (Ogbunka) (July 2024; Rainy Season)

S/N	Parameter	OGBSED3	OGKSED1	OGKSED2	OGKSED3	Min OGK	Max OGK	Mean OGK
	Physiochemistry							
1	pH	5.99	5.67	5.98	6.04	5.98	6.04	6.01
2	General Appearance	Red 4/6	Very dark	Dark brown 3/3	Reddish brown 4/3	NA	NA	NA
3	EC (μS/cm)	59.40	65.60	57.82	55.55	55.55	65.60	59.66
4	Sand (%)	46.30	60.45	67.38	60.20	60.20	67.38	62.68
5	Silt (%)	28.62	25.93	21.89	29.44	21.89	29.44	25.75
6	Clay (%)	25.08	13.62	10.73	10.36	10.36	13.62	11.57
7	Soil Texture	Loam	Sandy loam	Sandy loam	Sandy loam			
8	TPOC (%)	15.60	15.20	13.70	14.90	13.70	15.20	14.60
9	HCO_3^- (mg/kg)	0.02	0.01	0.01	0.02	0.01	0.02	0.01
10	Cl^- (mg/kg)	16.30	12.45	10.20	9.35	9.35	12.45	10.67
11	NH_4-N (mg/kg)	0.39	1.00	0.56	0.22	0.22	1.00	0.59
12	NO_2^- (mg/kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	NO_3 (mg/kg)	0.16	0.34	0.21	0.11	0.11	0.34	0.22
14	PO_4^{3-} (mg/kg)	0.59	0.90	0.77	0.62	0.62	0.90	0.76
15	SO_4^{2-} (mg/kg)	1.80	1.30	1.09	1.21	1.09	1.30	1.20
16	THC (mg/kg)	2.77	1.34	3.20	2.80	1.34	3.20	2.45
	Heavy Metals							
17	Al (mg/kg)	0.05	0.02	<<0.0011	0.03	<<0.0011	0.03	0.02
18	Cd (mg/kg)	<0.0011	<0.0011	<0.0011	<0.0011	<0.0011	<0.0011	<0.001
19	Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
20	Fe (mg/kg)	102.11	73.60	95.80	111.29	73.60	111.29	93.56

S/N	Parameter	OGBSED3	OGKSED1	OGKSED2	OGKSED3	Min OGK	Max OGK	Mean OGK
21	Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
22	Ni (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23	Zn (mg/kg)	0.67	0.02	0.92	0.34	0.02	0.92	0.43
	Microbiology							
24	Total Bacterial Count (x 10^2 Cfu/g)	6.90	5.00	7.70	9.00	7.70	9.00	8.35
25	Total Fungi Count (x 10^2 Cfu/g)	6.30	4.40	3.50	6.20	3.50	6.20	4.85
26	Total Coliform Count (x 10^2 Cfu/g)	1.80	0.28	9.10	0.99	0.99	9.10	0.99
27	Bacillus spp. (x 10^2 Cfu/g)	7.00	3.00	8.00	1.00	1.00	8.00	1.00
28	Pseudomonas aeruginosa x 10^2 Cfu/g	5	0.1	6	2	2	6	2

Source: Anambra SAPZ ESIA Field Data (2024)

Microbiology

The total bacterial count in the sediment from Eso River showed a population of 6.90 x 10^2 CFU/g, while the Uruokpukpo sediment samples had counts from 5.00 x 10^2 CFU/g - 9.00 x 10^2 CFU/g (mean = 8.35 x 10^2 CFU/g). Bacterial populations play a crucial role in the decomposition of organic matter and nutrient cycling.

The total fungi count was higher in sediment samples from Eso River (6.30 x 10^2 CFU/g) compared to River Uruokpukpo, where the counts ranged from 3.50 x 10^2 CFU/g - 6.20 x 10^2 CFU/g (mean = 4.85 x 10^2 CFU/g). Fungi are essential decomposers in sediment ecosystems, breaking down complex organic compounds.

For the total coliform count, the sediment from Eso River was 1.80 x 10^2 CFU/g, while sediment samples from River Uruokpukpo showed a wide range from 0.28 x 10^2 CFU/g - 9.10 x 10^2 CFU/g (mean = 0.99 x 10^2 CFU/g). Coliforms, which are typically indicators of faecal contamination, are significantly higher in OGKSED2, suggesting potential contamination sources at this site. The lower counts in other Ogbunka samples and Ogboji might indicate less contamination or environmental conditions for limiting coliform growth.

Bacillus spp. levels occurred at 7.00 x 10^2 CFU/g in River Eso, whereas in River Uruokpukpo, the counts ranged from 1.00 x 10^2 CFU/g - 8.00 x 10^2 CFU/g (mean = 1.00 x 10^2 CFU/g). The significantly higher *Bacillus* count in OGKSED2 aligns with the higher bacterial and coliform counts, potentially indicating more active organic decomposition processes in this area.

Pseudomonas aeruginosa level in River Eso was 5 x 10^2 CFU/g. In River Uruokpukpo, the count ranged from 0.1 x 10^2 CFU/g - 6 x 10^2 CFU/g (mean = 2 x 10^2 CFU/g).

4.2.12 Hydrobiology

Hydrobiology studies the diverse life forms and ecosystems within aquatic environments, focusing on biological diversity, community structure, nutrient and energy dynamics, and ecological processes. Understanding these factors is crucial for assessing the impact of human activities on aquatic systems and informing effective management strategies. In this study, hydrobiological investigations aimed to characterise and document the baseline composition and diversity of plankton (phytoplankton and zooplankton) and macroinvertebrate communities in the water bodies near the project areas. This baseline data is essential for monitoring changes and implementing future management actions.

4.2.13.1 Phytoplankton

Phytoplankton are microscopic, photosynthetic organisms that float in the water column, typically found in the upper layers of water bodies with sufficient sunlight. Major groups include diatoms (Bacillariophyceae), dinoflagellates (Dinophyceae), coccolithophores (Prymnesiophyceae), cyanobacteria (Cyanophyceae), and green algae (Chlorophyceae) (Nybakken and Bertness, 2004).

Diatoms, with their silica-based cell walls, are vital for primary production in aquatic environments. Dinoflagellates, which have two flagella, can be bioluminescent and sometimes cause harmful algal blooms. Coccolithophores, found mainly in marine environments, are recognized by their calcium carbonate plates. Cyanobacteria, some of which are toxic, are among the oldest photosynthetic organisms and can fix nitrogen. Green algae, prevalent in freshwater and coastal areas, contribute significantly to aquatic ecosystems. Other phytoplankton groups include Cryptophyceae, Phaeophyceae, Rhodophyceae, Xanthophyceae, Chrysophyceae, and Euglenophyceae, which also play roles in aquatic ecosystems but are less commonly studied in this context. Phytoplankton serve as a crucial food source for zooplankton and other higher trophic level organisms, influencing the overall structure and function of the aquatic food webs. Understanding the spatial and temporal variations in phytoplankton communities is essential for assessing the health and productivity of aquatic ecosystems

4.2.13.1.1 Phytoplankton Composition

Phytoplankton assessments were conducted at various sections along three rivers to evaluate the diversity and distribution of species. The study focused on three locations: Otakpu River in Omor, River Uruokpukpo in Ogbunka, and River Nnamuzu in Ugbene. Sampling was carried out upstream (OMPLK1), midstream (OMPLK2), and downstream (OMPLK3) along the Otakpu River; upstream (OGKPLK1), midstream (OGKPLK2), and downstream (OGKPLK3) along River Uruokpukpo; and upstream (UGBPLK1) and midstream (UGBPLK3) along River Nnamuzu. The results of this analysis, detailed in Table 4.40, provide critical insights into the diversity and abundance of phytoplankton communities across the sampled sections. Table 4.41 shows the abundance of the identified species by taxonomic division across the sampling stations.

The table shows that twenty-two species across six divisions were identified, including:

1. **Bacillariophyta (Diatoms):** Represented by six species: *Biddulphia paradosa*, *Coscinodiscus centralis*, *Radiates* sp., *Cyclotella omta, Cyclotella* sp., and *Melosira pusilla*.
2. **Chlorophyta (Green Algae):** Five species: *Closterium intermedium*, *Closterium pervulum, Closterium gracile, Coelastrum reticulatum*, and *Crusigenia truncate*.
3. **Cyanophyta (Blue-green Algae):** Five species: Anabaena affinis, Anabaena arnoldii, Chroococcus sp., and Lynbya limnetica.
4. **Dinophyta (Dinoflagellates):** Four species: Ceratium furca, Ceratium fusus, Gymnodinium sp., and Peridinium sp.
5. **Euglenophyta:** One species: Euglena acus.
6. **Xanthophyceae: One species**: *Tribonema* sp.

Table 4.40: Phytoplankton Distribution and Abundance (July 2024, Rainy Season)

S/N	DIVISION	Species	River Otakpu (Omor)			River Uruokpukpo (Ogbunka)			River Nnamuzu (Ugbene)	
	DIVISION	Species	OMPLK1	OMPLK2	OMPLK2	OGKPLK1	OGKPLK2	OGKPLK3	UGBPLK1	UGBPLK2
1	**Bacillariophyta**	*Biddulphia paradosa*	9	0	0	0	1	10	35	20
2		*Coscinodiscus centralis*	0	0	5	0	0	0	56	37
3		*Radiates*	0	0	34	0	6	0	82	21
4		*Cyclotella omta*	6	22	19	11	2	0	34	8
5		*Cyclotella*	9	0	0	0	0	0	20	9
6		*Melosira pusilla*	11	25	17	0	2	7	12	13
7	**Chlorophyta**	*Closterium intermedium*	0	14	0	12	3	6	31	45
8		*Closterium pervulum*	0	25	11	12	4	3	19	5
9		*Closterium gracile*	0	0	3	0	0	0	5	2
10		*Coelastrum reticulatum*	7	6	0	0	1	3	9	0
11		*Crusigenia truncate*	5	2	0	0	0	4	12	0
12	**Cyanophyta**	*Anabaena affinis*	17	0	18	0	0	5	29	11
13		*Anabaena arnoldii*	0	29	24	0	1	7	40	13
14		*Cylindrical*	35	0	1	0	0	8	11	1
15		*Chrococus* sp.	6	0	5	0	0	0	17	1
16		*Lynbya limnetica*	3	8	5	5	0	2	0	3
17	**Dinophyta**	*Ceratium furca*	0	15	0	4	3	0	0	0
18		*Ceratium fusus*	21	18	6	0	0	4	1	0
19		*Gymnodium* sp.	0	10	2	0	9	10	2	0
20		*Peridinium* sp.	6	6	1	9	4	5	1	1
21	**Euglenophyta**	*Euglena acus*	13	5	0	0	0	6	30	0
22	**Xanthophyceae**	*Tribonema* sp.	11	6	5	29	0	13	28	20
		Total phytoplankton abundance (N)	159	191	156	82	36	93	474	210
		Total Species Diversity (S)	21	24	22	16	10	18	22	16
		Log of Species Diversity (Log S)	1.32	1.38	1.34	1.2	1	1.26	1.34	1.2

S/N	DIVISION	Species	River Otakpu (Omor)			River Uruokpukpo (Ogbunka)			River Nnamuzu (Ugbene)	
	DIVISION	Species	OMPLK1	OMPLK2	OMPLK2	OGKPLK1	OGKPLK2	OGKPLK3	UGBPLK1	UGBPLK2
		Log of Abundance (Log N)	2.2	2.28	2.19	1.91	1.56	1.97	2.68	2.32
		Shannon-Wiener Index (Hs)	2.81	2.95	2.76	2.37	1.98	2.52	3.14	2.78
		Menhinick Index (D)	1.66	1.74	1.77	1.77	1.67	1.86	1.01	1.1
		Margalef Index (d)	3.6	3.86	3.78	2.85	2.29	3.24	4.08	3.19
		Equitability Index (j)	0.9	0.91	0.88	0.85	0.87	0.89	0.93	0.92
		Simpson's Dominance Index (D)	0.11	0.1	0.12	0.13	0.15	0.12	0.08	0.1

Source: Anambra ESIA Field Data (2024)

Table 4.41: Total Number of Phytoplankton Individuals by Taxonomic Division Across Sampling Location Per Ml (July 2024, Rainy Season)

Division	Number of Species	OM PLK1	OM PLK2	OM PLK3	OGK PLK1	OGK PLK2	OGK PLK3	UGB PLK1	UGB PLK2	Total	% Contribution
Bacillariophyta	6	35	47	75	11	11	17	239	108	543	38.8%
Chlorophyta	5	12	47	14	24	8	16	76	52	249	17.8%
Cyanophyta	5	61	37	53	5	1	22	97	29	305	21.8%
Dinophyta	4	27	49	9	13	16	19	4	1	138	9.9%
Euglenophyta	1	13	5	0	0	0	6	30	0	54	3.9%
Xanthophyta	1	11	6	5	29	0	13	28	20	112	8.0%
Total	**22**	**159**	**191**	**156**	**82**	**36**	**93**	**474**	**210**	**1401**	**100%**

Source: Anambra ESIA Field Data (2024)

The diatoms also dominated in terms of the total number of individuals. From Table 4.41, Bacillariophyta accounted for a total of 543 of the 1,493 individuals, representing 38.8% of the total number. The majority were found in River Nnamuzu in Ugbene. The Cyanophyta recorded 305 individuals (21.8%), and Chlorophyta recorded 243 individuals (17.8%). Dinophyta and Xanthophyceae contributed 138 (9.9%) and 112 (8.0%) individuals, respectively, while Euglenophyta, represented by *Euglena acus*, accounted for 54 individuals (4.9%). Figure 4.23 illustrates the percentage contributions by division.

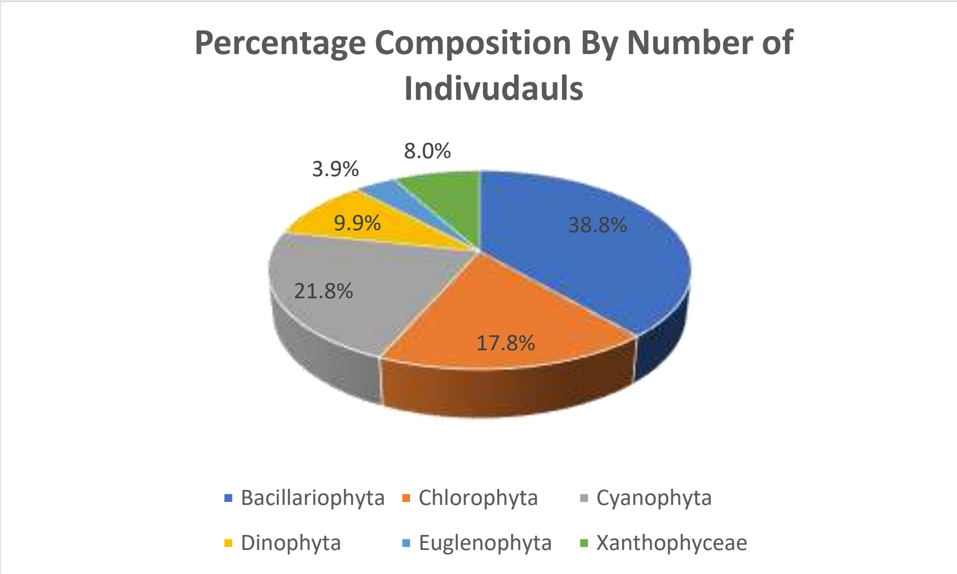


Figure 4.23: Percentage Composition By Number of Phytoplankton Occurence in Each Division

Source: Anambra ESIA Field Data (2024)

4.2.13.1.2 Abundance of Phytoplankton Across Sampling Stations

1. Diatoms (Bacillariophyta)

The abundance of diatoms varied significantly among different rivers and sampling locations, as discussed below:

Biddulphia paradosa: This species was fairly represented across all rivers, occurring as follows: UGBPLK1 in River Nnamuzu (35 individuals), UGBPLK2 (20 individuals), OMPLK3 in River Otakpu (10 individuals), and OGKPLK2 in River Uruokpukpu (1 individual).

- ***Coscinodiscus centralis:*** This species was only found in River Nnamuzu, with 56 individuals at UGBPLK1 and 37 individuals at UGBPLK2.
- ***Cyclotella omta:*** Present in all rivers, this species was observed in River Otakpu at OMPLK1 (6 individuals), OMPLK2 (22 individuals), and OMPLK3 (19 individuals). In River Uruokpukpu, it occurred at OGKPLK1 (11 individuals) and OGKPLK2 (2 individuals), and in River Nnamuzu at UGBPLK1 (34 individuals).

- ***Cyclotella* sp.:** Found in River Otakpu in Omor at OMPLK3 (9 individuals) and in River Nnamuzu in Ugbene at UGBPLK1 (20 individuals) and UGBPLK2 (9 individuals). It was absent from River Uruokpukpu in Ogbunka.

- ***Melosira pusilla***: Recorded in River Otakpu in Omor at OMPLK1 (11 individuals), OMPLK2 (25 individuals), and OMPLK3 (17 individuals). It was also present in Ugbene at UGBPLK1 (12 individuals) and UGBPLK2 (13 individuals).

- ***Radiates*** sp.: This species was predominantly found in River Nnamuzu, especially at UGBPLK1 (82 individuals) and UGBPLK2 (21 individuals). It was notably absent from Omor and Ogbunka sites.

2, Chlorophyta (Green Algae)

The green algae are distributed as follows:

- ***Closterium intermedium:*** This species was abundant in Ogbunka, with 31 individuals at OGKPLK1 and 45 individuals at OGKPLK2. It was also recorded in Omor at OMPLK2 (14 individuals) and in Ugbene at UGBPLK2 (45 individuals).

- ***Closterium pervulum***: Observed in Omor at OMPLK2 (25 individuals) and OMPLK3 (11 individuals). It was also found in Ogbunka at OGKPLK1 (12 individuals).

- ***Coelastrum reticulatum***: Recorded in Omor at OMPLK2 (6 individuals) and OMPLK3 (7 individuals), and in Ugbene at UGBPLK1 (9 individuals).

- ***Crusigenia truncate:*** Present in Omor at OMPLK2 (5 individuals) and in Ugbene at UGBPLK1 (12 individuals). This species was absent from other sampling locations.

- **Clo*sterium gracile***: Present in Ugbene, at OGBPLK1 (5 individuals) and UGBPLK2 (2

3. Cyanophyta (Blue-green Algae)

The occurrence of blue-green algae was as follows:

- ***Anabaena arnoldii:*** This species was highly abundant in Omor, with 29 individuals at OMPLK2 and 24 individuals at OMPLK3. It was also recorded in Ugbene, with 40 individuals at UGBPLK1 and 13 individuals at UGBPLK2.

- ***Anabaena affinis:*** Present in Omor, with 17 individuals at OMPLK1 and 18 individuals at OMPLK3. It was also found in Ugbene, with 29 individuals at UGBPLK1 and 11 individuals at UGBPLK2.

- ***Chrococus* sp.:** Recorded in Omor with 6 individuals at OMPLK1 and 5 individuals at OMPLK3. It was also observed in Ugbene at UGBPLK1 with 17 individuals.

- ***Lynbya limnetica:*** Found in Omor, with 3 individuals at OMPLK1, 8 individuals at

OMPLK2, and 5 individuals at OMPLK3. It was also recorded in Ugbene at UGBPLK2, with 3 individuals.

- **Cylindrical**: Distributed across several locations, with notable counts in OMORPLK 1 DS (35), OMORPLK 3 US (1), and UGBPLK 1 US (11).

4. Dinophyta (Dinoflagellates)

- *Ceratium fusus* was recorded in Omor with 21 individuals at OMPLK1 and 18 individuals at OMPLK2. Also present in Ogbunka at OGKPLK1 with 4 individuals.

- *Ceratium furca* was present in Omor at OMPLK2 with 15 individuals and in Ogbunka at OGKPLK1 with 4 individuals.

- *Peridinium* sp was present in Omor with 6 individuals at OMPLK3 and in Ogbunka at OGKPLK1 with 9 individuals. Also recorded in Ugbene at UGBPLK2 with 1 individual.

- *Gymnodium* sp. Was recorded in Omor with 10 individuals at OMPLK2 and 2 individuals at OMPLK3. Also observed in Ogbunka at OGKPLK2 with 9 individuals.

5. Euglenophyta and Xanthophyta

- *Euglena acus* was found in Omor with 13 individuals at OMPLK1 and 5 individuals at OMPLK2. Also recorded in Ugbene at UGBPLK1 with 6 individuals and 30 individuals at UGBPLK2.

- *Tribonema* sp occurred in Omor with 11 individuals at OMPLK1, 6 in OMPLK2, and 5 in OMPLK3. Was also present in Ogbunka at OGKPLK1 with 29 individuals and OGKPLK3 with 13 individuals. In Ugbene it was present at UGBPLK1 with 28 individuals and UGBPLK2 with 20 individuals.

4.2.13.1.3 Calculated Indices

Table 4.40 also shows the calculated indices for the species, providing the following insight:

- **Log of Species Diversity (Log S):** Reflects the logarithmic transformation of species diversity, with higher values indicating greater diversity. River Otakpu (OM) exhibited higher values compared to River Uruokpukpo in Ogbunka and River Nnamuzu in Ugbene (UG), suggesting richer diversity.

- **Log of Abundance (Log N):** Indicates the logarithmic transformation of total abundance, showing that River Otakpu has the highest values, suggesting a greater overall abundance of phytoplankton.

- **Shannon-Wiener Index (Hs)**: Measures species diversity with higher values indicating greater diversity. River Otakpu and River Nnamuzu show higher indices, reflecting more diverse phytoplankton communities.

- **Menhinick Index (D):** Measures species richness per unit abundance, with River Uruokpphkpo showing relatively high values, indicating good species richness relative to abundance.

- **Margalef Index (d):** Reflects species richness, with River Otakpu showing the highest values, indicating high species richness.

- **Equitability Index (j):** Shows the evenness of species distribution, with values close to 1 indicating more even distribution. River Otakpu and River Nnamuzu have higher values, reflecting a more even distribution of species.

- **Simpson's Dominance Index (C):** Indicates the probability that two randomly selected individuals will be of different species. Lower values in River Otakpu and River Nnamuzu suggest less dominance by a few species and higher diversity.

In summary, River Otakpu showed higher phytoplankton abundance and diversity compared to other sites, indicating a more robust and varied phytoplankton community. River #Nnamuzu in Ugbene and River Uruokpukpo in Ogbunka also showed significant phytoplankton diversity and abundance, though with some variations in species presence and distribution.

4.2.13.2 Zooplankton

Unlike phytoplankton, which are relatively uniform in their photosynthetic functions, zooplankton exhibit remarkable diversity. Zooplankton includes various larval and adult forms across most animal and protistan phyla. Copepods—small, holoplanktonic crustaceans—are the most common zooplankton in many aquatic ecosystems. Holoplankton, like copepods, spend their entire lives in the plankton, whereas meroplankton only occupy this stage temporarily. Zooplankton plays a crucial role in aquatic food webs, as they consume phytoplankton and are a key food source for larger carnivores such as fish, thus contributing significantly to nutrient cycling and overall ecosystem health.

4.2.13.1.1 Zooplankton Compositions

Table 4.42 presents the species diversity and abundance of zooplankton communities across the different sampling stations: Otakpu River in Omor (OM), River Uruokpukpo in River Uruokpukpo, and River Nnamuzu in Ugbene (UGB).

Table 4.42: Composition and Abundance Distribution of Phytoplankton Per Ml

S/N	Division	Species	River Otakpu (Omor)			River Uruokpukpo (Ogbunka)			S/N	
			OMZPK1	OMZPK2	OMZPK3	OGKZPK1	OGKZPK2	OGKZPK3	UGBZPK1	UGBZPK3
	Cladocera									
1	Bosminidae	Bosmina longirostris	0	0	6	6	0	5	15	8
2	Bosminidae	Bosminopsis deitersi	2	2	1	12	6	9	5	0
3	Chydoridae	Alona affinis	2	1	2	0	0	2	4	1
4	Chydoridae	Alona diaphana	0	5	2	6	4	2	7	8
5	Chydoridae	Alonella excise	1	3	2	3	2	3	1	0
6	Chydoridae	Chydorus eurynotus	2	0	0	1	0	2	3	0
7	Chydoridae	Chydorus sphaericus	0	3	2	1	3	2	3	3
8	Chydoridae	Chydorus parvus	25	6	18	9	6	12	28	17
9	Chydoridae	Euryalona orientalis	14	2	6	10	8	8	11	20
10	Chydoridae	Longirostris	7	1	6	4	6	3	0	12
11	Daphnidae	Ceriodaphnia cornuta	5	2	4	3	4	8	12	0
12	Daphnidae	Daphnia sp	10	4	12	13	17	13	11	4
13	Moinidae	Moina micrura	7	5	7	8	5	9	14	8
14	Moinidae	Moinodaphnia mecleayi	10	6	11	8	8	7	0	0
15	Sididae	diaphanosoma excisum	0	1	1	0	0	0	0	0
16	Sididae	Penilia sp	5	1	1	6	2	4	1	3
	Copepod									
17	Copepoda	Cryptocyclops bicolor	11	2	12	9	18	16	5	2
18	Copepoda	Eucyclops serrulatus	6	7	7	12	7	8	10	0
19	Copepoda	Halicyclops korodiensis	19	16	6	5	9	5	0	3
20	Copepoda	Mesocyclops sp	20	9	10	12	11	14	0	1
21	Copepoda	Microcyclops varicans	6	6	9	4	4	1	0	1
22	Copepoda	Thermocyclops crassus	21	16	19	11	2	8	0	2
23	Copepoda	Paracalanus parvus	10	9	11	9	8	7	0	2
24	Copepoda	Eucalanus elongatus	0	0	0	2	1	0	3	8

S/N	Division	Species	River Otakpu (Omor)			River Uruokpukpo (Ogbunka)			S/N	
			OMZPK1	OMZPK2	OMZPK3	OGKZPK1	OGKZPK2	OGKZPK3	UGBZPK1	UGBZPK3
25	Copepoda	Pseudocalanus elongates	8	2	4	0	1	1	7	2
26	Copepoda	Copepod nauplius	6	7	12	5	5	9	18	9
	Rotifera									
27	Asplanchnidae	Asplanchna priodonta	15	17	14	13	9	14	34	11
28	Brachionidae	Asplanchnopus multiceps	2	6	6	4	2	7	12	6
29	Trichocercidae	Trichocerca cylindrical	11	5	9	10	8	3	8	3
30	Trichocercidae	Trichocerca longiseta	0	3	0	0	0	0	0	1
31	Hexarthridae	Filina opoliensis	3	2	7	1	1	1	2	0
32	Lecanidae	Lecane curvicornis	3	4	4	4	9	3	1	0
	Meroplankton									
33	Meroplanktonic	Shrimp zoea	13	2	10	7	6	9	2	0
34	Meroplanktonic	Shrimp larva	10	1	3	4	3	0	10	1
35	Meroplanktonic	Brachiopod larva	11	3	4	6	11	6	0	0
36	Meroplanktonic	Polycheate larva	0	5	1	2	1	0	1	1
37	Meroplanktonic	Fish eggs	2	1	2	3	4	3	2	1
	Total zooplankton abundance (N)		267	165	231	213	191	204	230	138
	Total Species Diversity (S)		37	37	37	37	37	37	37	37
	Log of Species Diversity (Log S)		1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
	Log of Abundance (Log N)		2.43	2.22	2.36	2.33	2.28	2.31	2.36	2.14
	Shannon-Wiener Index (Hs)		2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06
	Menhinick Index (D)		2.26	2.88	2.43	2.54	2.68	2.59	2.44	3.15
	Margalef Index (d)		6.44	7.05	6.61	6.71	6.85	6.77	6.62	7.31
	Equitability Index (j)		0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
	Simpson's Dominance Index (D)		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13

Source: Anambra ESIA Field Data (2024)

The table reveals that a total of 1639 individuals belonging to 37 zooplankton forms were identified from the samples, which fall into four major groups, including Cladocera, copepod, meroplankton, and rotifers. Among the Cladocera were 16 species distributed across five families: Bosminidae, Chydoridae, Daphnidae, Moinidae, and Sididae. The Moinidae family was notably diverse, with 8 species, whereas the other families each contribute 2 species.

The Copepoda group includes nine species and one nauplii larva belonging in three families. The Cyclopoididae family was the most diverse with six species, followed by the Calanoidae family with three species, and Naupliidae, which includes the larval stage of copepods, contributing one species.

The Rotifera group comprises five species represented by five families: Asplanchnidae, Brachionidae, Hexarthridae, Lecanidae, and Trichocercidae. Each of the first four families contributes one species, while Trichocercidae has two species. Finally, the Meroplankton group comprises five identified planktonic forms, including shrimp zoea, shrimp larva, brachiopod larva, polychaete larva, and fish eggs.

Zooplankton Abundance By Division

Table 4.43 presents the occurrences of various zooplankton groups across different sampling stations. The totals for each group of zooplankton are summarized below:

Cladocera: The Cladocera group has the highest number of individuals, totalling 662 (40.4%). This group showed variability in abundance across different stations, with counts ranging from 42 to 115. The highest occurrence was recorded in Ugbene River (UGBZPK1) with a total of 115 individuals, while the lowest was in Omor (OMZPK) with 42 individuals. The Chydoridae family was the most abundant, particularly in the Nnamuzu River (UGBZPK2) with 61 occurrences. Daphnidae and Moinidae families also showed significant presence, while Sididae was the least abundant family across all stations.

Copepoda: This group has the second-highest overall count, with 548 individuals (33.4%). The counts ranged from 30 to 107 across stations, with the peak in Otakpu River (OMZPK1) at 107 and the lowest count observed in Ugbene River (UGBZPK2) at 30. The high occurrence in the Otakpu River suggests a particularly favourable environment for this group in that location.

Rotifera: A total of 278 occurrences of rotifers (17.0% of the total zooplankton) were recorded, with station totals ranging from 21 to 57. The highest count was found in the Nnamuzu River (UGBZPK1) with 57 occurrences. The Families Asplanchnidae and Trichocercidae contributed notably to the total counts.

Meroplanktonic: The Meroplanktonic group exhibited lower overall counts, with 151 individuals (9.2%). The highest occurrence was 36 in Otakpu River (OMZPK1) and the lowest in Ugbene River (UGBZPK2) with three occurrences. This group shows significant variability, which may be attributed to the specific environmental conditions of each river.

Table 4.43: Total Number of Zooplankton Individuals by Taxonomic Division Across Sampling Location Per Ml (July 2024, Rainy Season)

DIVISION	Sum of OMZPK1	Sum of OMZPK2	Sum of OMZPK3	Sum of OGKZPK1	Sum of OGKZPK2	Sum of OGKZPK3	Sum of UGBZPK1	Sum of UGBZPK2	Total	%Compostion
CLADOCERA	90	42	81	90	71	89	115	84	662	40.4%
Bosminidae	2	2	7	18	6	14	20	8		
Chydoridae	51	21	38	34	29	34	57	61		
Daphnidae	15	6	16	16	21	21	23	4		
Moinidae	17	11	18	16	13	16	14	8		
Sididae	5	2	2	6	2	4	1	3		
COPEPODA	107	74	90	69	66	69	43	30	548	33.4%
Copepoda	107	74	90	69	66	69	43	30		
ROTIFERA										
Asplanchnidae	15	17	14	13	9	14	34	11		
Brachionidae	2	6	6	4	2	7	12	6		
Hexarthridae	3	2	7	1	1	1	2	0		
Lecanidae	3	4	4	4	9	3	1	0		
Trichocercidae	11	8	9	10	8	3	8	4		
MEROPLANKTONIC	36	12	20	22	25	18	15	3	151	9.2%
Meroplanktonic	36	12	20	22	25	18	15	3		
Grand Total	267	165	231	213	191	204	230	138	1639	100.0%

Source: Anambra ESIA Field Data (2024)

Figure 4.24 visually present the occurrences of individuals by divisions, highlighting the dominance of Cladocerans and copepods in the zooplankton community..

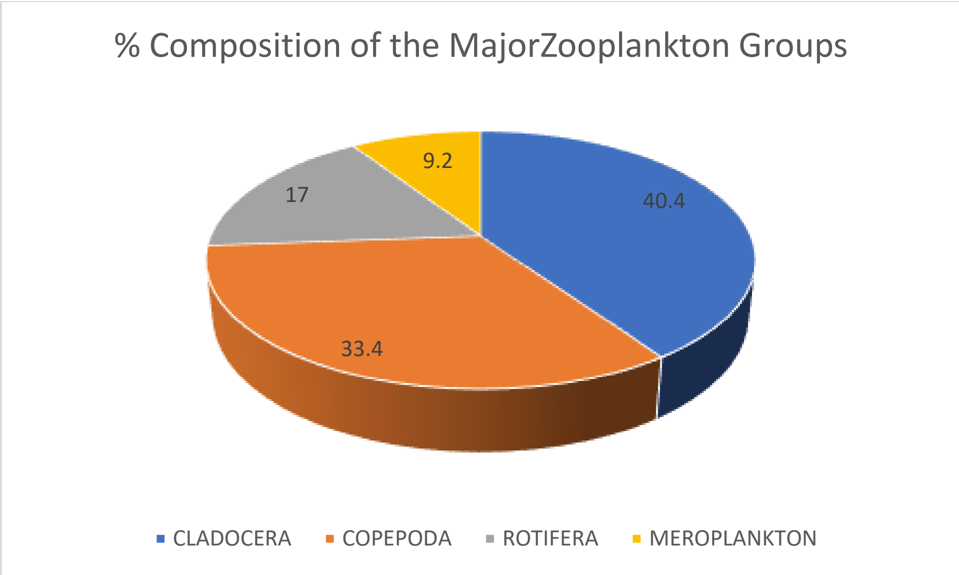


Figure 4.24: Percentage Composition by Number of Zooplankton Occurrence in Each Division

Source: Anambra ESIA Field Data (2024)

The analysis of zooplankton across the sampling stations reveals notable patterns in species dominance within each group.

Among the Cladocera, *Chydorus parvus* was the most abundant species, being particularly present in River Nnamuzu (UGBZPK1), where it reached its highest occurrence of 28 individuals. It also maintained relatively high numbers in UGBZPK2, with 17 recorded.

Euryalona orientalis was another important Cladocera species, which showed considerable abundance, especially in River Nnamuzu (UGBZPK2) with 20 occurrences, and Otakpu River (OMZPK1), where it occurred 14 times.

The Copepoda as a group shows the highest count in Otakpu River (OMZPK1) with 107 occurrences. Within this group, *Halicyclops korodiensis* was dominant in Otakpu River (OMZPK1), accounting for 19 occurrences. Similarly, *Thermocyclops crassus* occurred 21 times in the Otakpu River (OMZPK1).

For the meroplanktonic group, Shrimp zoea was the most dominant species, exhibiting the highest abundance in Otakpu River (OMZPK1) with 13 occurrences. Additionally, Brachiopod larva was notably present in Otakpu River (OMZPK1) with 11 occurrences.

Among the Rotifera, Asplanchnidae was particularly prevalent, especially in River Nnamuzu (UGBZPK1), where it had 34 occurrences. Trichocercidae was also a common group across all stations, with significant counts in Otakpu River (OMZPK1) where it was recorded 11 times.

Overall, Otakpu River (OM) displayed the highest diversity and abundance in both Cladocera and Copepoda, indicating a rich zooplankton community in this area. In contrast, River Nnamuzu (UGB) highlights a peak in Rotifera, specifically Asplanchnidae. These patterns reflect the variations in environmental conditions across the different sampling stations.#Di

Abundance of Zooplankton Across Sampling Stations

The analysis of zooplankton occurrence across the sampling stations reveals notable patterns in species dominance within each group.

Among the Cladocera, *Chydorus parvus* was the most abundant species, being particularly present in River Nnamuzu (UGBZPK1), where it reached its highest occurrence of 28 individuals. It also maintained relatively high numbers in UGBZPK2, with 17 recorded. *Euryalona orientalis* was another important Cladocera species, which showed considerable abundance, especially in River Nnamuzu (UGBZPK2) with 20 occurrences, and Otakpu River (OMZPK1), where it occurred 14 times.

The Copepoda as a group shows the highest count in Otakpu River (OMZPK1) with 107 occurrences. Within this group, *Halicyclops korodiensis* was dominant in Otakpu River (OMZPK1), accounting for 19 occurrences. Similarly, *Thermocyclops crassus* occurred 21 times in the Otakpu River (OMZPK1).

Among the Rotifera, the Family Asplanchnidae was particularly prevalent, especially in River Nnamuzu (UGBZPK1), where it had 34 occurrences, led by the species *Asplanchna priodonta*. Trichocercidae was also a common group across all stations, with significant counts in Otakpu River (OMZPK1) where it was recorded 11 times. *Trichocerca cylindrical* was a n important contributor to this group

For the meroplanktonic group, Shrimp zoea was the most dominant species, exhibiting the highest abundance in Otakpu River (OMZPK1) with 13 occurrences. Additionally, Brachiopod larva was notably present in Otakpu River (OMZPK1) with 11 occurrences.

Overall, Otakpu River (OM) displayed the highest abundance in both Cladocera and Copepoda, In contrast, River Nnamuzu (UGB) highlights a peak in Rotifera, specifically Asplanchnidae. These patterns reflect the variations in environmental conditions across the different sampling stations.

Calculated Indices

Log of Species Diversity (Log S): The logarithmic transformation of species diversity was consistent across all sites, reflecting similar levels of diversity in zooplankton communities.

- **Log of Abundance (Log N):** River Otakpu showed higher values, suggesting a greater overall abundance of zooplankton compared to other sites.

- **Shannon-Wiener Index (Hs):** This index was constant across all sites, indicating similar levels of diversity and evenness.
- **Menhinick Index (D):** Measures species richness per unit abundance, with higher values in River Otakpu and lower values in River Nnamuzu, indicating variations in species richness relative to abundance.
- **Margalef Index (d):** Reflects species richness, with higher values in River Otakpu and River Uruokpukpo, indicating higher species richness in these areas.
- Equitability Index (j): Remains constant across all sites, reflecting consistent evenness in species distribution.
- **Simpson's Dominance Index (C):** Consistent values across all sites indicate similar levels of species dominance and diversity.

In summary, River Otakpu exhibited the highest total zooplankton abundance and diverse communities, with notable peaks in specific sampling points. River Uruokpukpo also shows significant zooplankton diversity and abundance, though slightly lower than Omor. River Nnamuzu had a lower total abundance but maintained similar diversity and evenness compared to the other sites

4.2.13.3 Macrobenthic Fauna

Macrobenthic fauna, commonly referred to as benthic macroinvertebrates, are aquatic organisms that live on or within the substrate of surface waters. These organisms, including various species of insects, crustaceans, molluscs, and annelids, are integral to the ecological balance due to their roles in nutrient cycling, organic matter decomposition, and as a food source for higher trophic levels (Rosenberg and Resh, 1993). Their abundance and diversity are crucial indicators of the health and quality of freshwater ecosystems (Merritt *et al.*, 2008).

In this Environmental and Social Impact Assessment (ESIA), the macrobenthic fauna was studied at four locations, including OGKBENSW1, located upstream in River Uruokpukpo in Ogbunka; and three locations in River Nnamuzu, Ugbene, namely UGBBENSW1 (upstream), UGBBENSW2 (midstream), and UGBBENSW3 (downstream). This assessment aimed to evaluate the distribution and abundance of these macroinvertebrates across different points in the rivers to understand better the ecological conditions and potential impacts of the proposed project.

4.2.13.3.1 Macrobenthic Composition

The analysis of benthic organisms in River Uruokpukpo in Ogbunka and River Nnamuzu in Ugbene revealed distinct patterns in species distribution and abundance across the two river systems. A total of 24 macrobenthic species were observed distributed across four groups as shown in Table 4.44 as follows:

- **Phylum Annelida**: Five species including *Capitella sp, Nereis pelagica, Notomastus abserans, Eiseniella tetrahedral* and *Tubifex* sp.
- **Class Crustacea**: Ten species, including *Alpheus pontederiae, Balanus* sp.,

Callinectes Amnicola, Cardisoma armatum, Clibanarius sp., *Cthamalus dentatus, Macrobrachium macrobrachium, Mysis* sp.*, Sesarma alberti,* and *Uca tangeri*

- **Class Gastropoda**: Five species, including *Littorina* sp., *Nerita glabrata, Pachymelania aurita, Thais* sp., *and Tympanotonus* sp.,
- **Class Insecta**: Four species, including *Baetis* sp.*, Coenagrion* sp., *Chironomus* sp. *and Libellula* sp.)

Table 4.44: Benthic Distribution of Macrobenthic Fauna in Study Areas (July 2024, Rainy Season)

Scientific Name	Common Name	OGBKBENSW	UGBBENSW1	UGBBENSW2	UGBBENSW3
Crustacean Group					
Alpheus pontederiae	Snapping shrimp	0	1	1	0
Balanus sp.		1	1	0	1
Callinectes amnicola	Swimming crab	1	1	1	0
Cardisoma armatum	Rainbow crab	0	0	0	1
Clibanarius sp.	Hermit crab	0	1	0	1
Cthamalus dentatus		0	0	0	0
Macrobrachium macrobrachium		0	1	1	0
Mysis sp.		7	8	5	2
Sesarma alberti	Mangrove crabs	0	0	0	0
Uca tangeri	Fiddler crab	0	0	3	0
Gastropoda Group					
Littorina sp.		0	2	0	2
Nerita glabrata		1	0	1	2
Pachymelania aurita		2	4	1	4
Thais sp.		1	1	0	1
Tympanotonus	Mud-flat	2	2	2	3
Annelida Group					
Capitella sp.		0	0	1	2
Nereis pelagica		3	1	5	2
Notomastus abserans		1	3	2	1
Eiseniella tetrahedral		7	6	8	8
Tubifex sp.		1	1	1	4
Insecta Group					
Baetis sp.	Mayfly larva	2	5	2	1
Coenagrion sp.	Dragonfly larva	7	5	9	8
Chironomus sp.		4	5	10	8
Libellula sp.		0	2	0	2

Scientific Name	Common Name	OGBKBENSW	UGBBENSW1	UGBBENSW2	UGBBENSW3
Baetis sp.	Mayfly larva	2	5	2	1
Total Benthos abundance (N)		40	50	53	53
Total Species Diversity (S)		13	13	13	13
Log of Species Diversity (Log S)		1.11	1.11	1.11	1.11
Log of Abundance (Log N)		1.6	1.7	1.73	1.73
Shannon-Wiener Index (Hs)		2.06	2.06	2.06	2.06
Menhinick Index (D)		3.06	3.66	3.59	3.59
Margalef Index (d)		1.85	1.93	1.91	1.91
Equitability Index (j)		0.57	0.57	0.57	0.57
Simpson's Dominance Index (C)		0.13	0.13	0.13	0.13

Source: AN SAPZ ESIA Field Data (2024)

In River Uruokpukpo, the crustacean community was relatively sparse, with only five species recorded. Among them, *Mysis* sp. stood out as the most dominant, with a notable presence of seven individuals, indicating a potentially favourable habitat for this species in the river.

In contrast, River Nnamuzu in Ugbene exhibits a higher diversity of crustaceans, with nine species observed across the three sampling points. *Mysis* sp. showed significant presence in all locations, though with varying counts. Notably, *Uca tangeri*, the fiddler crab, was uniquely found in the midstream of River Nnamuzu (UGBBENSW2), suggesting the presence of microhabitats or conditions suitable for this species that are absent in River Uruokpukpo.

Of the three gastropod species present in the River Uruokpukpo. *Pachymelania aurita* was as the most abundant gastropod species in this river, albeit with just two individuals recorded. *Pachymelania aurita* also remained a dominant species in Rover Nnamuzu as well, particularly in two of the sampling points, indicating a broader distribution and more favourable conditions for this species in River Nnamuzu.

The annelida community in River Uruokpukpo includes five species, with *Eiseniella tetrahedral* being the most dominant, with seven individuals. In River Nnamuzu, *Eiseniella tetrahedral* was the key species, consistently present in all sampling points with even higher abundance. Additionally, *Notomastus abserans* were present at all sites in River Nnamuzu.

The insect community in River Uruokpukpo consisted of four species, with *Coenagrion* sp.. and *Chironomus* sp. showing the highest counts. In River Nnamuzu, *Chironomus* sp. was particularly abundant across all sites. Additionally, *Coenagrion* sp. and *Baetis* sp. were present across the sites in River Nnamuzu, with *Coenagrion* sp. showing particularly high counts in midstream (UGBBENSW2) and downstream (UGBBENSW3) of the sampling points, further demonstrating the richness of the insect community in this river.

4.2.13 Vegetation Cover Characteristics

Vegetation ecology, the study of Earth's diverse plant cover and its interactions with environmental factors is crucial for understanding biodiversity preservation, sustainable resource use, and global environmental changes (Van der Maarel & Franklin, 2013).

Vegetation, which describes plant assemblages and their physiography, is the most visible element of landscapes and a direct reflection of local environmental conditions (Goudie, 2013).

In Nigeria, the variability in vegetation is pronounced across different regions, from the species-rich coastal and forest zones in the south to the near-desert Sahel savannah in the north, where low-growing grasses, thorny shrubs, and scattered acacia and baobab trees dominate (White, 1983; Keay, 1953). Climate, topography, and human activities significantly shape these diverse ecosystems, creating a mosaic of vegetation types (Nwaogu *et al.*, 2017). Keay's (1953) classification remains a foundational framework for distinguishing Nigeria's vegetation, which includes coastal (mangrove, freshwater swamp), rainforest, Guinea savanna (woodland and tall grass savanna), Sudan savanna (short grass savanna), and Sahel savanna (marginal savanna) types (Figure 4.25). Understanding these variations is essential in efforts to preserve Nigeria's rich biodiversity and manage its natural resources sustainably.

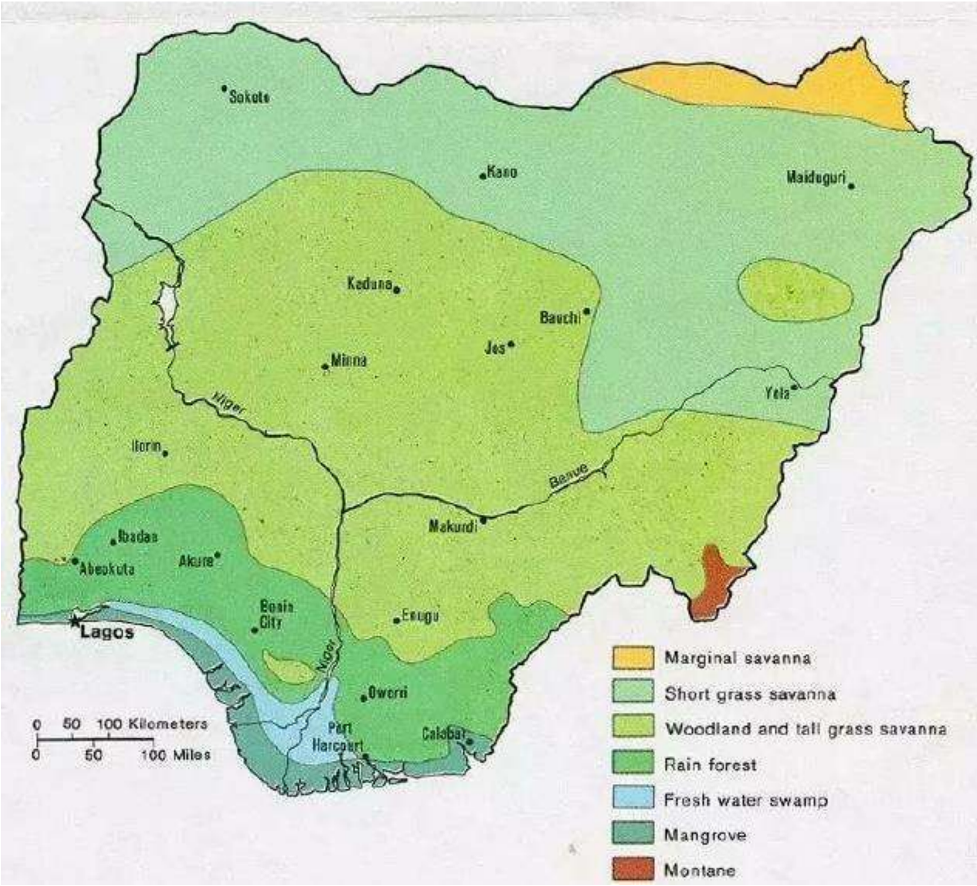


Figure 4.25: Vegetation Zones of Nigeria

Source: Akpan-Ebe (2017)

This vegetation study was conducted to establish the baseline vegetation of the Anambra SAPZ II project areas. It aims to understand the current state of the vegetation, providing a foundation for predicting potential biodiversity impacts of the project and developing appropriate mitigation strategies to address them.

4.2.13.1 The Vegetation Types in Anambra State

The vegetation of Anambra State is diverse due to its varied topography and climatic conditions. The principal vegetation types include tropical rainforest, derived savannah, freshwater swamps, and secondary forests (Ekwealor *et al.,* 2020; Anyanwu *et al*., 2016; Okereke *et al*., 2014; Floyd, 1967). As Floyd (1967) observed, the boundaries between vegetational zones are not sharply defined due to the intermingling of communities from different regions, particularly between the rainforest and derived savannah zones. Typically, there is a transition belt where rainforest and savanna coexist to varying degrees.

- **Tropical Rainforest**: This is the predominant vegetation type in Anambra State, especially in areas with high rainfall. The rainforest features a dense canopy of tall trees, including species such as *Elaeis guineensis* (oil palm), *Mitragyna ciliata*, *Ricinodendron heudelotii*, *Chlorophora excelsa* (iroko), *Triplochiton scleroxylon* (obeche), *Entandrophragma utile* (utile), and *Terminalia superba* (mara).
- **Derived Savannah:** Derived savanna results from the clearing of natural forests for agriculture, housing, or infrastructure development. This transformation leads to a mixed ecosystem characterised by grasslands interspersed with scattered trees (Ratnam *et al*., 2011). Common tree species include *Eugenia* spp., *Protea*, *Uapaca guineensis,* and scrubby *Vitex detarium*, with tall *Daniellia* and fan palms (*Borassus aethiopium*) dominant in the richer, loamy alluvial soils of the Anambra Basin.
- **Freshwater Swamp Forest:** This vegetation type is found in the low-lying and riverine regions of Anambra State, thriving in waterlogged conditions. It is characterised by species such as *Raphia hookeri* (raffia palm), *Pandanus candelabrum*, and various sedges.
- **Secondary Forests:** These forests develop in areas where the original rainforest has been cleared and then abandoned, allowing for natural regeneration over time. The species composition of secondary forests includes pioneer species like *Musanga cecropioides*, *Alchornea cordifolia*, and various fast-growing tree species.

In addition, the cultivation of food and cash crops for sustenance and economics have given rise to farmlands with their characteristics of plant species, such as cassava, maize, and oil palm. This has not only shaped the agricultural landscape of the project area but also influenced its vegetation, contributing to local sustenance and economic activities. However, these human activities pose significant threats to biodiversity through habitat destruction and land degradation (Goudie, 2013). In the Anambra SAPZ project area, agricultural expansion, urbanisation, and resource extraction have further intensified pressures on natural habitats, leading to their degradation and loss.

Understanding the baseline vegetation conditions in areas like Ogboji, Ogbunka, Ugbene, and Omor is essential for assessing the potential impacts of the Anambra SAPZ project. By documenting the existing vegetation types, identifying sensitive ecological zones, and evaluating the risks associated with the project's development, effective mitigation measures can be designed and implemented to minimise environmental impacts and ensure sustainable land use.

4.2.13.1 Vegetation in the Project Areas

The methodology used to study the vegetation is detailed in Section 4.1 of this report. The project area spans several locations, including Ogboji and Ogbunka in Orumba South LGA, Ugbene in Awka North LGA, and Omor in Ayamelum LGA, Anambra State. These areas feature a diverse range of vegetation types shaped by the region's varied topography and climatic conditions.

The study area includes a mix of tropical rainforests, derived savannahs, freshwater swamps, and secondary forests. The vegetation cover is characterised by the presence of species such as *Bambusa vulgaris* (bamboo), oil palms (*Elaeis guineensis*), cassava (*Manihot esculenta*), various indigenous trees and several types of grasses. However, the natural vegetation has been significantly altered due to human activities, including agricultural expansion and infrastructural and industrial developments. This fragmentation of natural habitats in the area has led to a mosaic of cultivated lands interspersed with remnants of secondary forests and other natural vegetation. This has implications for local biodiversity and ecosystem functioning, which are being closely monitored as part of the environmental assessment.

Table 4.45 presents the assemblage of plant species recorded during the study, including their abundance, common uses, and the IUCN status. during the survey conducted in July 2024 (rainy season). Plates 4.10-13 provide visual documentation of the vegetation types and plants observed during the study.

Key Findings

1. A total of 154 plant species belonging to 53 families were identified
2. Based on the IUCN classification, none of the species was vulnerable or endangered. However, one species: (*Irvingia gabonensis*, Family Irvingiaceae known locally as the Ogbono tree was classified as Near Threatened (NT) requiring monitoring.
3. Eight (8 growth habits were identified as follows (and depicted graphically in Figure 4.26 growth habits of the plants include:
    - Climbers (6 species): Notable members among this group are *Dioscorea* spp., (yam); *Cucurbita* sp., (pumpkin), *Smilax anceps* (West African sarsaparilla.
    - Creepers (3 species): Selaginella myosurus, Indigofera *spicata* (trailing indigo) and Cucumis melo (melon).
    - Grasses (33 species): They were very common, with species like *Panicum maximum (*Guinea grass), *and Eleusine indica* (Indian goosegrass) very common*.* Cultivated species included *Zea mays* (maize), *Oryza sativa (rice) and Brachiaria deflexa* (Guinea millet)*.* The *Bambusa vulgaris* (bamboo*) was* also commons
    - Herbs (57 species): They are the most diverse, with species like *Pteridium aquilinum, Bracken fern, Luffa cylindrica* (loofah), *Tridax procumbrns* and *Cleome rutidosperma* (Sspindle tap) thriving in grasslands, savannahs, and disturbed habitats.

- Sedges (4 species): They include *Scleria noumanniana, Rhynchospora corymbosa* (Golden beak sedge), *Hypolytrum heteromorphumm* and (umbrella grass).
- Shrubs (26 species): Notable species are *Senna* spp.*, Sida acuta* (broomweed), *Alchirnea* spp., and *Trema orientalis* (pigeonwood). Food species include *Manihot esculenta.*
- Sucker (2): They are *Musa acuminata* (banana) and *Musa paradisiaca* (plantain)
- Trees (21 species): Significant species include *Alstonia boonei, Mangifera indica*, (mango), *Dacryoides edulis* (ube tree), *Pentaclethra macrophylla* (ugba tree), *Raphia hookeri* (raffia palm) and *Elaeis guineensis* (oil palm).

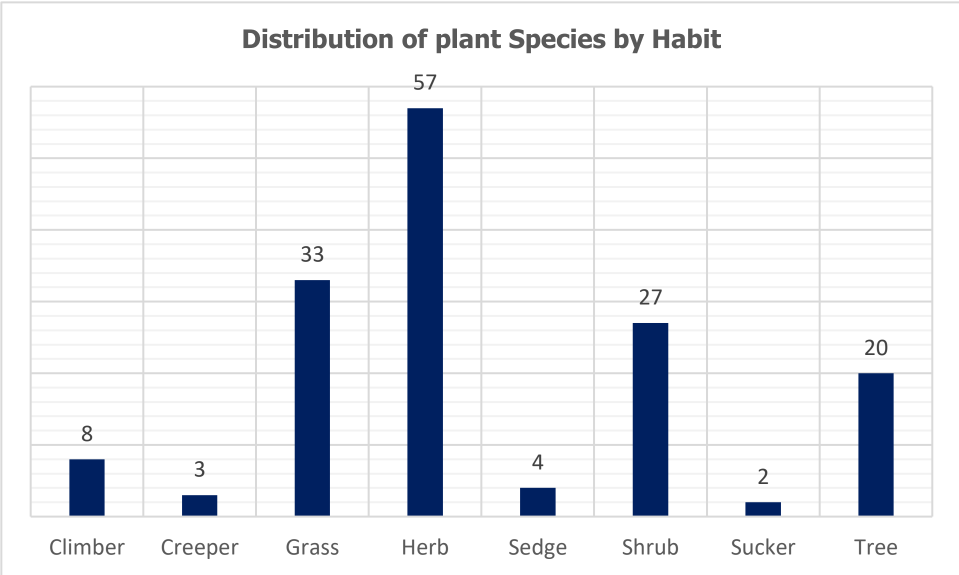


Figure 4.26: Distribution of Growth Habit of Identified Plant Species in the Study Areas

Source: AN ESIA Study Field Data (2024)

4. Several cultivated species abound, including *Carica papaya* (pawpaw), *Terminalia catappa* (almond), Ipomoea batatas (Potato), *Phaseolus vulgaris* (beans), *Arachis hypogaea* (peanut), *Abelmoschus esculentus* (okra), *Dialium guineense* (tamarind), among others.
5. The plant compositions were dominated by the family Poaceae (grasses), represented by 30 species and constituting 18.49 % of all identified species, followed by the family Leguminoseae (also known as Fabaceae) with 18 species (11.69%) and family Asteraceae, represented by 10 species of 6.49% of all identified species.

Table 4.45: Check List of Species of Plants Around the Project Areas (July 2024, Rainy Season)

S/N	Botanical Name	Family	Common Name	Local Name	Habit	Uses	Abundance/ Moderate/ Scanty	IUCN Status
A	**Climbers**							
1	*Cassytha filiformis*	Lauraceae	Devil gut		Climber	paste for paper-making	Scanty	Secure*
2	*Cucurbita* sp.	Asteraceae	Pumpkin plant		Climber	Food	Moderate	NE
3	*Dioscorea* spp.	Dioscoreaceae	Yam	Ji	Climber	Food	Abundant	NE
4	*Ipomoea batatas*	Convolvulaceae	Potato	Nduku	Climber	Food	Scanty	DD
5	*Lepistemon owariense*	Convolvulaceae			Climber	Vegetable leaves	Scanty	NE
6	*Merremia hederacea*	Convolvulaceae			Climber	Medicinal	Scanty	NE
7	*Reissantia indica*	Hippocrateaceae			Climber	Medicinal	Scanty	NE
8	*Smilax anceps*	Smilacaceae	West African sarsaparilla		Climber	Medicinal	Abundant	NE
B	**Creepers**							
9	*Cucumis melo*	Cucurbitaceae	Melon		Creeper	Food	Moderate	NE
10	*Indigofera spicata*	Leguminosae	Trailing indigo		Creeper	Erosion Control & Ornamental	Scanty	NE
11	*Selaginella myosurus*	Selaginellaceae	spikemosses		Creeper		Abundant	NE
C	**Grasses**							
12	*Anthephora ampullacea*	Poaceae			Grass	Forage	Abundant	DD
13	*Aristida kerstingii*	Poaceae			Grass		Abundant	NE
14	*Axonopus compresus*	Poaceae	Flat joint grass		Grass	Medicinal	Abundant	LC
15	*Bambusa vulgaris*	Poaceae	Bamboo	Osisi Achara	Grass	Craft/Construction	Abundant	Secure*
16	*Brachiaria deflexa*	Poaceae	Guinea millet	Achara	Grass	Food	Abundant	NE
17	*Brachiaria distachyoides*	Poaceae			Grass	Animal feed	Scanty	NE
18	*Brachiaria falcifera*	Poaceae			Grass	Animal feed	Abundant	NE
19	*Brachiaria lata*	Poaceae			Grass	Fodder for Livestock	Abundant	NE
20	*Chloris pilosa*	Poaceae	Finger grass		Grass	Medicinal	Abundant	NE

S/N	Botanical Name	Family	Common Name	Local Name	Habit	Uses	Abundance/ Moderate/ Scanty	IUCN Status
21	*Cymbopogon citratus*	Poaceae	Lemon grass		Grass	Food	Scanty	NE
22	*Cynodon dactylon*	Poaceae	Couch grass		Grass	Pasture for grazing	Scanty	NE
23	*Cyperus esculentus*	Cyperaceae	Yellow nutsedge		Grass	Food	Abundant	LC
24	*Cyperus rotundus*	Cyperaceae	Purple nutgrass		Grass	Medicinal	Abundant	LC
25	*Dactyloctenium aegyptium*	Poaceae	Crowfoot-grass		Grass	Medicinal	Moderate	NE
26	*Digitaria adscendens*	Poaceae			Grass	Animal feed	Scanty	Secure*
27	*Digitaria cilliaris*	Poaceae	Tropical crabgrass		Grass	Food and Medicinal	Moderate	Secure**
28	*Digitaria horizontalis, Digitaria horizontalis, *crab frass),*	Poaceae	Crabgrass		Grass	Forage	Moderate	NE
29	*Digitaria longiflora*	Poaceae	Crabgrass		Grass	Animal feed	Moderate	NE
30	*Digitaria nuda*	Poaceae	Digit grass		Grass	Food & Medicinal	Abundant	NE
31	*Echinochloa colona*	Poaceae	Jungle rice	Osikapa	Grass	Animal feed	Abundant	LC
32	*Eleusine indica*	Poaceae	Indian goosegrass		Grass	Weed	Abundant	LC
33	*Eragrostis trenella*	Poaceae	Feathery love grass		Grass	Animal feed	Scanty	NE
34	*Imperata cylindrica*	Poaceae	Speargrass		Grass	Erosion control	Abundant	NE
35	*Mariscus alternifolius*	Cyperaceae	Umbrella sedge		Grass	Medicinal	Abundant	NE
36	*Mariscus flabelliformis*	Cyperaceae			Grass	Ornamental	Abundant	NE
37	*Oplismenus burmannii*	Poaceae	Burmann basket grass		Grass	Medicinal	Scanty	NE
38	*Oryza longistaminata*	Poaceae	Wild rice	Osikapa	Grass	Food	Abundant	LC
39	*Oryza sativa*	Poaceae	Rice	Osikapa	Grass	Food	Abundant	NE
40	*Panicum brevifolium*	Poaceae			Grass	Fodder	Moderate	NE
41	*Panicum maximum*	Poaceae	Guinea grass	Ahihia	Grass	Fodder	Abundant	NE
42	*Schizachyrium exile*	Poaceae			Grass	Thatching and weaving	Abundant	NE
43	*Setaria barbata*	Poaceae	Bristly foxtail		Grass	Animal feed	Abundant	NE

S/N	Botanical Name	Family	Common Name	Local Name	Habit	Uses	Abundance/ Moderate/ Scanty	IUCN Status
44	*Zea mays*	Poaceae	Maize or corn	Oka	Grass	Food	Abundant in farmland	LC
D	**Herbs**							
45	*Abelmoschus esculentus*	Malvaceae	Okra	Okwuru	Herb	Food	Moderate	NE
46	*Ageratum houstonianum*	Asteraceae	Blue mink		Herb	Medicinal	Abundant	NE
47	*Amarantus spinosus*	Amaranthaceae	Thorny pigweed		Herb	Laxative	Moderate	Secure*
48	*Andropogon tectorum*	Poaceae	Giant bluestem		Herb	Ornamental	Abundant	NE
49	*Aneilema beniniens*	Commelinaceae			Herb	Livestock feed	Moderate	NE
50	*Arachis hypogaea*	Leguminosae	Peanut/Groundnut	Ntu oka/ Ahuekere	Herb	Food	Scanty	NE
51	*Asystasia gangetica*	Acanthaceae	Chinese violet		Herb	Vegetable	Moderate	NE
52	*Biophytum petersianum*	Oxalidaceae	Sensitive plant		Herb	Medicinal	Scanty	NE
53	*Calopogonium mucunoides*	Leguminosae	Calopo		Herb	Forage	Moderate	NE
54	*Capsicum annum*	Solanaceae	Red pepper	Ose	Herb	Food	Scanty	LC
55	*Celosia leptostachya*	Amaranthaceae			Herb	Food	Abundant	NE
56	*Cleome rutidosperma*	Cleomaceae	Spindle tap		Herb	Medicinal	Scanty	NE
57	*Colosiaca esculenta*	Araceae	Cocoyam	Ede	Herb	Food	Abundant	NE
58	*Commelina erecta*	Commelinaceae	Slender flower		Herb	Medicinal	Moderate	Secure*
59	*Commelina forskalaei*	Commelinaceae	Rat ear		Herb	Weed	Scanty	NE
60	*Corchorus tridens*	Tiliaceae	Wild jute		Herb	Medicinal	Moderate	NE
61	*Costus afer*	Costaceae	Ginger lily		Herb	Medicinal	Scanty	NE
62	*Crotalaria retusa*	Leguminosae	Rattlebox		Herb	Medicinal	Scanty	NE
63	*Diodia sarmentosa*	Rubiaceae	Tropical button weed		Herb	Medicinal	Scanty	NE
64	*Emilia coccinea*	Asteraceae	Yellow tassel flower		Herb	Medicinal	Abundant	NE
65	*Euphorbia heterophylla*	Euphorbiaceae	Spurge weed		Herb	Medicinal	Moderate	LC
66	*Euphorbia hirta*	Euphorbiaceae	Garden spurge		Herb	Medicinal	Moderate	NE

S/N	Botanical Name	Family	Common Name	Local Name	Habit	Uses	Abundance/ Moderate/ Scanty	IUCN Status
67	*Gomphrena celosioides*	Amaranthaceae	Gomprena weed		Herb	Medicinal	Abundant	NE
68	*Heliotropium indicum*	Boraginaceae	Indian heliotrope		Herb	Medicinal	Moderate	LC
69	*Hyptis lanceolata*	Lamiaceae			Herb	Medicinal	Moderate	NE
70	*Hyptis suaveolens*	Lamiaceae	Bush tea		Herb	Medicinal	Moderate	NE
71	*Luffa cylindrica*	Cucurbitaceae	Loofah		Herb	Medicinal	Abundant	NE
72	*Melanthera scandens*	Asteraceae			Herb	Medicinal	Abundant	NE
73	*Mimosa pudica*	Leguminosae	Sensitive		Herb	Medicinal	Abundant	LC
74	*Mitracarpus villosus*	Rubiaceae			Herb	Medicinal	Scanty	NE
75	*Nymphaea lotus*	Nymphaeaceae	Water lily		Herb	Medicinal	Scanty	LC
76	*Nymphaea maculata*	Nymphaeaceae	African tiger lotus		Herb	Edible fruit	Moderate	NE
77	*Oldenlandia Herbacea*	Rubiaceae			Herb	Medicinal	Scanty	NE
78	*Palisota hirsuta*	Commelinaceae			Herb	Ornamental	Scanty	NE
79	*Peperomia pellucida*	Piperaceae	Shiny bush		Herb	Medicinal	Scanty	NE
80	*Phaseolus vulgaris*	Leguminosae	Beans	Agwa	Herb	Food	Scanty	LC
81	*Phyllantus niruri*	Euphorbiaceae	Shatterstone		Herb	Medicinal	Moderate	NE
82	*Physalis angulata*	Solanaceae	Husk tomato	Otuboala	Herb	Medicinal	Scanty	NE
83	*Platostoma africanum*	Lamiaceae			Herb	Medicinal	Moderate	NE
84	*Pteridium aquilinum*	Dennstaedtiaceae	Bracken fern		Herb	Insect repellent	Abundant in aquatic habitats	Secure*
85	*Pueraria phaseoloides*	Leguminosae	Tropical kudzu		Herb	Fodder	Moderate	NE
86	*Pupalia lappacea*	Amaranthaceae			Herb	Medicinal	Moderate	NE
87	*Rhamphicarpa fistulosa*	Scrophulariaceae	Rice vampire-weed		Herb		Scanty	NE
88	*Sagittaria latifolia*	Alismataceae	Arrowhead		Herb	Medicinal	Moderate in aquatic habitats	LC
89	*Scleria verrucosa*	Cyperaceae			Herb		Scanty	NE
90	*Scoparia dulcis*	Scrophulariaceae	Sweet broom weed		Herb	Medicinal	Scanty	NE
91	*Sesamum indicum*	Pedaliaceae	Sesame	Mkpuru sesame	Herb	Food	Scanty	NE

S/N	Botanical Name	Family	Common Name	Local Name	Habit	Uses	Abundance/ Moderate/ Scanty	IUCN Status
92	*Solenostemon monostachyus*	Lamiaceae	Monkey potato		Herb	Medicinal	Moderate	NE
93	*Spermacoce verticillata*	Rubiaceae	White-brown broom		Herb	Medicinal	Scanty	NE
94	*Spigella anthelmia*	Loganiaceae	Pink weed		Herb	Medicinal	Scanty	NE
95	*Spilanthes costata*	Asteraceae			Herb	Medicinal	Abundant	NE
96	*Spilanthes filicaulis*	Asteraceae			Herb	Medicinal	Abundant	NE
97	*Synedrella nodiflora*	Asteraceae	Node weed		Herb	Medicinal	Abundant	NE
98	*Syngonium* sp.	Araceae			Herb	Medicinal	moderate	NE
99	*Talinum triangulare*	Portulacaceae	Waterleaf	Mgbolodi	Herb	Food	Scanty	NE
100	*Tridax procumbens*	Asteraceae	Tridax		Herb	Medicinal	Abundant	NE
101	*Typha australis*	Typhaceae	Reedmaces		Herb	Bioethanol	Abundant in rice farm	NE
E	**Sedges**							
102	*Fuirena cillaris*	Cyperaceae	Umbrella grass		Sedge		Scanty	NE
103	*Hypolytrum heteromorphum*	Cyperaceae			Sedge	Medicinal	Scanty	NE
104	*Rhynchospora corymbosa*	Cyperaceae	Golden beak sedge		Sedge	Medicinal	Scanty	LC
105	*Scleria noumanniana*	Cyperaceae			Sedge		Scanty	NE
F	**Shrubs**							
106	*Aeschynomene indica*	Leguminosae	Curly indigo		Shrub	Medicinal	Scanty	LC
107	*Alchornea cordifolia*	Euphorbiaceae	Christmas bush		Shrub	Medicinal	Abundant	LC
108	*Alchornea laxiflora*	Euphorbiaceae			Shrub	Medicinal	Abundant	NE
109	*Anthonotha macrophylla*	Leguminosae			Shrub	Food	Scanty	NE
110	*Chamaecrista momosoides*	Leguminosae	Tea senna		Shrub	Medicinal	Scanty	NE
111	*Chromolaena odorata*	Asteraceae	Siam weed		Shrub	Medicinal	Abundant	NE

S/N	Botanical Name	Family	Common Name	Local Name	Habit	Uses	Abundance/ Moderate/ Scanty	IUCN Status
112	*Clappertonia ficifolia*	Tiliaceae			Shrub	Ornamental	Moderate	NE
113	*Cnestis ferruginea*	Connaraceae			Shrub	Medicinal	Abundant	NE
114	*Combretum racemosum*	Combretaceae			Shrub	Medicinal	Abundant	NE
115	*Icacina trichantha*	Icacinaceae			Shrub	Medicinal	Moderate	NE
116	*Ludwigia abyssinica*	Onagraceae	Water primrose		Shrub	Medicinal	Abundant	NE
117	*Malvastrum coromandelianum*	Malvaceae	False mallow		Shrub	Medicinal	Moderate	NE
118	*Manihot esculenta*	Euphorbiaceae	Cassava	Akpu	Shrub	Food	Abundant	LC
119	*Manniophyton fulvum*	Euphorbiaceae			Shrub	Food	Scanty	NE
120	*Palisota hirsuta*	Commelinaceae			Shrub	Ornamental	Moderate	NE
121	*Senna alata*	Leguminosae	Candle bush		Shrub	Medicinal	Scanty	Secure*
122	*Senna hirsuta*	Leguminosae	Hairy senna		Shrub	Food	Moderate	NE
123	*Senna obtusifolia*	Leguminosae	Sickle pod		Shrub	Laxative	Moderate	LC
124	*Senna occidentalis*	Leguminosae	Coffee senna		Shrub	Medicinal	moderate	LC
125	*Sida acuta*	Malvaceae	Broom weed		Shrub	Medicinal	Abundant	Secure*
126	*Sida garckeana*	Malvaceae			Shrub	Medicinal	Abundant	NE
127	*Stachytarpheta cayennensis*	Verbenaceae	Blue rat tail		Shrub	Medicinal	Abundant	NE
128	*Trema orientalis*	Ulmaceae	Pigeon wood		Shrub	Medicinal	Moderate	LC
129	*Triumfeta rhomboidea*	Tiliaceae	Chinese bur		Shrub	Medicinal	Moderate	NE
130	*Urena lobata*	Malvaceae	Cadillo		Shrub	Medicinal	Scanty	LC
131	*Vernonia amygdalina*	Asteraceae	Bitter leaf	Onugbu	Shrub	Food	Abundant	NE
132	*Waltheria indica*	Sterculiaceae	Sleepy morning		Shrub	Medicinal	Scanty	LC
G	**Suckers**							
133	*Musa acuminata*	Musaceae	Banana	Unere ojii	Sucker	Food/Economic	Abundant	LC
134	*Musa paradisiaca*	Musaceae	Plantain	Ojoko	Sucker	Food/Economic	Abundant	NE
H	**Trees**							
135	*Albizia zygia*	Leguminosae			Tree	Fuel wood	Moderate	NE

S/N	Botanical Name	Family	Common Name	Local Name	Habit	Uses	Abundance/ Moderate/ Scanty	IUCN Status
136	*Anacardium occidentale*	Anacardiaceae	Cashew	Kashuu	Tree	Food/Economic	Moderate	LC
137	*Anthocleista vogelii*	Gentianaceae	Cabbage tree		Tree	Medicinal	Moderate	NE
138	*Carica papaya*	Caricaceae	Pawpaw		Tree	Food/Economic	Moderate	DD
139	*Citrus sinensis*	Rutaceae	Orange	Oroma	Tree	Food/Economic	Moderate	NE
140	*Cocos nucifera*	Arecaceae	Coconut	Aki bekee /Aku oyibo	Tree	Food/Economic	Moderate	NE
141	*Dacryoides edulis*	Burseraceae	Local Pear	Ube	Tree	Food/Economic	Abundant	NE
142	*Dialium guineense*	Leguminosae	Tamarind	Icheku	Tree	Food/Economic	Moderate	LC
143	*Elaeis guineensis*	Arecaceae	Oil palm tree	Akwu	Tree	Food/soapmaking	Abundant	LC
144	*Ficus exasperata*	Moraceae	Sandpaper tree		Tree	Medicinal	Moderate	NE
145	*Gmelina arborea*	Lamiaceae	Gmelina		Tree	Timber/Medicinal	Moderate	LC
146	*Irvingia gabonensis*	Irvingiaceae	Bush mango tree	Ogbono	Tree	Food/Economic	Moderate	NT
147	*Isoberlina doka*	Leguminosae			Tree	Timber	Moderate	LC
148	*Mangifera indica*	Anacardiaceae	Mango	Mangolo/ Ugiri bekee	Tree	Food/Economic	Moderate	DD
149	*Musanga* spp.	Urticaceae	Musanga		Tree	Medicinal	Moderate	NE
150	*Newbouldia laevis*	Bignoniaceae	Boundary plant		Tree	Medicinal/Boundary Marker	Abundant	NE
151	*Pentaclethra macrophylla*	Leguminosae	Oil bean	Ugba	Tree	Food	Abundant	NE
152	*Psidium guajava*	Myrtaceae	Guava	Gova	Tree	Food	Abundant	LC
153	*Raphia hookeri*	Arecaceae	Raphia palm	Ngwo	Tree	Palmwine	Moderate	NE
154	*Terminalia catappa*	Combretaceae	Almond		Tree	Food	Moderate	LC

IUCN Key: DD: Data Deficient; LC: Least Concern; NE: Not Evaluated; NT: Near Threatened. Accessed 23 August 2024
*: Nature Serve Conservation Status equivalent to IUCN's LC. Assessed 23 August 2024
Source: AN SAPZ ESIA Field Data (2024)

Summary of Vegetation Around Ogboji and Ogbunka

The ecological characteristics of Ogboji and Ogbunka are similar, with the two communities being separated by only a few kilometres. Each site features a primary forest intersected by a valley at the end of the proposed project area. The land is covered with secondary vegetation and cultivated farmland, where yam, cassava, and maize are grown (Plates 4.11 and 4.12). The plates also show the primary vegetation cover found in the respective project areas.

A. Vegetation Photos Around Ogboji

Graded part of the proposed project site. The vegetative dense canopy at the extreme of the photo is a primary forest

Secondary Vegetation cover of the proposed project site in Ogboji

Secondary regrowth forests (Derived Savannah) farmland around the project area

Forest vegetation adjacent to the proposed project location

Plate 4.11: Collage of Vegetation Photos Around Ogboji Project Site

Source: AN SAPZ ESIA Field Data

B. Vegetation Photos Around Ogbunka

9

. Secondary vegetation in the proposed project site in the Ogbunka community

Mix-cropping of cassava, yam, and corn near at the fringe of River Uruokpukpo. A community rep guides the ESIA team during the survey

Primary forest floor covered with fallen leaves and undergrowth. Situated close to River Uruokpukpo

Raffia in the swampy area near the river

Cassava farm within the forest vegetation

Plate 4.12: Collage of Vegetation Photos Around Ogbunka Project Site

Source: AN SAPZ ESIA Field Data

Summary of Vegetation Around Omor

The project site at Omor is characterised by a marshy secondary ecosystem. The dominant cultivated plant is rice, followed by maize, cassava, and melon, as shown in Plate 12. The site also features sparsely distributed oil palm trees, anthills, mango trees, herbs, shrubs, and grasses that act as weeds to the cultivated crops. Primary forests fringe the Otakpu River found within the community (Plate 4.13). The soil is dark, clayish, smooth in texture, and moist.

The proposed Project Location in Omor is a swampy rice field

Forest vegetation fringing the Otakpu River

Mix cropping farm of cassava and corn in the proposed project site at Omor community

Weeds in the farm

Eleusine indica established within the rice field in Omor

Plate 4.13: Collage of Vegetation Photos Around Omor Project Site

Source: AN SAPZ ESIA Field Data

Summary of Vegetation Around Ugbene

The terrain at Ugbene is also a marshy ecosystem. Oil palm trees are sparsely observed. At the time of sampling, the land was being prepared for rice cultivation, as depicted in Plate 4.14. The soil is similar to that of Omor-Orenja: dark, clayish, smooth, and moist. The River Nnamuzu traverses the site, serving as a water source for the rice fields.

Nuke Farm (Swampy rice farm) - Proposed project site in Ugbene

Floating vegetation in stagnant water in Nuke Farm

Nnamuzu river in Ugbene. Forest vegetation flanks the river along its course

Plate 4.14: Collage of Vegetation Photos Around Ugbene Project Site

Source: AN SAPZ ESIA Field Data

4.2.13.2 Summary of Major Identified Plant Families

An analysis of Table 4.45 above by the family shows that the Poaceae Family, represented by 30 species, has the highest species count, underscoring its significance in the local ecosystem, followed by the Leguminosae Family, represented by 18 species. These plants contribute to soil fertility and agricultural productivity due to the presence of nitrogen-fixing bacteria in their root noodles. The Asteraceae Family, known for its flowering plants, ranks third with 10 species, indicating its prominent role in the region's flora.

Cyperaceae (9 species) suggests the presence of sedge-like plants, typically associated with wetlands, aligning with the marshy conditions observed in parts of the study area. Euphorbiaceae (7 species) includes a variety of spurge plants, common in both wild and cultivated forms.

Other families, such as Commelinaceae, Lamiaceae, and Malvaceae, contribute five species each, while Amaranthaceae and Rubiaceae each account for four species. Families like Arecaceae, Convolvulaceae, and Solanaceae show moderate representation with 2-3 species each, while the remaining families, with only 1-2 species, represent less dominant but ecologically significant groups.

These findings are visually summarised in the Pareto graph in Figure 4.27. The graph demonstrates that a few dominant families, such as Poaceae and Leguminosae, encompass the majority of species, while numerous other families contribute fewer species each. This visual representation helps in quickly identifying which families play the most critical roles in the ecosystem, aiding in prioritising conservation efforts.

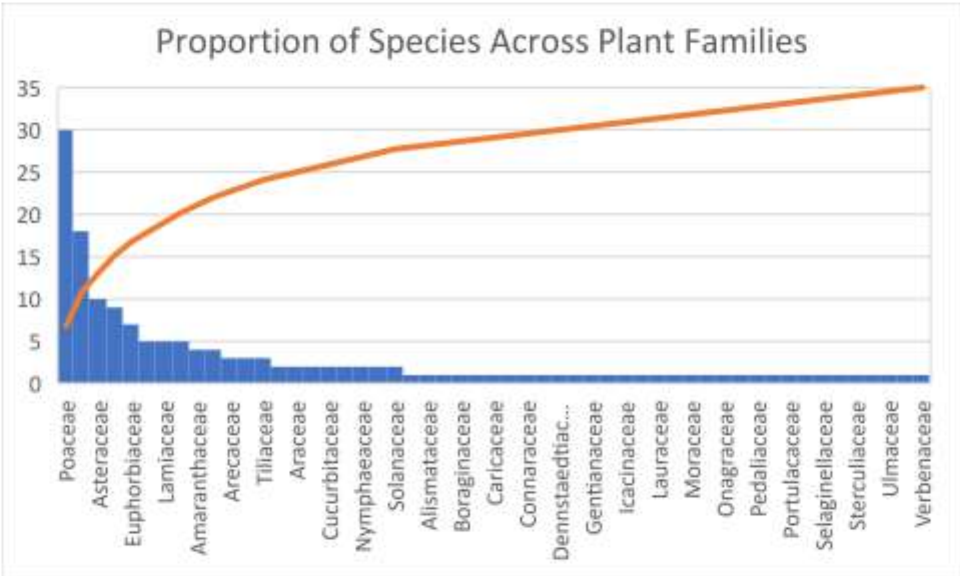


Figure 4.27:5Distribution of Plant Species by Family in Anambra SAPZ II Project Areas

Source: AN SAPZ ESIA Field Data

4.2.13 Wildlife Studies

4.2.12. Wildlife

Traditionally, wildlife is closely associated with animals and other life forms that grow or live in the wild, which were not introduced by humans. However, modern ecological studies recognise that even the most remote wildlife populations are increasingly influenced by human actions, whether directly through habitat destruction and pollution or indirectly through climate change and the introduction of invasive species (Harris and Brown, 2009). As a result, the interaction between humans and wildlife has become increasingly complex, with significant implications for both human society and natural ecosystems. While certain wildlife species can pose risks to human safety, health, and property, such as through the spread of zoonotic diseases, crop damage, or predation, many species also offer substantial benefits. These benefits may be economic (e.g., through ecotourism and sustainable hunting), educational (e.g., as subjects of scientific research and environmental education), or emotional (e.g., through the intrinsic value of biodiversity and its role in human well-being). The conservation and management of wildlife, therefore, require a nuanced understanding of the interconnectedness between species and the ecosystems they inhabit.

Given this complexity and the varying impacts of human activities on wildlife, it is essential to have a clear understanding of what constitutes wildlife. As reviewed by Tian *et al.* (2023), various definitions of the term have been advanced in the literature. Therefore, it becomes necessary to operationally define wildlife in the context of this study.

4.1.12.1 Operational Definition of Wildlife

For the purposes of this ESIA study, wildlife is defined as undomesticated animal species, including mammals, birds, and herpetofauna (reptiles and amphibians) that exist in the study area without direct human cultivation or management. This definition includes species that are native to the region as well as those that may have adapted to the changing environment due to human influence. The assessment will focus on the following key areas:

Species Identification: Identifying and documenting all observed and reported species within the study area is crucial for understanding its biodiversity.

- **Determination of Conservation Status:** Assessing the conservation status of observed species, particularly identifying those classified as endangered, threatened, or vulnerable according to the International Union for Conservation of Nature (IUCN) Red List. Special attention will be given to species critical to the local ecosystem's health and stability.
- **Ecosystem Functions (Optional):** The study may optionally consider the role of key species in maintaining ecosystem functions, such as nutrient cycling, seed dispersal, and predator-prey dynamics. Understanding these functions is critical for predicting potential ecological impacts and designing appropriate mitigation strategies.

4.3.12.2 Importance of This Definition

This operational definition of wildlife allows for a focused assessment of the study area's ecological baseline. By broadening the scope to include species affected by human activities, the study can more accurately predict and mitigate the potential environmental impacts of the proposed project. Moreover, this approach ensures that the conservation needs of both prominent and less conspicuous species are considered, ultimately contributing to more sustainable project outcomes. The definition also aids in managing the scope of the study and meeting its specific objectives.

4.3.12.2 Study Methodology

The methodology employed in the study is described in Section 4.1 of this report. In brief, it includes assessing both direct and indirect wildlife signs within the project areas. Interviews with local residents complemented field observations, particularly for elusive species.

4.3.12.3 Wildlife Composition in the Study Area

Table 4.46 presents a list of encountered and reported species within the project host communities. A total of 29 wild animal species were identified, distributed across different groups as follows: mammals (9 species), reptiles (6 species), birds (11 species) and amphibians (3 species). Though not targeted during the study, the following five invertebrate species were identified during the study: *Achatina achatina* (giant land snail) of Family Achatinidae, *Macrotermes* sp. (termite) of Family Termitidae, *Musca domestica* (housefly) of Family Muscidae, *Zonocerus variegatus* (grasshopper) of Family Pyrgomorphidae, and *Anax imperator* (dragonfly) of Family Aeshnidae.

Rice weaverbirds were common in Omor and Ugbene communities because their main food is rice. In addition, seven non-wildlife (domestic) species were identified around the project areas as shown in Table 4.47. These include *Bos taurus africanus* (cattle), *Canis lupus* (domesticated dog), *Capra hircus* (goat), *Felis catus* (domesticated cat), *Sus* sp. (pig), *Namida* sp (guinea fowl) and *Meleagris* sp. (turkey). All animals are common to all communities. Most of the identified species were either not evaluated or were classified as Least Concern except for *Python sebae* (python snake) and *Cercopithecus sclateri* which were classified as Near Threatened and Endangered, respectively, according to the IUCN Red List.

Table 4.46: Checklist of Wildlife Around the Project Areas (July 2024, Rainy Season)

S/N	Scientific Name	Family	Common Name	Native Name	Abundance	IUCN Status
	Class Mammalia					
1	*Protoxerus stangeri*	Sciuridae	Forest Giant Squirrel	Oke ohia	+++	LC
2	*Thryonomys swinderianus*	Thryonomyidae	Grasscutter	Nchi	++	LC
3	*Atherurus africanus*	Hystricidae	Porcupine		++	LC
4	*Heliosciurus rufobrachium*	Sciuridae	Red-legged Sun-squirrel	Osa	+++	LC
5	*Potamochoerus larvatus*	Suidae	Bushpig	Ezi ohia	+	LC
6	*Cephalophus niger*	Bovidae	Antelope	Mgbasa	+	LC
7	*Crocuta crocuta*	Hyaenidae	Spotted hyena	Nkita ohia	+	LC
8	*Cercopithecus sclateri*	Cercopithecidae	Sclater's Monkey	Enwe	+	EN
9	*Cricetomys gambianus*	Nesomyidae	African Giant Pouched rat	Oke ohia	+++	LC
	Class Aves					
10	*Ploceus cucullatus*	Ploceidae	Rice Weaverbird)		++++	LC
11	*Cypsiurus parcus*	Micropodidae	(African Palm Swift)		++++	LC
12	*Apus affinis*	Micropodidae	(Little Swift)		+++	LC
13	*Nectarinia olivacea*	Nectariniidae	(Olive-bellied sunbird)		+++	LC
14	*Stigmatopelia senegalensis*	Columbidae	(Laughing Dove)		++++	LC
15	*Turdoides plebeja*	Timaludae	(Brown Babbler)		+++	LC
16	*Passer griseus*	Fringillidae	(Grey-headed sparrow)		++++	LC
17	*Plesiositagra cucullatus*	Ploceidae	(Village Weaver)		++++	LC
18	*Anas sparsa*	Anatidae	Duck		++++	LC
19	*Bubulcus ibis*	Ardeidae	Cattle Egret	Chekeleke	++++	LC
20	*Aquila spilogaster*	Accipitridae	Hawk	Egbe	+++	LC

S/N	Scientific Name	Family	Common Name	Native Name	Abundance	IUCN Status
	Class Reptilia					
21	*Boa constrictor*	Boidae	Boa	Eke Ogba	++	LC
22	*Python sebae*	Pythonidae	Python	Eke	+++	NT
23	*Bitis arietans*	Viperidae	Puff adder		++	LC
24	*Dendroaspis polylepis*	Elapidae	Black Mamba		++	LC
25	*Dendroaspis viridis*	Elapidae	Green Mamba		++	LC
26	*Agama agama*	Agamidae	Rainbow Lizard	Ngwele	++++	LC
	Class Amphibia					
27	*Rana temporaria*	Ranidae	Frog	Awo	+++	LC
28	*Rana regularis*	Ranidae	Pond Frog	Mbara	+++	LC
29	*Xenopus Xenopus tropicalis*	Pipidae	African clawed Frog	Awo	++	LC

IUCN Key: EN: Endangered; LC: Least Concern; NT: Near Threatened. Accessed 28 August 2024

Source: AN SAPZ ESIA Field Data (2024)

Table 4.47: Identified Domestic Species Around Project Sites (July 2024, Rainy Season)

S/N	Scientific Name	Family	Common Name	Native Name (Isioko)	Abundance	IUCN Status
1	*Bos taurus africanus*	Bovidae	Cattle	Efi	++	NE
2	*Canis familiaris*	Canidae	Domesticated Dog	Nkita	++++	NE
3	*Capra hircus*	Bovidae	Goat	Ewu	++++	LC
4	*Felis catus*	Felidae	Cats	Nwangba	++	
7	*Meleagris* sp.	Meleagrididae	Turkey	Tolotolo	++	NE
6	*Namida* sp	Numididae	Guinea fowl	Ogazi	++	NE
5	*Sus* sp.	Suidae	Pig	Ezi	+++	

IUCN Key: EN: Endangered; LC: Least Concern; NT: Near Threatened. Accessed 28 August 2024

Source: AN SAPZ ESIA Field Data (2024)

4.2.1.3.1 Mammals

Nine mammal species belonging to seven families were either observed by the project team or reported by locals within the study areas (Table 4.46). These include *Cephalophus niger* (antelope) of Family Bovidae, *Cercopithecus sclateri* (Scateri's monkey) of Family Cercopithecidae, Crocuta crocuta (spotted hyena) of Family Hyaenidae, *Atherurus africanus* (porcupine) of Family Hystricidae, *Cricetomys gambianus* (African giant pouched rat) of Family Nesomyidae, *Heliosciurus rufobrachium* (red-legged sun-squirrel) and *Protoxerus stangeri* (forest giant squirrel) of Family Sciuridae, *Potamochoerus larvatus* (bushpig) of Family Suidaeand *Thryonomys swinderianus* (grasscutter) of Family Thryonomyidae. The overall abundance of these animals was low, except for squirrels, which were observed more frequently. Local testimonies suggest that larger mammals are becoming increasingly scarce, likely due to hunting pressures for both food and economic purposes.

Scateri's monkey, which is classified as endangered in the IUCN Red List highlights the need for targeted conservation efforts. Most of these herbivorous species play critical roles in the ecosystem, such as aiding in forest regeneration through seed dispersal and contributing to plant diversity. Additionally, *P. larvatus* functions as an ecosystem engineer by disturbing the soil, which enhances nutrient cycling and seed germination. Cercopithecus cephus, as an apex predator, helps regulate prey populations, thereby supporting the overall balance of the ecosystem.

4.3.12.2 Aves

Eleven bird species from nine families were identified as shown in Table 4.46. Species identified include *Aquila spilogaster* (hawk) of Family Accipitridae, *Anas sparsa* (duck) of Family Anatidae, *Bubulcus* ibis (cattle egret) of Family Ardeidae, *Stigmatopelia senegalensis* (laughing dove) of Family Columbidae, *Passer griseus* (grey-headed sparrow) of Family Fringillidae, *Cypsiurus parcus* (African palm swift) of Family Micropodidae, *Apus affinis* (little swift) of Family Micropodidae, *Nectarinia olivacea* (olive-bellied sunbird) of Family Nectariniidae, *Ploceus cucullatus* (rice weaverbird) of Family Ploceidae, *Plesiositagra cucullatus* (village weaver) of Family Ploceidae, and *Turdoides plebeja* (brown babbler) of Family Timaludae.

Of these, *P. cucullatus* was particularly abundant in Ugbene and Omor, likely due to the presence of rice fields in these areas. While all species were present across all locations, *C. parcus* was more frequently observed in Ogbunka and Ogboji. Certain species, such as *B. ibis, P. cucullatus,* and *A. sparsa*, were commonly found near wet areas, whereas others like *P. griseus, T. plebeja, S. senegalensis*, and N. *olivacea* appeared to prefer drier habitats. Hawks (*A. spilogaster*) were observed hovering across various locations, without a clear preference for any specific habitat type.

Bird species play vital roles in their ecosystems, from pest control and pollination to seed dispersal and maintaining ecological balance. Their presence and activities help sustain the health and biodiversity of habitats, making them integral components of the ecological landscape. The diversity of bird species observed underscores the ecological richness of the region, highlighting the importance of conservation efforts to protect these avian communities and their environments.

4.2.13.3 Herpetofauna

Herpetofauna play vital roles in maintaining ecological balance and enhancing biodiversity. They act as both predators and prey within the food web, controlling insect populations and serving as food sources for larger predators. Their presence often indicates a healthy environment, as these species are sensitive to changes in habitat quality and environmental conditions (Gibbon *et al*., 2000).

To establish the baseline herpetofauna of the project areas, the ESIA team relied on local guides' testimonies and documented six reptilian species and three amphibian species. The reptiles include *Boa constrictor* (boa) of the family Boidae, *Python sebae* (python) of the family Pythonidae, *Bitis arietans* (puff adder) of the family Viperidae, *Dendroaspis polylepis* (black mamba) and *D. viridis* (green mamba) of the family Elapidae, and *Agama agama* (rainbow lizard) of the family Agamidae, as shown in Table 4.46. Notably, the results indicate a clear dominance of the suborder Serpentes, with *P. sebae* being classified as endangered on the IUCN Red List.

The three amphibian species recorded are *Rana temporaria* and *R. regularis*, both frogs of the family Ranidae, and *Xenopus tropicalis* (African clawed frog) of the family Pipidae. These amphibians play a crucial role in pest control and contribute significantly to the health of their ecosystems.

Among the reptiles, *B. constrictor* and *P. sebae* are non-venomous snakes that kill their prey through constriction, indicating the presence of suitable prey animals and favourable environmental conditions for large snakes. Similarly, the venomous *B. arietans*, *D. polylepis*, and *D. viridis* contribute to controlling prey populations and maintaining ecological balance. On the other hand*, A. agama* occupies a middle position in the food chain, controlling insect populations while serving as prey for birds of prey, snakes, and larger mammals, further supporting ecological equilibrium.

Just like *A. agama,* the amphibian species occupy a middle position in the food web, serving as prey for larger predators and controlling insect populations, helping to maintain the health of aquatic and terrestrial environments. They also reflect the environmental quality of their habitats as bioindicators, being absent in polluted environments (Sumanasekara *et al*., 2015).

In summary, while the reported number of species appeared low, the reported species are vital bioindicators of environmental health. Their presence indicates that the project areas are in relatively good condition, providing suitable environments for biodiversity.

4.3 Socioeconomic Baseline Environment

This section offers a detailed examination of the current social and economic conditions within the project areas, including demographic profiles, economic activities, education levels, healthcare access, and overall living standards. The comprehensive baseline data establishes a thorough understanding of the community's existing conditions, which is crucial for assessing the potential impacts of the project. This understanding also ensures that proposed interventions are effectively tailored to meet the needs and circumstances of the local population.

4.3.1 Study Approach and Methodology

The study adopted a systematic approach to identify, analyse and evaluate the perceived and associated social impact of the proposed project on individuals or social groups within the project host communities. The study consisted of two parts: a desktop part using secondary data to collate information on baseline socio-cultural, economic and infrastructure indices of the study area, and direct studies via consultations (interviews and focus group discussions) and questionnaire administrations to residents to elicit information on resident views on their socioeconomic characteristics, concerns and expectations from the proposed project.

4.3.1.1 Objectives of the Study

The objectives of the study include:

1. To enhance knowledge and identify sensitivities:
    a. Increase understanding of the project's social, cultural, and economic implications for the proponent, community, and residents.
    b. Identify demographic, social, cultural, and economic aspects sensitive to project activities over short-, medium-, and long-term periods.
2. Establish baseline data and recommend measures:
    a. Gather baseline data on the demographic, social, cultural, and economic characteristics of the project host community.
    b. Recommend appropriate mitigation measures (avoidance, reduction, rectification, compensation) for potential negative impacts and enhancement for positive impacts, considering stakeholder attitudes, perceptions and behaviours.
3. Facilitate stakeholder engagement:
    a. Create awareness and foster linkage between individual, group, and regulatory stakeholders and the project proponent.

4.3.1.2 Contextual Meaning of Socioeconomic Factors

Table 4.48 provides definitions of key socioeconomic factors relevant to the project areas, explaining their significance and how they are used in this report to assess the social and economic context of the communities involved. The factors provide essential insights into the social and economic dynamics of the project areas, helping to inform a comprehensive assessment of the communities involved.

Table 4.48:Socio-economic Factors and their Meanings

S/N	Social Features	Significance
1	Demography	The population size and distribution (age, gender, ethnic groupings, population density, sex ratio and education attainment levels.)
2	Livelihood	Main sources of household income, including income distribution among residents.
3	Social Infrastructure	Major means of transportation, domestic water supply, electricity, communication and home ownership.
4	Cultural Properties	Value system, social norms, location and spatial distribution of historical sites, archaeological artefacts, shrines, sacred forests/scenic areas; religion, plants/animal species of cultural value, festivals, marriage practices, and cultural calendar.
6	Perception of the project	The residents] interpretation of the project deliverables and their impact on the environments and sociocultural environment.
7	Health Statistics	Most common illnesses and access to healthcare delivery.
8	Social Structure and Organisation	The settlement history, ethnic groups, social organisation and traditional governance structure.

4.3.1.3 Primary Data Collection

Primary socioeconomic field data-gathering was conducted between 9 and 13 July and between 29 July and 1 August 2024. Notwithstanding, consultation has been a continuous process involving the exchange of ideas and clarification of grey areas between the ESIA project team and community representatives. Primary data in the study area involves eliciting affected communities' members' perspectives on the project. The process begins with a stakeholder analysis followed by engagement. Stakeholder engagement was achieved using focus group discussions and household questionnaire administrations. Combining desktop research, stakeholder analysis, and primary data collection allowed the ESIA project team to establish a comprehensive understanding of the socioeconomic environment and potential social impacts. This information will be used to develop mitigation measures and ensure the project benefits the local community.

4.3.1.4 Identification and Analysis of Stakeholders

A two-pronged approach was used to identify project stakeholders following desktop reviews and a kick-off meeting with the client. Stakeholders were categorised based on an importance and influence matrix (Figure 4.28) to guide consultation efforts.

- **Influence:** Reflects a stakeholder's ability to impact the project (e.g., provide approvals or resources). Examples include government agencies and investors.

- **Importance:** Reflects the project's impact on a stakeholder and their interest in its success (e.g., livelihoods, well-being). Examples include farmers, communities, and farmer associations.

Identified key stakeholders include FGN, ANSG, AfDB, ANSIPPA, Anambra State ministries of Environment, Agriculture and Women and Social Welfare, community groups (women's groups, youths, traditional leaders), farmers' associations, residents, and transportation unions. This analysis, based on influence and importance, categorises stakeholders for focused engagement strategies, promoting successful project management and communication (Kantamaturapoj *et al.*, 2023). More information on statehooder identification and consultation process is presented in Section 4.5.

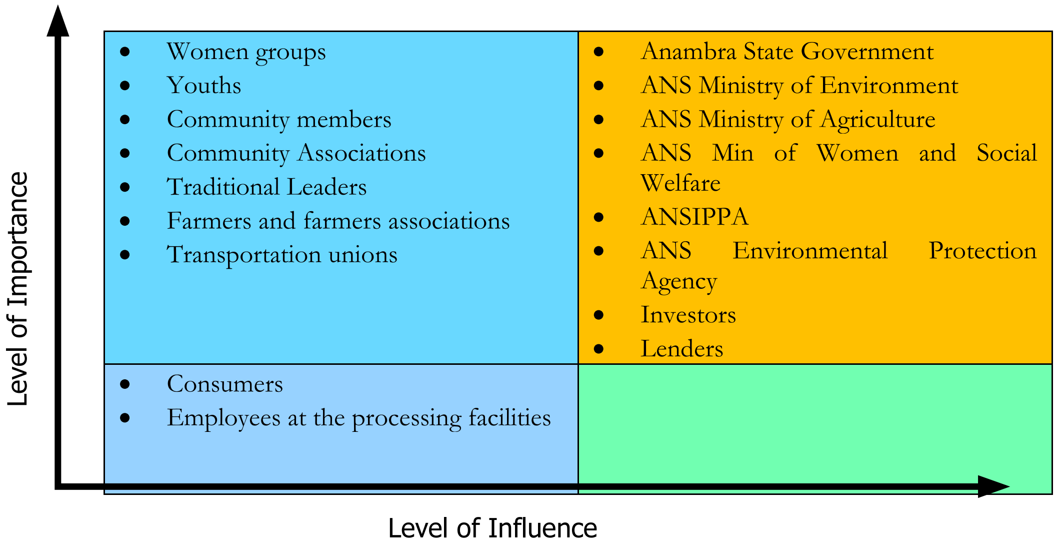


Figure 4.28: Stakeholder Identification and Analysis

During the stakeholder identification process, Aguluezechukwu Town in Aguata LGA was recognised as a key stakeholder due to the project's site in Ogboji encompassing a portion of land belonging to this community. As a result, Aguluezechukwu was actively included in the consultation process, which involved focus group discussions, interviews, and the administration of questionnaires.

4.3.1.5 Stakeholder Consultation

In compliance with the AfDB's Integrated Safeguards System (ISS) (2023) and the FMEnv EIA Procedural Guidelines (2017), stakeholder consultation aimed to ensure broad community support and gain their endorsement for proposed mitigation measures. This involved seeking and obtaining prior and informed consent through meaningful engagement with project host communities. Stakeholders were consulted for input on key documents, including scoping and draft ESIA reports. A consultation register was used to track all stakeholder interactions. The subject of discussion included the nature of the project, benefits, associated impacts and mitigation measures, and concerns and expectations of residents in the project areas. These are presented in Chapter 8 Stakeholder Consultation.

4.3.1.6 Household Survey and Questionnaire Administration

The population of project host communities was taken as the global/statistical population, while the corresponding total number of households in each project host community was considered as the total sampling population. The selection of sampling units and the sampling method were specific to each community. Each community hosting the project was taken as a sampling block. To select sampling units in each community, households were randomly selected as candidate-households for the survey. Residents within the project communities were surveyed using questionnaires and interviews. The questionnaires (Appendix 3) captured demographics, occupation, education, and project and healthcare perceptions. Responses were electronically transcribed and analysed using Microsoft Excel. The Questionnaires were administered randomly based on population distribution within the study boundary. Where the population is densely distributed more questionnaires were administered and where sparsely distributed less were administered. They were verified for QA/QC. A total of 410 Questionnaires were administered to men, women, the elderly and youths of different age brackets. All the questionnaires were directly administered to respondents and were retrieved. Table 4.49, presents details of questionnaire distribution in the study locations.

Table 4.49: Number of the questionnaires administered and retrieved

S/N	Community	Local Government Area	No. of questionnaire administered	No. of questionnaire retrieved	No. Of households surveyed	Average No. of Respondents per household
1	Aguluezechukwu	Aguata	70	70	24	3
2	Ogboji	Orumba South	96	96	32	3
3	Ogbunka	Orumba South	66	66	22	3
4	Omor Town	Ayamelum	98	98	33	3
5	Ugbene	Awka North	80	80	27	3
	Total	**5**	**410**	**410**	**138**	

Source: AN SAPZ ESIA Field (2024)

4.3.2.7 Population projection using the exponential model

The population sizes of the project were estimated using the determined using the following formulae:

$$P_n = P_o\ (1\ + r)^n$$

Where:

$P_o\ =\ Population\ in\ the\ base\ year$

$r\ =\ Estimated\ annual\ growth\ rate\ of\ population$

$$n = Time\ lapse\ in\ years$$

In estimating the population, the base year population was the 2006 Population Census data, published by the NPC. An annual growth rate of 2.8% was assumed (NBS, 2016). The time elapsed between the base year and 2024 is 18 years.

4.3.2 Socioeconomic Baseline of the Project Areas

4.3.2.1 The People of Anambra State

Administratively, Anambra State consists of twenty-one (21) local government areas, with the state capital at Awka. The people are mostly Igbos; however, a small percentage (about 2%) are Igala. The state has three senatorial districts, namely Anambra Central, Anambra North, and Anambra South. The communities closely affected by the proposed SAPZ initiative include Aguluezechukwu community in Aguata LGA, Ogboji and Ogbunka in Orumba South LGA, Omor in Ayamelum LGA, and Ugbene in Awka North LGA. The people are very resourceful and are known for their agricultural production. Rice, sesame seeds, maize, cassava and various vegetables and fruits are cultivated commercially in these agroecological zones (ANSG, 2024). In addition, Orumba is home to the thriving Eke Oko oil palm market, attracting patronages from beyond the state boundaries. The project areas are, therefore, critical to achieving food security in Anambra state. Furthermore, fisheries activities contribute significantly to food security in the state, particularly in riverine areas, where artisanal fishing activities take place, although some fishers may sell their catches to earn additional income for their households (Personal communication with a community member in Ugbene). Understanding these communities' cultural and economic backgrounds, especially their established agricultural practices, is crucial for the success of the Anambra SAPZ II initiative.

4.3.2.2 The Affected Communities

a). Aguluezechukwu

Aguluezechukwu is located within Aguata LGA and comprises seven villages: Enugu, Eziagu, Ifite, Ndiokolo, Ozalla, Uhiehi, and Umuchukwu. Aguluezechukwu shares boundary with Akpo, Ekwuluobia, Ndiowu Ogboji (Agu Uma and Oboofia) and Oko. Major celebrations in the town are: Iri ji ofuu (new yam festival in August; and Aguluezechukwu Day, previously celebrated on 26 December but was recently moved to 2nd January. There is also the Aguluezechukwu Prayer Day which takes place on the 1st of January every year. It involves all indigenes of the town, regardless of personal religious affiliation. Taboos in Aguluezechukwu include the following;

- Ivo ji na akolo ako (Harvesting prematured yam)
- Idina nwunye mmadu (Sleeping with another man’s wife)
- Igbu ochu (Murder)

- Igbu mbe (Killing tortoise)
- Land grabbing

The common crops planted in the community are yam, cassava, maize and vegetables. The Aguluezechukwu market day is called Oye.

Governance Structure: Igwe and Igwe in Council, PG and executives of Aguluezechukwu Improvement Union. Each village had their own village chairman and executives managing their village affairs. The next level of governance is the Ward level and they have 39 of them. This is not the same as a pollical ward as understood for election purposes, it is just the lowest communal governing structure. It is similar to the concept of Umunna or clan.

b). Ogboji

Ogboji is in Orumba South LGA. Neighbouring Villages are Aguluezechukwu, Akpo and Achina in Aguata LGA, Ndiokolo, Ndiokpalaeke, Ndiokpalaeze and Ndiowu in Orumba North LGA, Agbudo, Akpu and Onneh in Orumba South. There are 11 villages in Ogboji namely: Abakwuru, Amaeke, Amangwu, Anihu, Ebiife, Eziagu, Obeagu, Obinikpa, Okpunifite, Uhuala-Amaeke, and Umuokpala. Villages directly affected by the Project in Ogboji are; Amangwu and Ebiife.

Ogboji has a Town Union headed by a president general (PG) and the executive. Each village has a village town union headed by the chairman and his executives. Conflict Resolution in Ogboji starts with the chairman, umunna or the village vigilante group depending on the issue to resolve. From where it can be escalated if not resolved. Igwe is the highest authority.

Festivals in Ogboji include Iwaji (New Yam festival), which is celebrated in September and Oriri Okochi, celebrated to mark the beginning of the planting season in February. Usually starts on an Eke Day. (Source: Ogboji Community Leader)

The deities in Ogboji are Okwubudo and Okpala. Markets in the village are Eke and Afor markets. Afor is the major one. Marriage can take place during market days, but no other social activities, including burial or meetings, can take place on any of the market days. Taboos in Ogboji include; Stealing yam, unere and ite mkpa mmanu (oil). Offenders are ex-communicated from interacting with other members of the village which means such persons cannot buy or sell in the community. (Source: Ogboji Community Leader).

c). Ogbunka

Eziagu, Nawfija, Owerre-Ezukala, Ufuma, Umuchukwu (formerly Nkerehi), and Umunze in Orumba North, Anambra State; Eziama Nneato in Umunnochi LGA, Abia State and Awlaw in Oji-River LGA, Enugu State. The Project Site is in Isiokpu Village, Ogbunka.

Ogbunka has a Town Union headed by a president-general and the executive. Each village has a Village Town Union headed by the chairman and the executive. Conflict resolution in Ogbunka starts with the chairman, umunna or the village vigilante group, depending on the issue. From there, it can be escalated, if not resolved. Igwe is the highest authority.

Festivals in Ogbunka include; Iwaji (New yam festival) - celebrated in September. Each village in Ogbunka has their celebration before the commencement of the farming season in Feb/March. Such celebrations include; Erichaa a puo oru, Oganihu (Umunoke Village) and Odinma ofu akwuoba. Markets in the village are Eke and Afor markets. Afor is the major one. Taboos in Ogbunka include no marriage between members of the same Umunna (Kindred), stealing yam, unere (green banana) and ite mkpa mmanu (oil). Offenders are ex-communicated from interacting with other members of the village which means such persons cannot buy or sell in the community. (Source: Ogbunka Community Leader).

d). Omor

Omor is a town in Ayamelum LGA. There are eight towns in Ayamelum: Anaku (Headquarters), Ifite Ogwuala, Igba-akwu, Omor, Omasi, Umueje, Umuerum and Umumbo.

Omor is made up of four quarters: Orenja, Akanato, Aturia and Amigwe. The proposed project location is in the Orenja Quarter, which has four villages: Isiokwe, Umuokpanta, Ezeonyia and Umuuzu. The immediate project community is Isiokwe-Orenja. Orenja shares borders with Amikwe and the towns of Umuerum and Umumbo.

Communities sharing boundaries with Omor include Anaku, Umuerum, Umumbo, Ifite Ogwuari, and Igbakwu in Ayamelum LGA, Anambra State and Ogbosu-Umulokpa in Uzo Uwani LGA, Enugu State.

The community governance of Omor is led by the Igwe and his Igwe-In-Council. Each village has a Development Union, for example, the Isiokwe Development Union but there is no collective Development Union or any other body at the quarter level. However, the executives of each village discuss any issues that affect their quarter. At the village level, matters affecting the villages are discussed with the exco (headed by the chairman) and the Ndiichie. They are also the peace committee and the first point of contact for resolving crises or disagreements in the village. It is forbidden to steal in the community and is punishable by excommunication. Fighting in public is also forbidden and is punished by a fine. Abortion is also forbidden.

Festivals celebrated in Omor Town include:

1. Ofala: Celebrated by Igwe
2. Aja Ani Ukwu Day - The town's deity is celebrated in February or March. The festival is in honour of Aja Ani Ukwu and to thank it for general protection and Prosperity
3. Iwaji (New Yam festival) - Celebrated in August/September

1. Ajaegwu Festival - Celebrated in August/September. It is a celebration that takes place immediately or at the same time as Iwaji. Ajaegwu is personal Chii (god). The festival is appeasement and thanksgiving to Personal Chi.

2. Another deity in Omor is Nnemurunn, which is celebrated by adherents. (Source: Omor town Leader).

Omor is a big rice-producing area. Fadama III is located adjacent to the project site and supports agricultural activities in the town by providing tractors for hire. There is a rural electrification project on the same land as Fadama where a solar farm has been installed, which supplies light to the community. Each quarter in Omor has a primary school and a primary health centre.

e). Ugbene

Ugbene is in Awka North LGA. It comprises 6 villages namely; Enuagu, Ifiteora, umuagu Nwokwe, Umuemem, Umualo and Umunokwam. The project's proposed location is Nuke Farm, owned by the people of Ugbene collectively.

Ugbene shares boundaries with Oba Ofemiri, Ugbenu, and Achalla in Anambra State as well as Ogulogu in Eziagu LGA, Enugu State. The Community Governance of Ugbene is led by the Igwe followed by the Igwe-In-Council, the PG and the Executives of Ugbene Progressive Union followed by the Chairman and Executives of Each Village Union.

Notable Festivals in Ugbene are:

1. Ibone – Mmanwau celebration. It’s a four-night and four-day celebration, so a total of eight days. The night celebration features Obianuchichi masquerade which comes out at about 9 pm until dawn. It is forbidden for women to participate in this festival. After four nights, the daytime masquerade celebrations start, which women can participate in.

2. Iwaji (New Yam Festival): It takes place in the middle of October, around 15 or 16. This is a bit different from what is obtainable in most other villages where it takes place in August or September.

3. The Egwu Arusi Festival: In honour of the town’s deity known as Ofe Ugbene. It is celebrated in March or April. (Source: Ugbene Community Leader)

Taboos in Ugbene include abortion and murder. Murder used to be punished by death, however, recently, perpetrators would be handed over to law enforcement agencies. If someone commits an abortion in secret, there is nothing the community can do unless the person starts to suffer some mysterious misfortune. Then such a person will need to confess to Ofe Ugbene and do reparations and sacrifices prescribed by the priest of the deity.

4.3.2.1 Traditional Governance in the affected communities

Traditional institutions play an important role in various spheres of the state and society at large. These institutions existed in the past, and they were necessary for the normal functioning of a good society, but now they are being integrated into local governance to play a big role in Anambra state. The traditional institutional arrangement in communities studied within Anambra State is comprised of the traditional rulers, council of elders or chiefs, market women or women groups, youth community associations, and age groups. Based upon centuries-old practices, it provides critical leadership, often acting as a "custodian and repository" of the traditional "social system/values" of the indigenous communities. Alongside, it is entrusted by law with important public duties on land and revenue administration, protection and management of natural resources of the community, administration of the tribal judicial system and the provision of advice to the government authorities (ADB, 2001). The high stratification system is characterized by a council of kingmakers which exists to install a new traditional ruler (Igwe) and to work toward making the Igwe operate within his traditional responsibilities.

In the surveyed communities, there are also other social titles, such as; The Ezeji (yam lord). Chieftaincy titles are very common and highly regarded. They include Igwe (king), Okenze, Nze, Ozo, Durunze and more. The project host communities are made up of villages which consist of several compounds. Each compound is based on patrilineal relationships. Status is accorded to the male in order of seniority despite whether the family is polygamous or not. In the family, therefore, the first son is the head and is entrusted with the family heirlooms like Ofo na Ogu, Chi, and Obi. The first son (known as Okpala) holds the symbol of the family authority.

Within the family, there are two Igbo positions of esteem which are formally institutionalized. These are Okpala (first son) and Ada (first daughter). The Okpala and Ada, are accorded higher status in the Igbo family. In a monogamous family, the birth order follows. The younger is required to defer to the older brother(s) or sister(s). This seniority and respect accorded to old age is one of the fundamental beliefs among the Igbos. Elders are generally respected and honoured. Elders are often approached in both good and bad times for advice. A leader is always expected to speak the truth at all times. The village head often combines the village priest. An elder may equally be a titled person who presides over traditional functions in the family compound and in the village. There is also a President General and the Executives of different Progressive Unions in the villages, who are part of the traditional governance structure in the communities.

4.3.2.2 Cultural Festivals in the Project Host Communities

The project host communities have a rich cultural heritage deeply rooted in Igbo traditions. According to information obtained during interviews with residents, the communities celebrate various traditional festivals, ceremonies, dances, and music that reflect the customs and beliefs of the Igbo people. These cultural practices are prominently showcased during social gatherings and events.

In Isiokpu Village, Ogbunka, Orumba South LGA, notable cultural festivals include the New Yam Festival and several village-specific celebrations that precede the planting season in February or March. These include Erichaa A Puo Oru, Oganihu (Umunoke Village), and Odinma Ofu Akwuoba. In Ugbene Town, Awka North LGA, cultural festivals such as Egwu Arusi (held between January and February) and Onwa Ito (celebrated before cultivation) are observed. Meanwhile, Amangwu Village in Ogboji, Orumba North LGA, uniquely celebrates the Iri-Ji (New Yam) Festival, which marks the end of the farming season.

4.3.2.3 Cultural Beliefs in the Project Host Communities

It is sacrilegious to steal yam, kola nut and palm oil in the project host communities, according to the residents. The punishment for this is banishment from the communities. It is also a taboo to marry among the kindred (Umunna). A widow in these communities is forbidden from trading in the village markets for a year following her husband's death. These are some of the taboos in the project host communities, which are respected by all residents of the communities.

4.3.3 Demography

Anambra State has a growing population, with data from the National Population Commission (NPC 2006) revealing a population of 4,177,828 (50.96% male, 49.30% female) during the 2006 National Census. A notable demographic feature is the high proportion of youth. The population distribution for the project's Local Government Areas (LGAs) reflects this trend, with an average of 79.3% of the population under 40. This young population presents both opportunities and challenges. While a youthful workforce can fuel economic growth and innovation, it also carries the risk of unemployment and underemployment if not addressed properly. Investments in quality education, vocational training, and job creation are crucial to harnessing the potential of this demographic.

Meanwhile, Anambra State's estimated annual population growth is 2.8% according to the data from the NBS and NPC (nd). The annual growth was assumed to be the same across all the local government areas in the state. Based on the 2005 population Census data and the growth rate, the population of Anambra State in 2024 is about 6,867,942.

Table 4.50 shows the population distribution by gender and youth contribution of the project LGAs during the 2006 census. The population mirrors that of Anambra State in having a high proportion (approximately 79.3%) of youths under 40. The success of the Anambra SAPZ II project provides an enormous opportunity for employment opportunities for this demography in the area.

Table 4.50:: Historical and Estimated Population Distribution of Project LGAs by Sex

S/N	LGA	Male 2006	Male 2024	Female 2006	Female 2024	Total 2006	Total 2024
1	Aguata	**81,996**	90,370	**87,777**	94,062	**169,773**	**184,433**
2	Awka North	54,973	**133,263**	**57,219**	126,724	**112,192**	**259,987**
3	Ayamelum	81,065	**134,793**	77,087	144,297	**158,152**	**279,090**
4	Orumba South	**93,199**	153,210	91,349	**150,169**	**184,548**	**303,379**
	Total	**81,996**	**90,370**	**87,777**	**94,062**	**69,773**	**1,026,889**

Source: 2006 Data (NPC/NBC); 2024 Estimate by the AN SAPZ ESIA Based on NPC/NBS Data

4.3.3 Livelihood Parameters

The life expectancy of Anambra state is 56 years. The child mortality rate is low in Anambra state compared to other states in the southeast region. Anambra registered 35 deaths at infant per 1000 births.

4.3.4 Household Characteristics

Household characteristics capture the respondent's demographic factors like age, sex, marital status, occupational and social organisational profile, household size and level of employment.

4.3.4.1 Age distribution

From the results obtained, the majority of the respondents fall within the age bracket of 31-45 in Ogboji and Ugbene communities while in Ogbunka, Omor and Aguluezechukwu majority of respondents were within the age bracket of 46-60 years. The age distribution shows a large base (for the middle age groups) and narrows towards the older age group of 61-70 years. The largest percentage of total respondents interviewed fall under the middle age brackets.

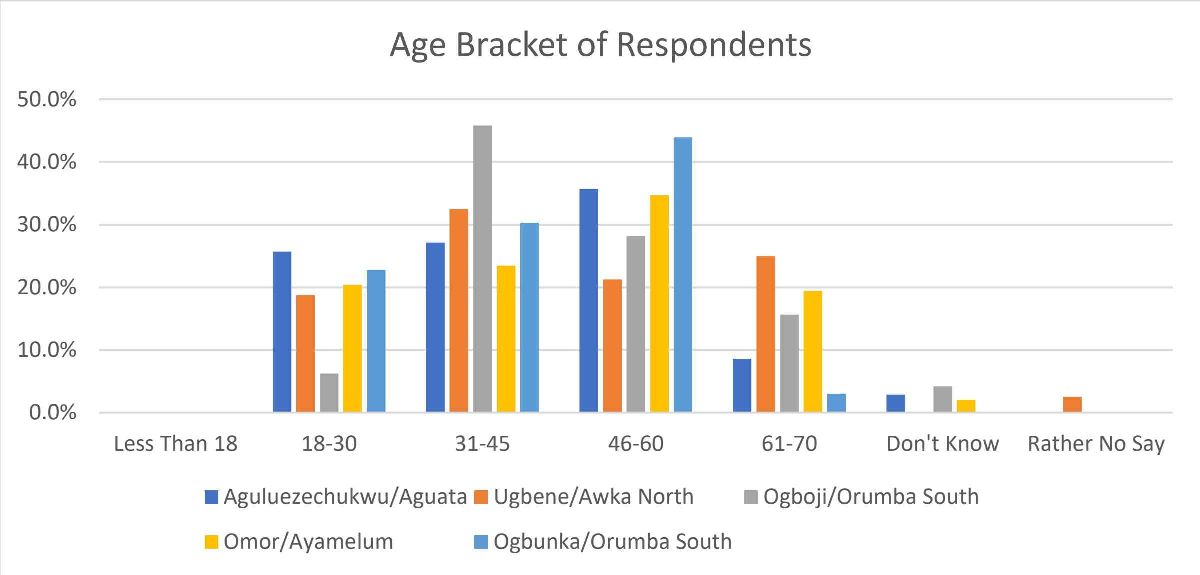


Figure 4.29:Age Bracket of Respondents
Source: AN SAPZ ESIA Field Data (2024)

4.3.4.2 Distribution of Respondents Based on Gender

The result shows male dominance across the five communities except at Ogboji which showed female dominance among the respondents. The sex composition showed that the overall male population was higher than that of females. The males outnumbered the females.

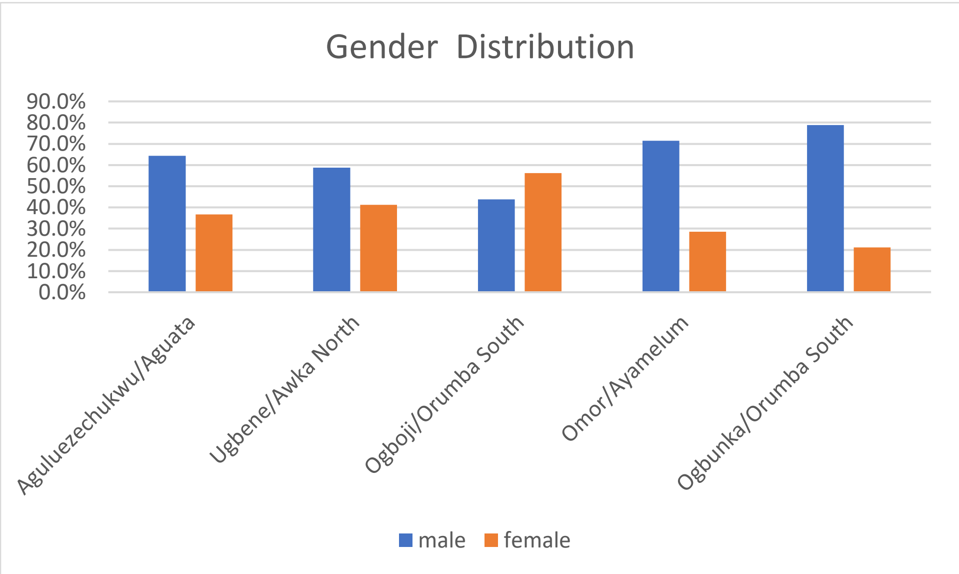


Figure 4.30: Respondents Gender Distribution

Source: AN SAPZ ESIA Field Data (2024)

4.2.4.3 Marital Status of Head of Households in the Communities

There are more married household heads in all the communities within the Anambra state SAPZ project. The result for all marital statuses is slightly above those obtained from NBS, 2011. Figure 4.31 presents the marital status of Household heads in the five communities surveyed.

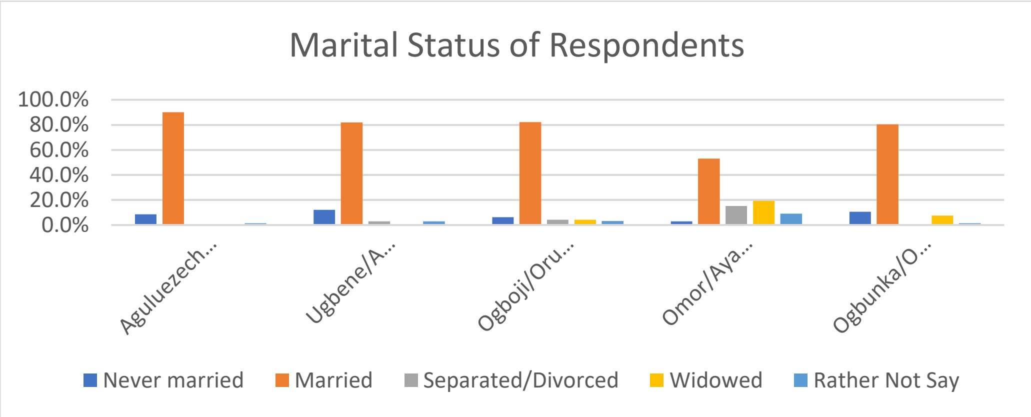


Figure 4.31: Marital Status of Household Head in the Communities

Source: AN SAPZ ESIA Field Data (2024)

4.3.4.4 Household Size

Information on the household size in the five communities is presented in Figure 4.32. The findings indicate that respondents in Aguluezechukwu, Ugbene, Ogboji and Ogbunka communities have dominant household size within the bracket of 5 and 8 persons per household while in the Omor community, the dominant household size of respondents falls within the above 8 persons per household. Generally, the findings show that the majority of the respondents are members of large families with huge dependents. The findings are in tandem with 2010 NBS statistics which put the average family size in Anambra State at 4.5 persons. At the national level, the number of persons in the size class 3-8 was about 136 million. In respect to any form of project implementation in the communities which will affect the available farming land in these communities, there is likely to be a disruption of economic activities or sources of income as these communities are agrarian, hence, this may have a detrimental effect on the dependents such as a drop in available household income as well as available food.

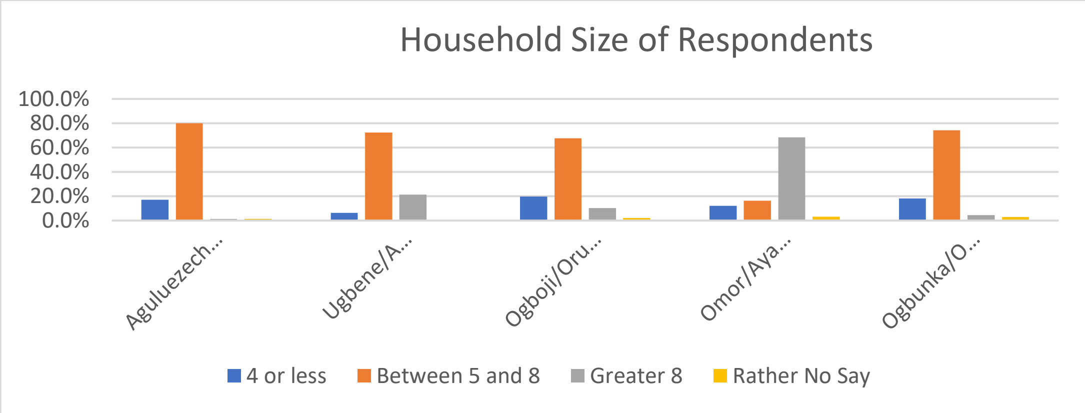


Figure 4.32: Household Size of Respondents

Source: AN SAPZ ESIA Field Data (2024)

4.3.4.5 Ethnic Composition

Ethnic composition in the five communities is homogenous as only the Igbo ethnic group was recorded by all respondents in the five communities. Other ethnic groups were observed to be absent within the project areas. The ethnic groups and their respondent populations in each affected community are presented in Figure 4.33. The data revealed a dominance of the landowners (Ibo) where the proposed project is to be sited. The results also revealed a poor relationship between the project area and the contiguous ethnic groupings. This was evident in the absence of other ethnic groups in the five communities.

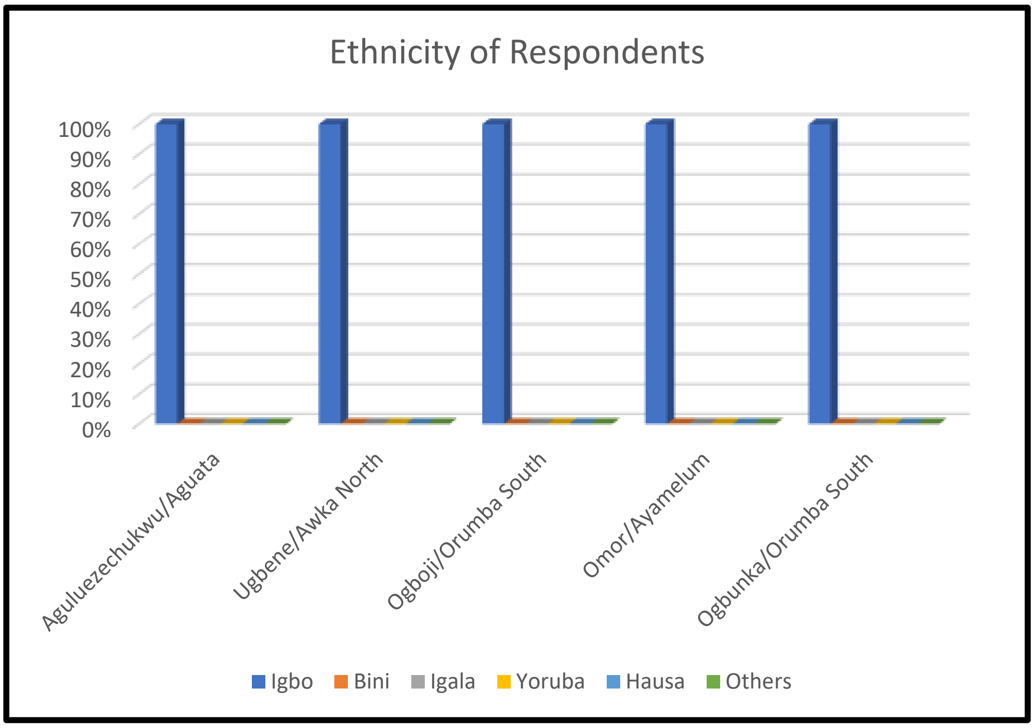


Figure 4.33:: Ethnic Groups in the five communities of the Project Area

Source: AN SAPZ ESIA Field Data (2024)

4.3.4.6 Religion

The study revealed that the people are adherents of two religions. These are Christianity and Animist/ African Traditional Religion (ATR). Christianity was the most practiced religion with 100% of the respondents in Aguluezechukwu and Ogbunka accounting for Christianity as their religion while in Ugbene and Ogboji 84% and 94% of respondents respectively accounted for Christianity. However, in the Omor Community, the African Traditional Religion was dominant as 56% of respondents indicated ATR as their religion.

The majority of the Christians in the project area are Catholics among other denominations. The African Tradition and Christian adherents in the area observe the worldwide traditional religious festivals. Traditional festivals offer opportunities for the people to seek divine favour, prosperity, bumper harvest, peace, security, long lives and good health for the communities.

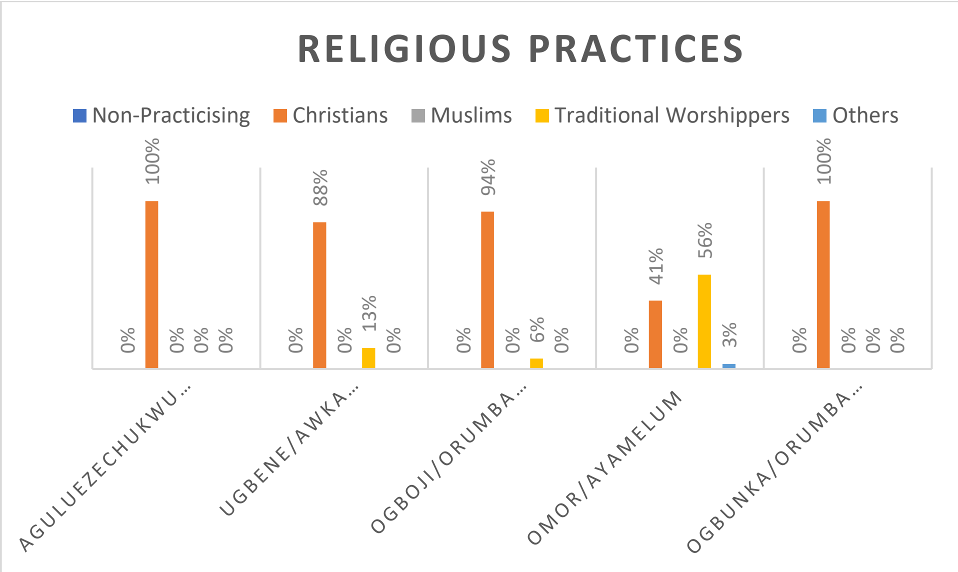


Figure 4.34: **Religious practices of Respondents in the five surveyed communities**
Source: AN SAPZ ESIA Field Data (2024)

Plate 4.15: Place of worship in Ogbunka Community
Source: AN SAPZ ESIA Field Data (2024)

4.3.5 Economics and Livelihoods of Households

4.3.5.1 Formal Education Level of the Respondent

Figure 4.35 below presents the levels of formal education attainment of the respondents in the five communities surveyed.

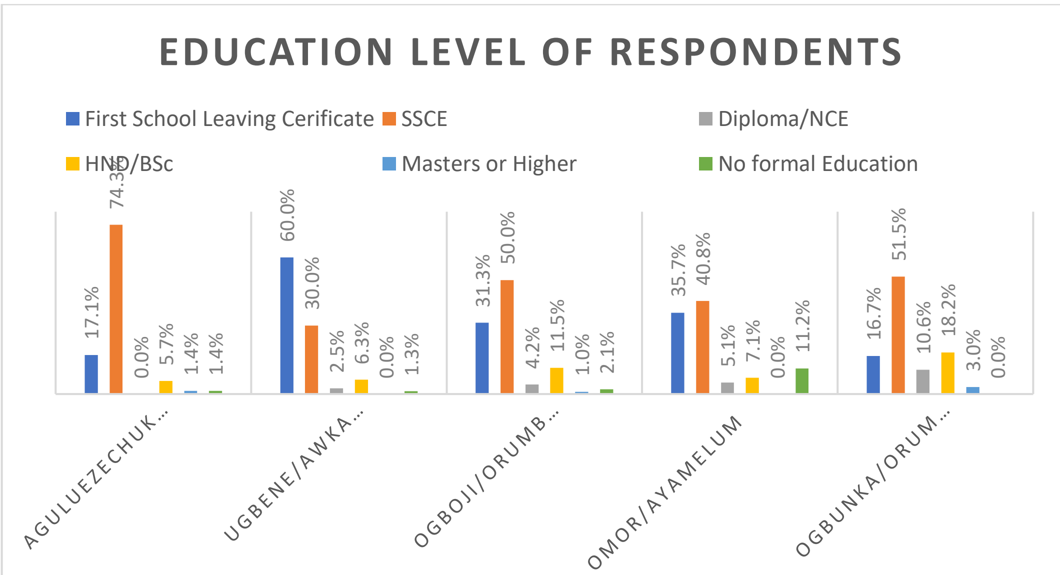


Figure 4.35: Highest Educational Level of the Respondents

Source: AN SAPZ ESIA Field Data (2024)

The result shows that the respondents with no formal education attainment in Aguluezechukwu, Ugbene, Ogboji, Omor and Ogbunka communities are only about 1.4%, 1.3%, 2.1%, 11.2% and 0.0% respectively. Omor town recorded the highest number of respondents without formal education while Ogbunka recorded 0%. Respondents with First School Leaving Certificate and SSCE are dominant across the five communities which depicts a low level of formal education attainment among the respondents. A higher level of formal education attainment is presented in Ogbunka than in all other 4 communities surveyed. A high level of formal education attainment increases the level of knowledge of the importance of development projects in a place and may increase the level of acceptability of the project in the selected communities. However, the educational level of First School Leaving and SSCE which are dominant in the communities seem sufficient in understanding and accepting the project across the communities as the project was introduced to the communities in the local language to aid understanding and feedback from the respondents.

4.3.5.2 Occupational Profile of People in the Selected Communities

The result of the occupation profile of the respondents is shown in Figure 4.36 below. The data on the occupational distribution of the people in these communities is done using multiple responses since each person can engage in multiple occupations.

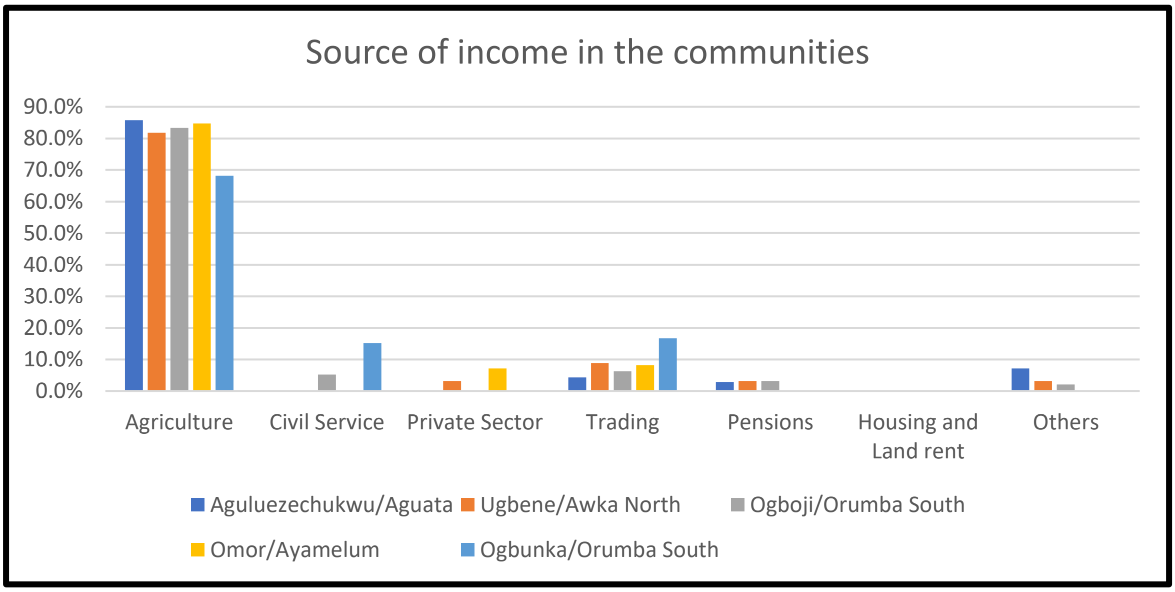


Figure 4.36:: Occupational Distribution of the Respondents.

Source: AN SAPZ ESIA Field Data (2024)

The result shows that Agriculture is the prevailing occupation of the people in the surveyed communities with the Aguluezechukwu community in Aguata LGA recording the highest in agricultural activities (85.7%) followed by Omor town (84.7%). Trading is the second predominant occupation in the communities studied.

Plate 4.16: Small-Scale Oil Palm Processing Facility in Ogboji

Source: AN SAPZ ESIA Field Data (2024)

Plate 4.17: Small-Scale Rice Processing Mill in Omor, Left Stone Machine

Source: AN SAPZ ESIA Field Data (2024)

4.3.5.3 Income of the Surveyed Communities in Anambra.

Crop farming, trading, artisanship, livestock rearing, processing of farm produce and self-employment are the income-generating activities of the people in the project area. The majority of the respondents did not disclose their monthly income across the five communities surveyed. From the findings, the dominant monthly income range of the respondents falls within N50,000-N100,000. In the Ogboji community, the dominant monthly income range of respondents who disclosed their monthly income is from N0-10,000 which indicates a widespread poverty situation. The N10,000-30,000 and N30,000-50,000 monthly income ranges were dominant in Omor town. Generally, the monthly income range of respondents is low depicting a wide spread of poverty.

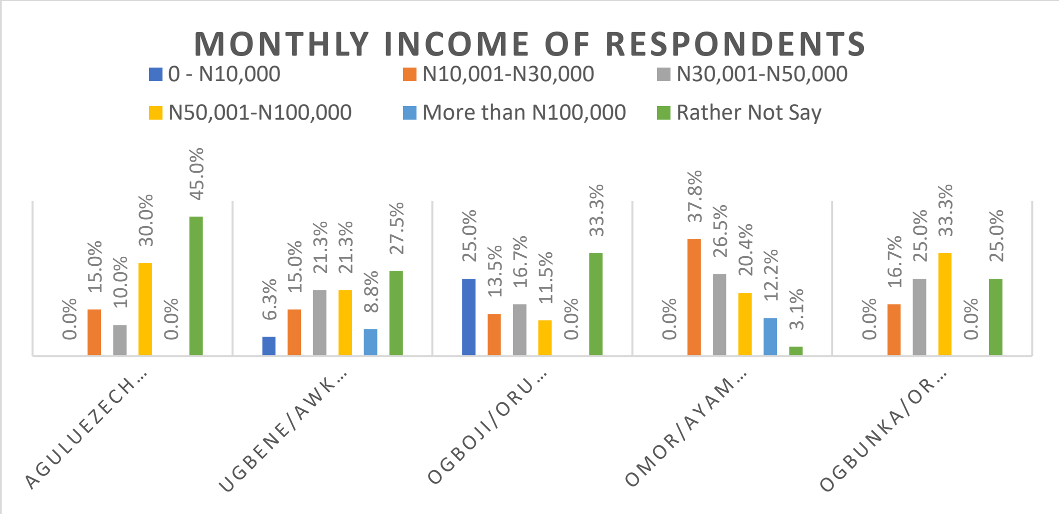


Figure 4.37: Monthly income of respondents
Source: AN SAPZ ESIA Field Data (2024)

4.3.5.4 Link between Income and Poverty Among Respondents

The income disparity of the respondents may be conceptualized as a dispersion of the welfare status of the population and may explain a dimension of poverty. Where the majority of the populace falls at a common base in wealth status while a few individuals are at the top rank of wealth in a region, it can create a wide disparity in consumption expenditure of different households, thus leaving some in perpetual poverty while a few remain in affluence (Adeola and Dopper, 2011). This means that the increase in the cost of living is stimulated by the disparity in the standard of living of these two extreme income groups. It is therefore possible to attribute the widespread poverty situation in the project host communities to income-induced poverty.

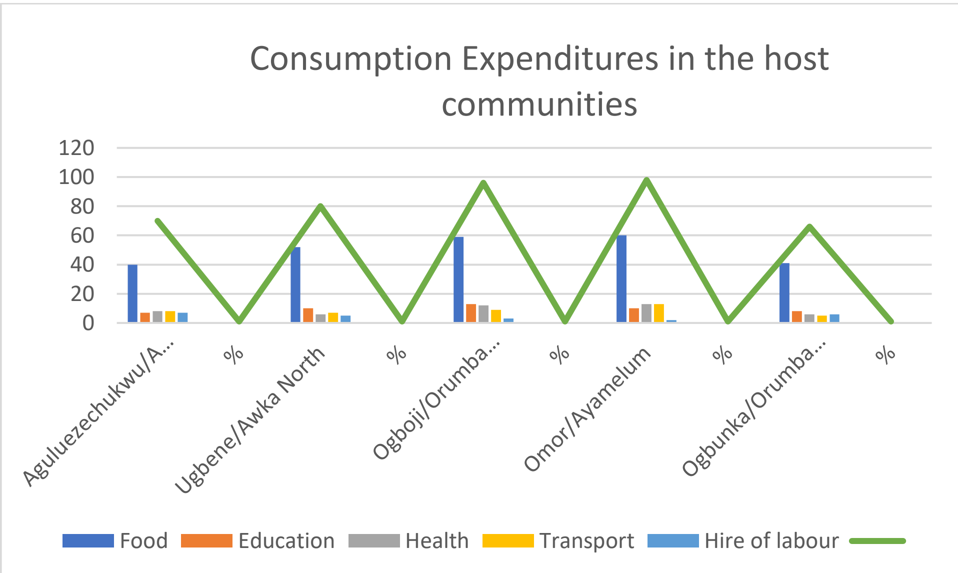


Figure 4.38: Consumption Expenditures in the surveyed communities
Source: AN SAPZ ESIA Field Data (2024)

Respondents were asked to rank 5 items in their monthly expenditure in their order of importance. Food, healthcare, Transport and Education were ranked 1st, 2nd, 3rd and 4th. Labour Hire expenses were identified as the least in the domestic priority list of households.

4.3.5.5 Households' Main Source of Energy

From the survey, sources of energy used by households in the project area revealed that electricity from the national grid is the main source of energy. Other frequently used energy sources for lighting are Kerosene lamps and petrol-powered generators. Conversely, torchlight, wick lamps, solar and candles were the least sources of energy used for lighting by the respondents. On the other hand, fuelwood is the dominant energy source used for cooking in the five communities surveyed while electricity from the national grid is the least. This is attributed to the higher cost of electricity when used for cooking than wood and charcoal. According to the respondents, fuel wood is more affordable to them for cooking, which also has serious environmental implications.

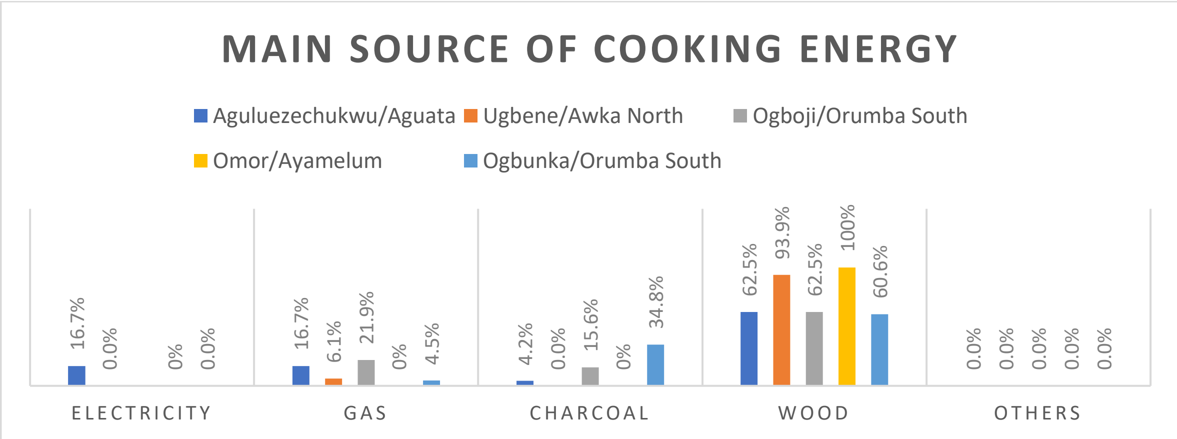


Figure 4.39: Respondents main source of cooking energy

Source: AN SAPZ ESIA Field Data (2024)

4.3.6 Vulnerable Groups

The category and number of vulnerable groups in the project communities were identified and analysed as shown in Figure 4.40. This was compiled with assistance from the village heads. Only one person was living with disability in the Ugbene community. The other communities showed no persons living with a disability. Out of 410 respondents across the five communities, only one person indicated to be living with disability as a result of left arm amputation.

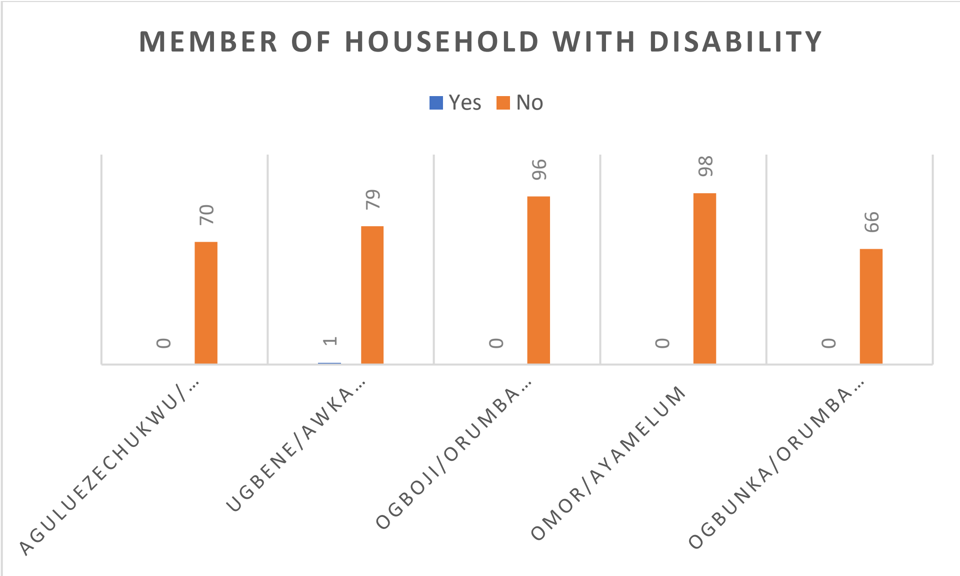


Figure 4.40: Number of persons living with disability in the communities
Source: AN SAPZ ESIA Field Data (2024)

4.3.7 Social Amenities and Infrastructure

Socio-cultural and economic activities as well as social infrastructures in the communities such as structural organisation of the area, types of religion, private and government-owned institutions, level of income and expenditure, employment and dependency ratio, poverty profile etc. were discussed in this section of the study.

4.3.7.1 Government and Private Institutions Present in Project Host Communities

The presence of public and private institutions in the project host communities is presented in Table 4.51 below. The presence of some primary, post-primary and higher institutions in a place is a drive to the socio-economic development of the people.

Table 4.51:Number of Public and Private Institutions across the Selected Communities in Anambra State, Nigeria

Category	Ogbunka	Ogboji	Ugbene	Omor	Aguluezechukwu
No. of Primary schools	2	2	3	3	2
No. of Secondary Schools	2	2	1	2	1
No. of Higher Institutions	0	1	0	0	0
No. of Hospitals	2	2	3	2	2
No. of Restaurants/Hotels	3	1	2	4	2
No. of Churches	5	3	5	4	5
No. of Mosques	0	0	0	0	0
Markets	2	2	1	2	1

Source: AN SAPZ ESIA Field Data (2024)

The selected communities have the presence of both private and government-owned primary and secondary schools. However, there are several reports of poor maintenance of these schools making the people to choose private schools as an alternative. The deplorable condition of both primary and secondary schools in the five communities is a source of concern. There are no tertiary institutions in the selected communities except for St. Peter's University located close to Ogboji community. The selected communities have well markets situated for daily activities or operate on the traditional market days. Omor town has fadama III project and a solar mini grid.

Plate 4.18:: Fadama III project in Omor town

Plate 4.19: Solar farm project in Omor town

4.3.7.2 Transportation and Communication in the Project Host Communities

Road transportation is most dominant in Anambra state. The road system of transportation provides easy access to the communities surveyed. However, the major access roads which comprise both the state and federal roads are the ones that have been tarred and are in good condition. Some minor roads which lead to the villages after branching off the major roads are however in untarred conditions and can be said to be in averagely poor conditions. Although members of the project host communities have formed community development associations to maintain the roads, movement of vehicles is difficult due to the presence of excess sand or erosion of soil in the area.

Additionally, it was observed that commercial buses limit their movement to the major access roads and the State Government had put a ban on motorcyle movement on these roads.

Tricycles have become the vehicle of choice for movement in the communities. They also operate charter services for those interested in moving to areas where there are no assigned. Other means of transportation employed by residents of the communities include cycling and walking to get to their destinations.

Residents in the project host communities visited have access to mobile phones and the internet. However, it was observed that for certain networks, the connection signals are unstable causing loss of calls during transmission or loss of service for periods of 2 minutes or less. Additionally, some residents also have connections to subscription-based television services. Information is mainly passed to the residents through town criers.

4.3.7.3 Security and Other Social Issues in the Project Host Communities

4.3.7.3.1 Causes of Violence and Violent Conflict in the Host Communities

Respondents were to identify the common causes of violence and violent conflict in the host communities. 16.7%, 52% and 2.0% of them indicated land dispute, robbery attacks and communal/ethnic crisis, respectively. 29.3% identified 'Other Factors'.

4.3.7.3.2 Presence of Security Agencies

The Nigeria Police is responsible for protecting lives and properties and maintaining law and order within the project host communities. Communities have vigilante groups that secure the communities internally. Police stations and police posts are seen at strategic places to curb crime. Police anti-robbery squad and patrol teams, patrol day and night to ensure security of lives and properties in the communities.

4.3.8 Housing and Living Conditions

4.3.8.1 Housing Types

In all the communities surveyed, there was a mix of housing types ranging from modern houses built with bricks to mud houses which were predominant in most of the communities. While the modern houses appear conducive the same cannot be said of the mud houses most of which were poorly ventilated, with poor flooring and roofing materials. Most of the houses lack toilet facilities therefore human wastes were often disposed into the surrounding bush.

Data from this study revealed that 47.3% of the houses that respondents live in are houses built with cement block and zinc roof, and 36% were houses built with cement block and asbestos roof. One common feature in most of the rural communities is that an average of 3 persons sleep in a room. Overcrowding is depicted in many of the houses and this will facilitate the spread of communicable diseases.

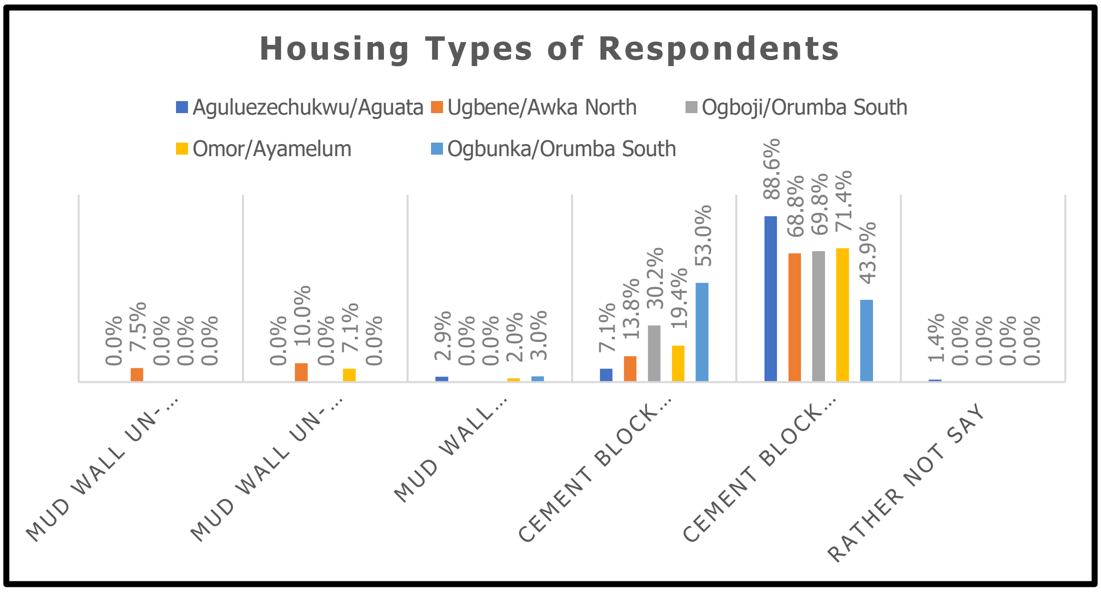


Figure 4.41: Housing types of respondents
Source: AN SAPZ ESIA Field Data (2024)

4.3.8.2 Land Use Land Planning and Uses

Land ownership in the project site is either by community or family. However, under the Public Lands Acquisition Law, the state government may acquire land compulsorily for public purposes from individual landowners, subject to the payment of compensation to such landowners. The way leave is served by the existing road infrastructure and other rural roadways from which access along the way leave is provided.

The residential areas are mostly rural settlements. The population in the Project Affected communities is predominately made up of low and middle with few high-income earners. Access to financial institutions especially in rural communities is very poor as there are none within these areas. The residential areas and the surrounding sub-places consist mostly of single-unit residential homes. On the other hand, the rural settlements (all other communities except the listed semi-urban/urban) are sparsely populated with low-cost, single-unit dwellings on small stands.

4.3.8.3 Waste Management in the Project Host Communities

Residents in the communities visited have put methods in place to take care of generated waste. They have cultivated a cleanliness culture in waste gathering and disposal in their environment. Additionally, a comprehensive waste management system is practised in the state. Other methods of waste and refuse disposal such as burying waste, dumping in approved and unapproved sites, and burning after accumulation are still in practice across the state.

4.3.9 Conflict Resolution Method/Mechanism in the Project Host Communities

The project host communities have unique ways of managing conflict. The methods stressed the need to foster a spirit of peace and mutual respect for both individuals and groups, in times of peace and in times of conflict within the communities. This is effectively ensured through the institutions of the council of elders and traditional rulers in the communities surveyed. Various forms of conflict were identified as common in the communities. These conflicts include gender-based violence, land-related conflicts, family conflicts and value-based conflicts, among others. All these conflicts are managed by the council of elders and traditional rulers when issues are reported to these groups of persons.

4.4 Perception About the Project

All 410 respondents across the project areas expressed their support for the SAPZ II project. When asked about their principal reasons for backing the initiative, respondents highlighted improvements in agricultural production, local economic activities, food security, and employment opportunities, as shown in Figure 4.42.

In Aguluezechukwu, improving economic activities (24%) was the main reason respondents cited for supporting the project. Employment opportunities (16%) and access to modern agricultural facilities (10%) are also significant factors. 13% of respondents preferred not to say.

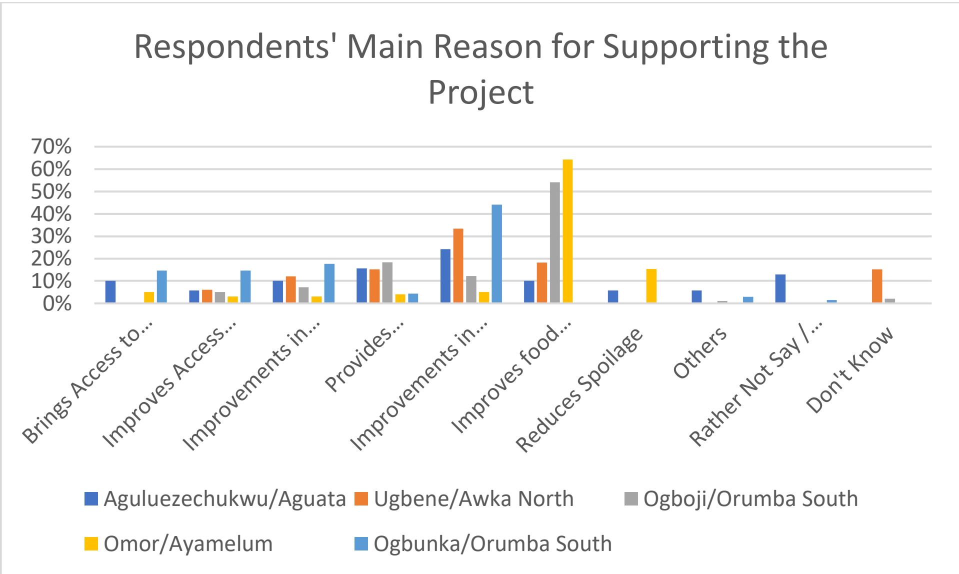


Figure 4.42 Reasons for Supporting the SAPZ II Project Across Project Communities: R

In Ugbene, the community's main reason for support is improvements in economic activities (33%), followed by food security (18%) and employment opportunities (15%). 15 % of respondents (15%) were not sure or preferred not to express a specific reason.

Food security stands out as the overwhelming reason for supporting the programme in Ogboji, with 54% of respondents prioritising this. Employment opportunities came a distant second with 18, and improvements in agricultural production (7%) are other significant factors.

Omor/Ayamelum: In Omor, the majority of respondents cited good security (64%), with 64% citing this reason. Reducing spoilage (15%) and improving economic activities (5%) also contribute to the support.

Ogbunka/Orumba South: Economic activities (44%) and improvements in agricultural production (18%) were the primary reasons for support. Access to modern agricultural facilities and communication (both 15%) also play a key role, while employment opportunities were less significant here (4%).

4.5 Health Study

4.5.1 Health Problems/Ailment, Cost Implications in Project Host Communities

The health issues of individual households in the surveyed communities in the last year were analysed and presented in Figure 4.43.

The common health issue in the surveyed communities is malaria.

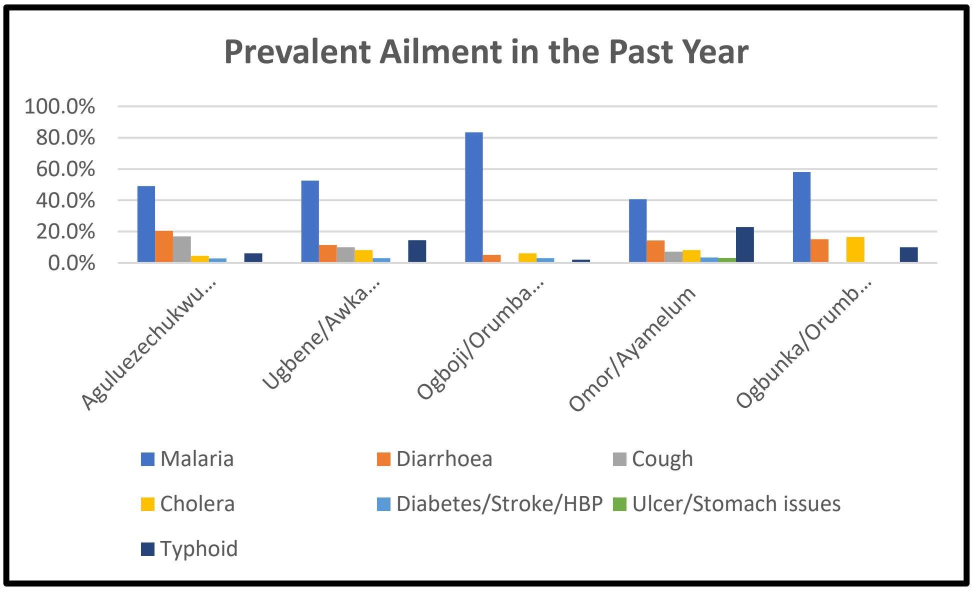


Figure 4.43: **Prevalent Ailment in the Project Host Communities in the Past Year**
Source: AN SAPZ ESIA Field Data (2024)

The prevalence of these health problems in these communities could be an indication of a poor healthy lifestyle which allows the breeding of malaria parasites and other disease-causing vectors in the areas (Ojukwa and Njom, 2012). The prevalence of malaria in these communities in the project host communities is because of mosquito bites, which transmit plasmodium falciparum to its victim.

Similarly, typhoid is a common disease caused by the ingestion of contaminated foods and drinks. Typhoid ranked higher in Omor town than in other communities. Although the people in the project host communities generally did not show a high prevalence of typhoid, diarrhoea was accounted for in all the communities which implies a poor sanitary condition of the communities.

It can be seen from the study (Figure 4.43) that all the communities ranked low in the incidence of diabetes and stroke, which may be attributed to the lifestyles of the people. The Anambra SAPZ will introduce a better living condition that will not only ensure a better sanitary condition but also reduce stress-induced livelihood activities to ensure that the prevalence of these diseases is reduced in the community.

Table 4.52 shows the Occurrence of Common Diseases obtained from healthcare facilities in the project areas. Malaria is the most common illness treated at the facilities followed by diarrhoea and gastrointestinal problems.

Table 4.52: Occurrence of Common Diseases by Age and Sex

Disease	**<5 years**			**5-14 years**			**15-49 years**			**50-64 years**			**≥64 years**			**Total**
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	
Malaria	4839	4101	4097	1836	3991	3489	2929	5107	5858	1192	2043	3032	172	291	3101	15264
Diarrhea	263	184	180	7	184	15	24	37	48	15	15	26	38	32	62	164
Gastroenteritis	335	264	260	37	264	89	122	185	244	23	29	64	45	32	167	523
Pneumonia	81	66	62	21	66	37	49	28	98	25	26	50	8	4	57	156
Tuberculosis	5	7	3	0	7	5	62	45	124	21	11	25	13	10	75	155
UTI	121	102	98	17	132	28	118	182	236	34	44	55	23	22	141	439
HIV/AIDS	2	5	1	7	5	6	12	24	24	4	5	6	9	8	21	39
Measles	149	116	112	23	216	61	7	17	14	4	4	31	4	4	11	89
URTI	1297	1115	1111	237	1115	443	441	625	882	94	162	335	55	68	496	1876
Cellulites	58	63	59	65	60	122	84	115	168	37	46	106	21	33	105	446
Conjunctivitis	103	93	89	90	93	195	307	393	614	158	210	252	102	111	409	1464
Skin disease	157	210	206	141	230	281	170	242	340	63	95	208	40	33	210	912
Covid 19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Secondary data obtained from health facilities in the project host communities.

4.5.2 Health Services Profile in the Project Host Communities

There are private and government health facilities in the host communities. The project host communities have healthcare centres, maternities and dispensaries spread across the Local Government Areas. The maternity clinic and some primary health centres are not well equipped compared with those in urban areas.

The study areas have both orthodox and non-orthodox healthcare providers and facilities. The orthodox facilities comprise health centres and health posts while the non-orthodox comprise mainly traditional birth attendants (TBAs). The functional orthodox facilities provide first aid and treatment for minor ailments, as well as immunisation services for children and women of childbearing age.

Apart from the orthodox facilities, there are drug stores (chemists) located in some of the communities. There are also hawkers (individuals who carry drugs, especially malaria drugs, analgesics, antibiotics and various creams and balms) hawking drugs from one settlement to another. The number and distribution of these were not determined during the study.

Some primary healthcare centres around project sites visited are:

- Ogbunka Health Centre Orumba South LGA
- Ogbunka Health Post
- Ugbene Comprehensive Health Centre
- Health Post Ogboji
- Aguluezechukwu Primary Health Post

4.5.3 Accessibility and Affordability of Health Facilities and Services in Communities

Due to the limited number of government-owned cottage hospitals in the selected area, most of the respondents find health services inaccessible. Poor access to health facilities and services is a lack of effective and appropriate utilisation of health facilities and services provided by the government. However, this result shows that most of the respondents in the project host communities moderately access the health facilities closest to them.

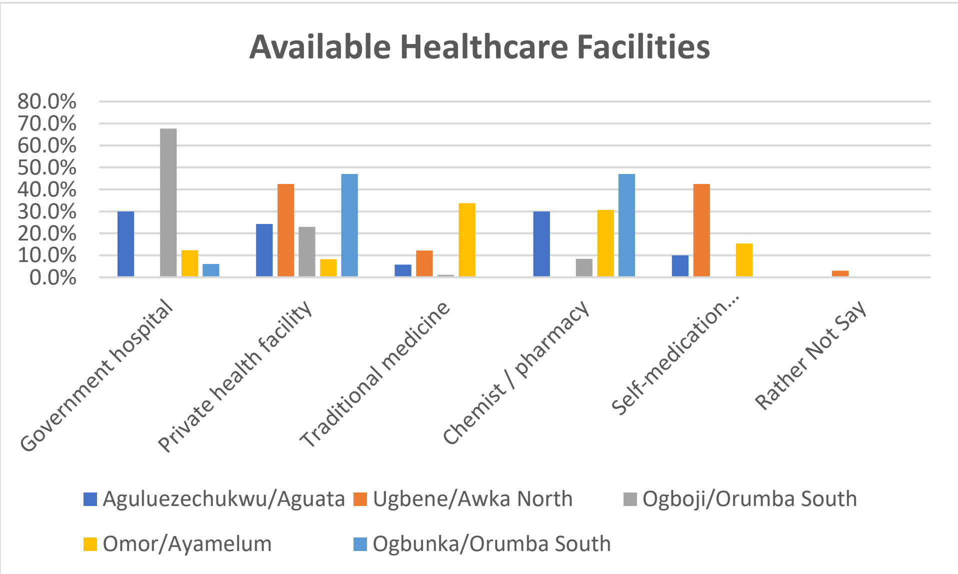


Figure 4.44: **Available Healthcare Facilities in the Communities**
Source: AN SAPZ ESIA Field Data (2024)

4.5.4 Condition and Frequency of Use of Government Healthcare Services

The condition of service provided by these health facilities in the areas under survey suggests that huge global and national investments aimed at effective healthcare delivery have not yielded the desired result given the poor utilisation and lack of access to these healthcare centres in project host communities. The National Health Service system was designed so that patients should have initial contact with the primary healthcare system through the primary healthcare centres located close to them. Patients are there after being referred to a higher level of health care. Unfortunately, services at the centres are very poor and unaffordable. It can be seen from the result that the primary health care centres in the selected communities have limited doctors and nurses, and functional laboratories are conspicuously lacking.

4.5.5 Sources of Drinking Water

The source of drinking water is an essential aspect of the development of an area because it promotes socio-economic development and people's well-being (Uzoh and Osuagwu, 2017). Availability, types and patterns of potable drinking water in the selected communities can express the level of development in the communities. Findings from this study show that the communities largely depend on water from Rivers and Springs for domestic use followed by rainwater during the wet season. Borehole water in the communities is not readily available which makes it an unreliable source of domestic water in the communities. Figure 4.45 presents the percentage of domestic water sources available and used by the five communities surveyed in Anambra State.

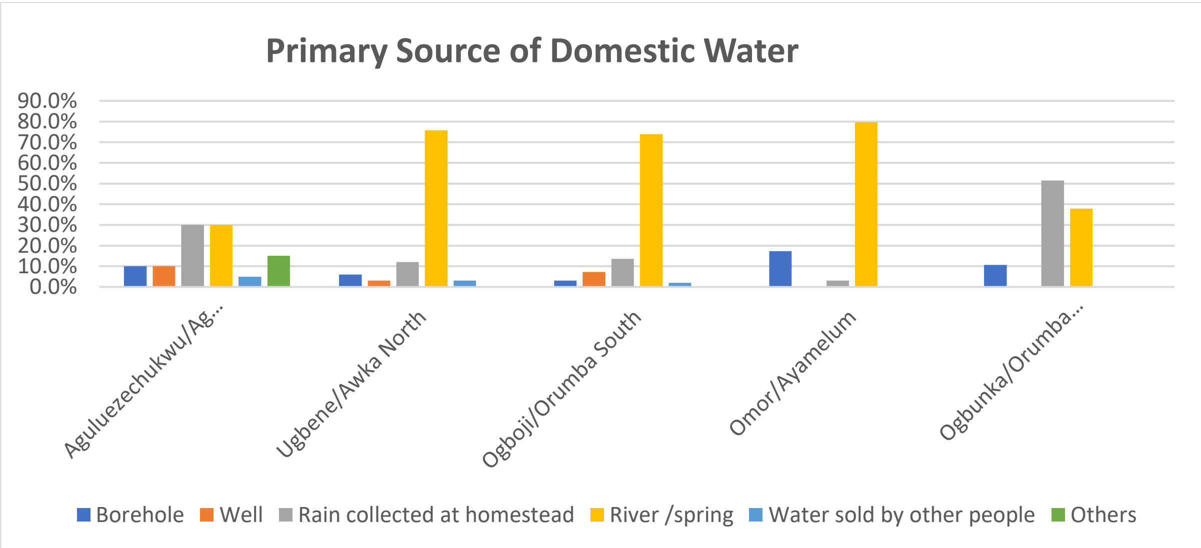


Figure 4.45: **Primary Sources of domestic water in the communities**
Source: AN SAPZ ESIA Field Data (2024)

As an essential ingredient of well-being and a healthy life, water should be taken in its purest, odourless, colourless and tasteless form but due to human and animal activities in the area, its sources have different levels of solid, human and chemical contaminants. Town water supply, which supplies quality water to the people is conspicuously lacking in the area. Access to safe drinking water in communities is tied to boreholes which is not readily available due to the unavailability of power to pump water as well as the fact that only a few boreholes are available in the communities, hence, not sufficient to serve the communities. It is important to state that a tube well (borehole) as the commonest source of safe water supply may not need any treatment to meet drinking water standards but needs a steady power supply to power it from the source. USEPA (2021) noted tube wells usually sourced underground have natural filtering agents to remove germs and chemical contaminants depending on the water's depth and the local geology.

Plate 4.20: Community Borehole in Omor Town

4.5.6 Toilet System and Sanitation Status of Surveyed Communities

The study investigated the toilet system used by the people in the surveyed communities in the last year to establish the level of sanitary conditions in the communities. The use of water closet system is dominant in Aguluezechukwu, Ogboji and Ogbunka communities while 76.5% of respondents in Omor town indicated not having any toilets, which is worrisome considering the public health implications of open defecation as adopted by these respondents. The toilet systems in the communities are presented in Figure 4.46.

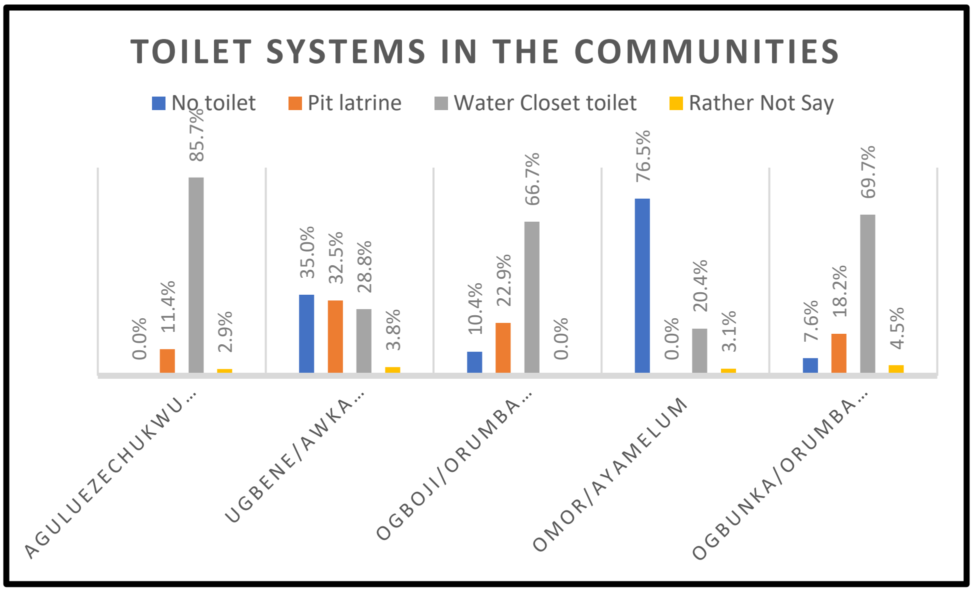


Figure 4.46: **Toilet systems in the surveyed communities**
Source: AN SAPZ ESIA Field Data (2024)

The toilet condition of most rural communities in Anambra may not be properly understood in terms of its forms and content. Yet, it is a common indicator of the sanitary condition of the place and a surrogate for policy outcomes in rural welfare and development.

Toilet systems in most of the host rural communities may not be mutually exclusive implying that any type accessible at one time does not stop the use of the other at a different time and there is no particular choice of toilet system for an individual (Pat-Mbano and Okeoma, 2012). Using a pit-latrine or bucket system does not prevent the use of surrounding bushes for the same defecation purpose.

4.5.5.1 Forms and Contents of Toilet Facilities in the Communities.

The distribution of toilet systems shows that rural communities are predominantly poorly developed with surrounding bushes everywhere. The bushes are ideal grounds for the disposal of human and animal waste. This can be indiscriminately done. Using surrounding bushes for human waste disposal is a common practice in almost all communities most especially in Omor town.

CHAPTER 5 ASSOCIATED AND POTENTIAL IMPACTS

Impact identification and evaluation play a crucial role in systematically identifying and assessing the potential environmental and social impacts associated with the proposed SAPZ project. An impact is a cause-effect relationship between the project and the surrounding environment and socioeconomic aspects (Julien *et al.,* 1992). It can be adverse, meaning it has detrimental effects, or positive if it improves the environmental or socioeconomic conditions. The impact identification and evaluation process considers the significance of these impacts and how they might occur. This process aims to develop measures to avoid, minimize, or compensate for negative impacts while enhancing positive ones. Engaging stakeholders throughout the process ensures a comprehensive evaluation, and the resulting information helps decision-makers ensure sustainable development and make informed project approvals. The following sections will detail how we will identify and evaluate the impacts of this SAPZ project, following the FMEnv recommendations, AfDB's ISS, and ISO 14001 guidelines.

5.1 Impact Characteristics

Impact characteristics refer to the various attributes or features that define the nature and extent of an impact resulting from a project or activity (Table 5.1). These characteristics help understand and evaluate the impacts on the environment or society. Tables 5.2 and 5.3, on the other hand, provide a further definition of the "Designation" element of Impact Characteristics as used in the ESIA report.

Table 5.1: Impact Characteristics, Their Designations and Meaning

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct Indirect Induce
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The period over which a resource/receptor is affected.	Temporary Short-term Long-term Permanent
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.).	No fixed designations; intended to be a numerical value]
Frequency	A measure of the constancy or periodicity of the impact.	No fixed designations; intended to be a numerical value]

Table 5.2: Designations Meanings

Designation	Definition
Type	
Direct	Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats that are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., the viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
Extent	
Local	Impacts that affect an area in proximity to the development area within an area are defined on a resource/receptor-specific basis.
Regional	Impacts occurring at a regional scale as determined by administrative boundaries or which affect regionally important resources or ecosystems.
International	Impacts that extend across international boundaries or affect resources such as features, resources or areas protected by international conventions.
Duration	
Temporary	Impacts are predicted to be of short duration (in the order of days) and/or intermittent/occasional.
Short-term	Impacts that are predicted to last only for the duration of the construction period (i.e. – 8 years).
Medium-term	Impacts that will continue for a period of 5 to 10 years following the completion of the construction phase e.g., where the impact may reverse or affected resources or receptors recover within this period of time.
Long-term	Impacts that will continue for the life of the Project, but will either cease when the Project stops operating or is decommissioned, or where the impact may reverse or the affected resource/receptor recovers or reverts to a near-natural state after 10 or within 20 years following the completion of the construction phase.
Permanent	Impacts that cause a permanent change in the affected receptor or resource (e.g., removal or destruction of ecological habitat) that endures substantially beyond 20 years following the completion of the construction phase.

Table 5.3: Designations Meanings

Likelihood	Definition
Unlikely	**The event is unlikely but may occur at some time during normal operating conditions.**
Possible	**The event is likely to occur at some time during normal operating conditions.**
Likely	**The event will occur during normal operating conditions (i.e., it is essentially inevitable).**

5.2 Impact Prediction

Impact prediction aims to identify the magnitude and other dimensions of identified change in the environment with a project/action, by comparison with the situation without that project/action, thereby providing a basis for assessing the significance of the impact (Glasson and Thrivel, 2019). It begins with identifying potential changes in indicators of impact receptors and must take into the impact characteristics. A receptor component is defined as a component of the natural or human environment that is measurably affected by the project and which forms an endpoint of a given effect pathway (Horvath and Braun, 2017). At a minimum, impact prediction is evaluated based on the magnitude of the impact and the sensitivity of the environmental receptor receiving the impact, especially where the impact can be foreseen. In cases of unforeseen impacts, such as an oil spill, the dimension of probability of the occurrence of the impact must also be considered.

5.2.1 Impact magnitude

Impact magnitude reflects how much a resource or receptor will change due to project activities, considering the impact characteristics, such as severity and scale. Beneficial impacts are often rated positive but can be quantified if data is available (e.g., number of jobs created) for a more detailed rating (small, medium, large). Otherwise, significance relies on the sensitivity of the impacted resource or receptor.

Pre-mitigation impact significance considers existing controls built into the project design, like noise reduction measures. This avoids overestimating impacts by assuming no controls exist. Additional mitigation measures can be proposed to further reduce significance and are assessed separately.

5.2.2 Sensitivity

Sensitivity is used to assign significance to a given impact by considering the degree the environmental receptor is to the activity causing the impact. Receptors' sensitivity will be ranked as follows:

- Low;
- Medium; or
- High.

5.2.3 Impact Probability

Impact probability refers to the likelihood that the impact will occur, raising the important issue of uncertainty and how to handle it. Stakeholder involvement, robust options selection, and impact interaction modelling are some methods to address uncertainty (Cardenas & Halman, 2016). In this report, impact probability is ranked on three levels, including high probability, medium probability and low probability, with their definitions shown in Table 5.4.

Table 5.4: Definitions of Probability Ranking

Ranking	Impact Probability	Frequency of Occurrence
High	A very probable impact	Occurs frequently
Medium	A probable impact	Occurs occasionally
Low	An improbable impact	Occurs rarely

5.2.4 Impact Evaluation

The criteria used for impact evaluation are described in Table 5.5.

Table 5.5: Impact Evaluation Criteria and Ratings

Consequence	Evacuation Criteria	
Environmental legislation and corporate Policy (A)	Is there any legislation affecting this aspect?	**Score**
	The impact is covered by legislation and policy	3
	The impact is covered by legislation	2
	The impact is covered by policy	1
	The impact is not covered by legislation or policy	0
Stakeholder concern/interest (B)	What stakeholder concern or interest does the stakeholder raise?	**Score**
	The impact raises considerable global, national and local interest or would have a serious detrimental effect on the reputation of the client	3
	The impact raises some interest and may have some detrimental effect on the reputation of the client	1
	The impact raises no interest and would have no effect on the reputation of the client	0
	The impact raises some interest and may have some positive effect on the reputation of the client	-1
	The impact raises global, national and local interest or would have a significant positive effect on the reputation of the client	-3
Severity of environmental impact (C)	What is the severity of the environmental impact?	**score**
	The impact has a moderate detrimental effect on the environment or a scarce, non-renewable resource. Long-term/ Irreversible Impact.	3

	The impact has a moderate detrimental effect on the environment or a scarce, non-renewable resource. Impact not reversible within a year. Year	2
	The impact has a minor detrimental effect on the environment and on scarce, non-renewable resources. Impact reversible within a month to a year.	1
	The impact has no known effect on the environment	0
	The impact has a minor positive effect on the environment and on scarce, non-renewable resources.	-1
	The impact has a moderate positive effect on the environment and on scarce, non-renewable resources.	-2
	The impact has a major positive effect on the environment or a scarce, non-renewable resource	-3
Scale of Impacts (D)	What is the scale of the impact?	**Score**
	The negative impact occurs in high or large quantities	3
	The negative impact occurs in medium quantities	2
	The negative impact occurs in low or small quantities	1
	The positive impact occurs in low or small quantities	-1
	The positive impact occurs in medium quantities	-2
	The positive impact occurs in high or large quantities	-3
LIKELIHOOD FREQUENCY	How frequently does the impact occur	**Score**
	The impact occurs daily	5
	The impact occurs every week	4
	The impact occurs every month	3
	The impact occurs on an annual basis	2
	The impact is unlikely to occur	1

5.2.5 Impact Significance Ranking

The main aim of an ESIA is to predict whether the identified impacts of a proposed initiative are significant or not. It can be calculated by multiplying the magnitude (consequence) and probability score for that impact.

To calculate the magnitude of an impact, the sum of the magnitude scores scored during the impact magnitude evaluation for all components (A-D) are added together to obtain the magnitude score for that impact. This score is then multiplied by the probability score to arrive at the assessed significance for that impact. Mathematically, the equation is as follows:

$$Significance\ Evaluation\ Score = Magnitude\ (A + B + C + D) \times Probability\ (Z)$$

Where A, B, C, D = Impact Characteristics and Z = Probability of Occurrence

This number is then compared against the Significance Categories shown in Table 5.6.

Table 5.6: Significance Level Categories

Impact Significance	Score

Low Negative Significance	1 – 25
Medium Negative Significance	26 – 50
High Negative Significance	> 50
Positive Significance	< -1

5.3 Impact Identification

Impact identification is a crucial step in the Environmental and Social Impact Assessment (ESIA) process, to ensure that all potentially significant environmental impacts—both adverse and positive—are thoroughly identified and considered. This process integrates project characteristics with baseline environmental conditions to assess how various project phases might affect both biophysical and socioeconomic receptors. This approach enables a comprehensive evaluation of the project's impacts, facilitating the identification of direct, indirect, and cumulative effects that may require mitigation or enhancement measures (Glasson and Therivel, 2019). All identified impact categories are described in the context of affected biophysical or socio-receptors (Table 5.7).

5.3.1 Pre-construction Phase

The preconstruction phase begins with feasibility studies, as described in Chapter 3 of the report. During this phase, while the project is not expected to cause significant impacts from feasibility studies, potential impacts may arise from the choice of contractors and procurement appointment processes. Selecting contractors with strong environmental and social management practices is crucial, as their operations can influence the project's overall impact. Inadequate contractor selection may lead to poor implementation of environmental safeguards, poor waste management, or non-compliance with regulations. Additionally, procurement practices must ensure that materials and services are sourced responsibly to prevent adverse social and environmental outcomes. Ensuring that contractors adhere to robust sustainability criteria and responsible procurement practices will mitigate these potential risks and contribute to the project's overall success.

Additional pre-construction impacts result from land acquisition, site clearing and preparation activities, with the following potential and associated impacts:

- **Livelihood Impacts:** Converting farmlands to industrial use may displace local farmers, resulting in the loss of agricultural livelihoods and necessitating resettlement plans.
- **Involuntary Displacement:** Involuntary resettlement due to farmland loss can lead to loss of livelihoods, food security challenges, social disruption and environmental impacts.
- **Soil Erosion:** The undulating terrain, especially in Ogboji, combined with forest clearance, may exacerbate soil erosion. Effective soil management and erosion control measures are essential.

- **Increased Flood Risk:** Site clearance and grading during pre-construction disturb natural absorption, leading to higher runoff rates. Poor stormwater management design exacerbates flood risks, affecting the project site, local water bodies, soil, farmlands, and nearby properties.
- **Biodiversity Loss:** Removal of primary and secondary vegetation could impact local flora and fauna, potentially leading to biodiversity loss.
- **Impairment of Water Quality:** Site preparation activities may cause runoff containing sediments and pollutants, degrading nearby water bodies such as the Eso stream in Ogboji and River Nnamuzu in Ugbene.
- **Noise and Air Pollution:** The use of heavy machinery and construction vehicles can generate significant noise, dust, and emissions of air pollutants like particulate matter, CO, NOx, and VOCs.
- **Traffic Congestion:** Increased vehicle movements related to site surveys and material delivery may cause minor congestion on local roads, particularly where access routes are underdeveloped.
- **Land Degradation:** The movement of heavy construction equipment can degrade access roads, especially in Ugbene and Ogbunka.
- **Poor Waste Management:** Effective waste management during the pre-construction phase is crucial to prevent environmental contamination, visual pollution (aesthetics), and health risks. The primary waste stream is cleared vegetation, with minimal packaging waste expected. Hazardous materials used during preliminary studies, such as chemicals for soil testing, need careful management to avoid soil and water contamination.
- **Health & Safety:** Occupational health and safety risks can arise from improper equipment handling, exposure to hazardous substances, improper/inadequate personal protection equipment (PPE), lack of adequate training for personnel, poor engineering design, conflicts with local community and accidents
- **Engineering Design Considerations:** The design of infrastructure, such as roads and drainage systems, can significantly influence soil erosion and water runoff. Poor drainage design may lead to waterlogging or flooding, affecting local agriculture and settlements. Sustainable material selection and green design principles, including energy-efficient buildings and renewable energy sources, can mitigate environmental impacts and enhance sustainability.
- **Inadequate Stakeholder Consultation:** Inadequate stakeholder consultation could lead to community dissatisfaction and conflict. Insufficient baseline data collection may also result in an incomplete understanding of current environmental and social conditions.

5.3.1-1 Site-Specific Peculiarities:

- **Ogboji, Orumba South LGA:** Pre-construction activities near the Eso stream pose risks of sedimentation and pollution. Traffic congestion, noise and dust could affect nearby St. Peter's Catholic University and the local community.
- **Ugbene, Awka North LGA:** The site's swampy nature may exacerbate flooding and waterlogging. Proximity to River Nnamuzu raises concerns about runoff contamination. Heavy vehicular movement may also degrade secondary access roads. The site proximity to Enugu State requires careful consideration of potential cross-border impacts.
- **Omor, Ayamelum LGA:** Similar concerns regarding flooding and waterlogging as Ugbene. Potential noise and dust from construction could affect the partially isolated host community and the Fadama III project area.
- **Ogbunka, Orumba South LGA:** The site's proximity to the Abia State boundary requires careful consideration of cross-border environmental and social impacts. The conversion of secondary regrowth forests may affect local biodiversity. Heavy vehicular movement could also degrade secondary access roads.

5.3.2 Construction Phase

Most potential impacts identified during the pre-construction phase will continue into the construction phase, with some intensifying. These include impacts on air quality, noise levels, water quality, land degradation, traffic management, and waste management. Others are excessive resource (water, energy) consumption, energy efficiency, climate change resilience, health and safety. Ongoing stakeholder engagement and consultations are crucial during this phase.

5.3.2.2 Site-Specific Peculiarities

The site-specific peculiarities observed during the pre-construction phase for each location remain valid, with a greater focus on managing noise, air quality, and waste management. Protecting sensitive receptors, such as surface waters in Ogboji and Ugbene, remains critical.

5.3.3 Operational Phase

During the operational phase of the SAPZ programme, the sources of impacts on biophysical and social receptors are expected to differ from those experienced during the pre-construction and construction phases. The phase involves the day-to-day functioning of the SAPZ AIH and the ATCs and associated facilities. Unlike the transient nature of construction, operational activities are ongoing and persistent. This sustained activity means that even if individual impacts seem less intense, their continuous nature can lead to significant cumulative effects. Therefore, constant management and monitoring are essential.

The anticipated include noise pollution, impairment of air quality, soil contamination, groundwater contamination, increased risks of flooding, increased risk of erosion, product contamination, poor waste management, impairment of surface water, traffic congestion and socioeconomic impacts.

5.3.3-1 Site-Specific Peculiarities:

- Ogboji, Orumba South LGA: Proximity to sensitive receptors like Eso stream and St. Peter's Catholic University, Achina, will necessitate stringent controls on noise, air emissions, and water quality. Vulnerability to erosion is expected to have been mitigated during the preconstruction and construction phases.
- Ugbene, Awka North LGA: Given the swampy nature and proximity to River Nnamuzu, there will be a need for robust water management systems to prevent flooding and contamination. Vulnerability to erosion is expected to have been mitigated during the preconstruction and construction phases.
- Omor, Ayamelum LGA: The proximity to the Fadama III project area will require careful noise management and dust emissions to avoid disruptions. Remains vulnerable to flood risks. Vulnerability to flooding is expected to have been mitigated during the preconstruction and construction phases.
- Ogbunka, Orumba South LGA: Cross-border environmental and social impacts should be monitored, with a focus on preserving local biodiversity and managing the impacts of increased traffic. Vulnerability to erosion is expected to have been mitigated during the preconstruction and construction phases.

5.3.4 Decommissioning Phase

As the project nears the end of its lifecycle or if it is abandoned, the decommissioning phase will be triggered. This phase focuses on closing operations, dismantling infrastructure, and removing facilities to minimise long-term environmental and social impacts while preparing the area for future use, either through restoration or repurposing (Morrison-Saunders, 2023). Ensuring personnel safety and responsibly managing potential impacts is crucial during this stage.

Potential impacts during this stage also include noise pollution, impairment of air quality, surface water degradation, soil contamination, traffic congestion, waste management, health and safety risks, land rehabilitation and restoration and socio-economic impacts.

5.3.4-1 Site-Specific Peculiarities

- Ogboji, Orumba South LGA: Proximity to sensitive receptors like Eso stream and St Peter's Catholic University requires stringent controls on noise, air emissions, and water quality.

- Ugbene, Awka North LGA: The site's swampy conditions and proximity to River Nnamuzu necessitate careful water management to prevent contamination and flooding.

- Ogbunka, Orumba South LGA: Monitoring of cross-border environmental impacts is essential.

5.4.5 Summary of Identified Impact Categories

Table 5.7 below presents a comprehensive overview of potential environmental impact impact categories associated with the Anambra SAPZ programme. It categorises impacts based on their nature, identifies the affected environmental components, and outlines specific indicators to measure the extent of these impacts. This structured approach facilitates the identification, assessment, and management of environmental impacts throughout the project lifecycle. In summary, 16 impact categories affecting 10 environmental receptors (socioeconomics, health, safety, vegetation, wildlife, land use [agricultural land], hydrology (surface water, groundwater and sediment quality], air quality and climate) were identified.

Table 5.7: Summary of Identified Impact Categories, Receptors, Indicators and Phases Indicators

Impact Category	Environmental Component	Impact Indicators	Project Phases	Site-Specific Peculiarities
Involuntary Displacement	Socioeconomics	Loss of livelihoods, food security challenges, social disruption	Preconstruction	
Livelihood Impacts	Socio-economics	Changes in household income, employment rates, livelihood diversification, market access, food security, access to quality education and health facilities	Pre-construction, Construction, Operational, Decommissioning	
Economic Impacts	Socio-economics	Impacts on local businesses, shifts in regional economic activities	Operational	
Community Dynamics	Socioeconomics	Changes in social cohesion, potential conflicts, impacts on community structure	Preconstruction, Construction, Operational, Decommissioning	
Biodiversity Loss	Vegetation, Wildlife	Reduction in biodiversity, habitat loss, and species decline	Pre-construction, Construction, Operational	
Flood Risk	Water Bodies, Soil, Farmlands, Properties	Elevated runoff, frequent and severe flooding, Loss of topsoil, increased gully erosion rate, increased sedimentation	Pre-construction, Construction, Operational, Decommissioning	Ugbene and Omor are particularly at risk.
Soil Erosion/Land Degradation	Land Use, Hydrology	Loss of topsoil, land use changes, reduced land availability, increased gully erosion rate, increased sedimentation	Pre-construction, Construction, Operational, Decommissioning	**Ogboji:** Erosion risks due to the topography of the area. Risk of sedimentation of the nearby Eso stream **Ugbene and Omor:** Potential degradation from swampy conditions. Potential sedimentation of Nnamuzu River in Omor

Impact Category	Environmental Component	Impact Indicators	Project Phases	Site-Specific Peculiarities
				Ogbunka: Heavy vehicular movement affecting untarred access roads
Soil Contamination	Land, Groundwater, Health	Elevated levels of contaminants (heavy metals, pesticides, or hydrocarbons) in soil and groundwater, dramatic changes in soil pH, significant increases in organic carbon/matter in soil and groundwater, and the presence of faecal coliforms in soil and groundwater.	Pre-construction, Construction, Operational, Decommissioning	
Water Quality Impairment	Water Quality, Hydrology	Increased levels of pollutants, changes in water chemistry, reduced aquatic life	Pre-construction, Construction, Operational, Decommissioning	Eso Stream in **Ogboji** and River Nnamuzu in **Ugbene** are particularly at risk
Noise Pollution	Socio-economics	Noise levels, health impacts, community disturbance	Pre-construction, Construction, Operational, Decommissioning	
Air Quality Impairment	Climate & Air Quality	Increased air pollutants, reduced visibility, and respiratory health impacts	Pre-construction, Construction, Operational, Decommissioning	
Traffic Congestion	Health, Socioeconomics	Increased travel time, fuel consumption, emissions, accidents	Construction, Operational	
Poor Waste Management	Land, Water, Air, Health, Socioeconomics	Waste generation, improper disposal, pollution, health risks, community impacts	Pre-construction, Construction, Operational, Decommissioning	
Excessive Resource Consumption	Groundwater, Surface water, Socioeconomics	Water scarcity, energy shortages, material scarcity, economic impacts	Construction Operational, Decommissioning	

Impact Category	Environmental Component	Impact Indicators	Project Phases	Site-Specific Peculiarities
Energy Use and Efficiency	Climate, Air Quality	Increased energy consumption, resource overexploitation, impacts on sustainability and environmental efficiency	Operational, Decommissioning	
Climate Change Resilience	Climate, Air Quality	Changes in vegetation cover, resilience to extreme weather events, greenhouse gas emissions	Pre-construction, Construction, Operational, Decommissioning	
Health and Safety Risks	Health, Socioeconomics	Risks to the health and safety of workers and local communities, accidents, hazardous conditions	Preconstruction, Construction, Operational, Decommissioning	

Source: Anambra SAPZ ESIA Analysis (2024)

5.3.6 Positive Impacts

The development, implementation, and operation of the SAPZ Programme are expected to generate significant positive impacts across various sectors, which are summarised below.

Employment and Economic Growth

The SAPZ project is anticipated to create numerous job opportunities. Direct employment will be generated within the SAPZ facilities and associated industrial raw material procurement areas, benefiting both skilled and unskilled labour. Additionally, indirect employment opportunities will arise in sectors such as banking, logistics, insurance, and manufacturing, contributing to broader economic growth within the project area of influence.

Local contractors and businesses will benefit from the project's investment, particularly during the construction phase. The SAPZ initiative will also support the production and sale of value-added goods and services, enhancing industrial and commercial growth. This growth is expected to attract young people to agribusiness through targeted programs and incentives, such as training, grants, and access to resources. Moreover, the project will boost SME competitiveness, increase youth income, and improve overall living standards, with long-term strategies for sustained economic growth.

Capacity Building and Skill Transfer

The project includes early training and capacity-building initiatives to prepare the local workforce for employment during the construction and operational phases. These programs aim to enhance local skills and increase employment prospects. Additionally, centres of excellence will provide ongoing training and support to farmers, promoting knowledge transfer and technical expertise. Collaboration with domestic and international experts will further facilitate skill transfer to local stakeholders, enhancing their capabilities and promoting knowledge sharing.

Agricultural and Food Security Benefits

The SAPZ and ATCs will significantly enhance agricultural productivity by introducing advanced technologies and practices, resulting in higher yields and better-quality produce. This will benefit local farmers and consumers alike. The availability of reliable market access and storage facilities will encourage farmers to produce surplus crops, reducing poverty and hunger while improving food security for the region.

Infrastructure Development

The project involves the construction of supporting infrastructure, such as roads, utilities, and communication networks. These improvements will enhance connectivity, reduce transportation costs, and provide better access to services for the local population. The development of this infrastructure will not only support the SAPZ operations but also benefit the wider community.

Public Revenue and Investment

The SAPZ project is expected to attract significant foreign and national investment, fostering a favourable business climate and restoring confidence among investors. This influx of investment will contribute to public revenue through tax payments, strengthening the national and state treasury. Additionally, the project will promote rural and community development, further enhancing economic stability and growth at the local level.

Environmental and Community Benefits

The project's end phase offers opportunities for site rehabilitation and environmental restoration, including reforestation and soil remediation. These efforts will improve local biodiversity and ecosystem health. Additionally, infrastructure developed during the project may be repurposed for community use, such as converting buildings into community centres, schools, or other public facilities, providing long-term benefits to the local population. Community engagement in deciding the future use of these facilities will ensure that the benefits are aligned with local needs and priorities.

In conclusion, the SAPZ Programme promises significant positive impacts across employment, economic growth, capacity building, food security, infrastructure development, public revenue, and environmental sustainability. The project's comprehensive approach aims to create a sustainable and inclusive growth model that benefits the local communities and the broader economy.

5.3.7 Negative Impacts

The development and operation of the SAPZ Programme, while providing numerous benefits, also has potential negative impacts on various environmental components (receptors). The key environmental receptors affected by the project include air quality, water resources, soil health, biodiversity, and the social environment. Understanding how project impacts act on these receptors is essential for developing sustainable strategies that minimise adverse effects and promote environmental stewardship throughout the project’s lifecycle. These are discussed below.

5.3.7.1 Impact on Air Quality

The project, located in rural areas where air quality is typically good, faces potential air quality impacts due to construction and operational activities. The primary sources of existing air pollution in the areas are vehicular traffic, which contributes to particulates and combustion emissions. Agricultural practices like tilling and ploughing can contribute to dust and particulate matter. Other sources are the burning of crop residues, the use of diesel-powered equipment (available in Omor from the Fadama III project), grain processing facilities (In Ugbene and Omor), as well as wind-blown dust. However, as shown in the Air Quality Section of Chapter 4, field measurements indicate pollutants are either not detectable or within regulatory standards.

During the preconstruction, construction and decommissioning phases, air quality may degrade temporarily due to activities like vegetation clearing, soil excavation, and the transportation of materials. These activities will generate fugitive dust and emissions from diesel-powered equipment such as bulldozers, trucks, and other construction machinery.

Pollutants likely to be emitted include sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), suspended particulate matter (SPM), and volatile organic compounds (VOCs). These emissions can have localised impacts, potentially affecting air quality and health, particularly if they exceed FMEnv ambient air quality standards. For instance, high levels of SO_2 can exacerbate respiratory illnesses and chronic bronchitis, while NO_2 can affect lung function in individuals with asthma. CO exposure can reduce the oxygen-carrying capacity of blood, posing health risks.

During the operational phase, the project will continue to emit pollutants, primarily CO_2, SPM, and VOCs, from equipment operation and vehicle use. While the overall impact on global warming from these emissions may be small, VOCs, including harmful hydrocarbons like benzene, can pose health risks. The transportation of materials, powered by diesel engines, will further contribute to emissions of SOx, CO_2, CO, NOx, and SPM, which can impact air quality and health if ambient limits are exceeded.

5.3.7.2 Impact on Hydrology

The hydrological impacts of the Anambra State SAPZ II project affect both surface and groundwater systems. Understanding these impacts is essential to implement effective management and mitigation strategies. This will safeguard water quality and maintain the ecological balance of nearby surface waters throughout the project's duration.

5.3.7.2.1 Impact on Surface Water

The project may cause increased sedimentation and turbidity in surface waters, such as the Eso Stream in Ogboji and River Nnamuzu in Ugbene, due to soil erosion from earthworks. This elevated turbidity can negatively affect aquatic habitats, fauna, and flora. Improper handling of lubricants, hazardous substances, and hydrocarbons may contribute to water pollution; however, with proper management practices, significant impacts on water quality are unlikely.

During the preconstruction and construction phases, surface water quality may be affected by site clearance, removal of vegetation, and increased runoff, heightening the risk of flooding and soil erosion. Construction activities can lead to sediment loading in nearby streams, and accidental leaks or spills of hydrocarbons may also pollute surface water.

During operations, surface water quality faces risks from leaks or spills of hydrocarbons used in generators and pollution from pesticides, fertilizers, sewage, and effluents from processing plants.

During decommissioning, surface water quality may be further impacted by the dismantling of infrastructure and removal of construction materials, which can expose soil and increase erosion and sedimentation in nearby bodies of water. This can negatively affect aquatic ecosystems. Effective decontamination, waste disposal practices, and proper site restoration are crucial to mitigate these risks.

5.3.7.2.2 Impact on Groundwater

Throughout the project lifecycle, groundwater quality may also be affected by accidental spills or leaks of hydrocarbons and other substances seeping into the groundwater. Proper management practices are essential to prevent contamination.

During the decommissioning phase, residual contaminants and improperly managed materials may continue to pose risks to groundwater quality. Thorough cleanup and effective remediation practices are essential to prevent groundwater contamination. Continuous monitoring and management of potential sources of leakage or seepage at all project phases are crucial to maintain groundwater quality.

Finally, any restoration efforts must be complete and address potential sources of groundwater contamination to ensure the protection of both surface and groundwater throughout the project's lifecycle.

5.3.7.3 Impact on Soil

The Anambra State SAPZ II project will have several impacts on soil due to various project activities during different phases. Effective management of these impacts is crucial to maintain soil health and ensure the sustainability of agricultural activities in the area. Key impacts on soil include erosion and loss of fertility, compaction and alteration of soil structure, contamination, and salinisation.

5.3.7.3.1 Impact of Site Clearance and Preparation

- **Erosion and Loss of Fertility**

During the preconstruction and construction phases, site clearance, removal of vegetation, and earthworks will expose soil surfaces, making them susceptible to erosion. The dismantling of infrastructure and removal of facility structures during the decommissioning phase can also expose soil surfaces, leading to increased erosion. Increased soil erosion can lead to the loss of topsoil, which is the most fertile layer crucial for plant growth. The reduction in soil fertility can affect plant growth and reduce agricultural productivity, impacting local farming communities that rely on the soil for their livelihoods. Eroded material can be transported to nearby waters (Eso Stream and River Nnamuzu), negatively impacting aquatic health (see Section 5.3.7 on Impact on Hydrology). Additionally, these materials may be carried over long distances by wind, contributing to increased particulate matter levels in regional air quality or sedimentation further afield (Boardman & Poesen, 2006; Lal, 2003).

- **Compaction and Alteration of Soil Structure**

Using heavy machinery during preconstruction, construction and decommissioning can compact the soil and disrupt its natural structure. Soil compaction reduces soil porosity and permeability, hindering root growth, decreasing water infiltration, and increasing surface runoff, which can further contribute to erosion and reduce soil productivity. Disrupted soil structure can increase erosion susceptibility, reduce soil's ability to support plant life, and impact soil drainage and aeration.

5.3.7.3.2 Impact of Chemical Use, Storage and Handling

- **Soil and Water Contamination**

Improper handling of lubricants, hazardous substances, and hydrocarbons (such as fuels used in generators) throughout the project phases can lead to soil and water contamination. During the operational phase, the use of pesticides, fertilizers and other chemicals can also introduce harmful chemicals into the soil. Contaminants can accumulate in the soil, posing long-term risks to plant health and the broader ecosystem. Chemicals from contaminated soils can seep into underground water sources, compounding their impacts and potentially affecting both surface and groundwater quality.

- **Contaminate Products**

Improper storage and handling of chemicals in agro-processing facilities can lead to product contamination, causing off-flavours, reduced nutritional value, and potential health risks. Such contamination may necessitate product recalls, leading to financial losses and damaging the company's reputation.

- **Health and Safety Risks**

Improper chemical storage, handling or use can lead to significant health and safety risks. Acute health issues may include skin and eye irritation, respiratory problems, headaches, dizziness, and nausea. On the other hand, chronic exposure could result in serious conditions such as cancer, respiratory diseases, neurological disorders, and reproductive problems. Safety risks include potential fires, explosions, and chemical spills, which can cause severe injuries, environmental damage and monetary losses.

- **Deterioration of Air Quality / Climate Impact (GHG Emissions)**

Additionally, chemical vapours and fumes can deteriorate air quality, contributing to both indoor and outdoor air pollution, which can affect the health of workers, visitors, and the public. Chemicals released into the atmosphere may also exacerbate climate change, as some are greenhouse gases.

5.3.7.4 Impact from Noise and Vibration

5.3.7.4.1 Impact of Noise from Project Activities

The baseline noise levels in the area are primarily from natural sources, such as animal sounds and weather-related noise, as well as simple farming activities. Their levels complied with FMEnv and NESREA standards for ambient noise. However, the project will introduce additional noise sources that may impact workers and nearby residential communities.

During the preconstruction phase, activities such as clearing vegetation and grading will generate additional noise. The establishment of temporary construction camps will also increase noise levels through activities related to material procurement, transportation and access road development. The use of heavy machinery, such as bulldozers and excavators, will further elevate noise levels, potentially disturbing local wildlife and communities. During the construction phase, significant noise will be generated from equipment like cranes and concrete mixers, as well as from generators and heavy vehicles moving to and from the site.

Noise levels from heavy construction equipment will cease during the operational phase; however, additional noise sources will be introduced from the operating of processing equipment, machinery, and utility systems within the SAPZ facilities. Generator operations will continue to contribute to noise during this time. In the decommissioning phase, noise will emanate from dismantling activities, on-site generators, and the movement of demolition equipment.

5.3.7.4.2 Impact of Vibration

Vibrations from construction, operational, and decommissioning activities can affect the local environment. Vibrations are typically measured in terms of peak particle velocity (PPV), expressed in millimetres per second (mm/s) or acceleration, expressed in metres per second squared (m/s^2), frequency (Hz) or less commonly in dB. These measurements help assess the intensity of vibrations and their potential impact on the environment and infrastructure. Baseline vibration levels were not measured during the study. However, it is anticipated that the baseline vibrations are within normal values, given the rural and largely undisturbed nature of the project areas.

Vibrations during the project arise primarily from the use of heavy machinery and equipment across different phases, especially during the preconstruction, construction and decommissioning phases. Impacts from vibration include effects on soil stability and nearby structures. The operation of heavy machinery and demolition work during these phases can lead to vibrations that may disturb soil stability and nearby structures. Prolonged exposure to vibrations could result in structural damage to sensitive buildings and discomfort to residents.

Overall, while baseline noise levels at the project sites comply with regulatory standards, additional noise and vibrations generated by project activities across all phases could have significant impacts. Implementing effective noise and vibration mitigation measures, such as equipment noise reduction, operational controls, and the use of noise barriers, is essential to minimise disturbances and ensure regulatory compliance throughout the project lifecycle.

5.3.7.5 Impact on Landscape

Construction activities at the SAPZ facility, including the construction of campsites, equipment and machinery mobilisation, and other operations, will occur both day and night. Nighttime lighting, while necessary for safety and operational purposes, can lead to visual impacts on local communities and sensitive fauna. Excessive or uncontrolled lighting may disrupt natural behaviours such as migration, breeding, and foraging, potentially hindering the recovery of threatened species and affecting their long-distance movements, breeding success, and survival rates. Additionally, the presence of construction infrastructure and operational facilities may alter the visual aesthetics of the landscape, impacting local communities' perception of their environment. Mitigating these impacts requires limiting lighting to the minimum necessary for safety. Furthermore, the engineering and architectural design should aim to minimise visual disruption.

5.7.3.6 Impact on Agricultural Land Use

The transition from farmland to industrial use can significantly reduce agricultural productivity and heighten food security risks. This shift not only affects the immediate availability of food but also impacts the economic stability of those who rely on farming as their primary income source. Consequently, individuals and communities affected by the loss of agricultural land may experience financial instability.

Additionally, converting agricultural land to industrial use can have broader environmental implications. This includes changes to local ecosystems, such as reduced biodiversity and alterations in soil and water quality. The conversion may also introduce new environmental concerns, including pollution, increased water consumption, and waste management challenges.

In summary, converting agricultural land to processing facilities requires careful consideration of its impacts on land use, local economies, and communities. Although resettlement processes may offer compensation and support, the effects on agricultural land use are substantial. Effective planning and mitigation strategies are essential to balance development with the preservation of agricultural livelihoods and environmental health.

5.7.3.7 Impact on Socioeconomics

The implementation of the SAPZ project can have wide-ranging socioeconomic impacts on local communities, which can occur at various phases of the project. Key impacts include threats to community culture; disagreements arising from sharing proceeds from the conversion of public lands to industrial uses; increased risk of sexually transmitted diseases (STDs); disruptions to access routes for farmers and other road users; increased demand on local resources and infrastructure; and the potential rise in illicit activities. Addressing these impacts requires comprehensive planning and intervention strategies.

- **Threat to Community Culture, Safety and Security**

The influx of migrant workers (labour) to the project communities can negatively impact community culture, safety and security. An increase in population density from incoming workers during the preconstruction and construction phases can strain local resources and services, leading to potential conflicts and disruptions in community life. Sensitising workers to the cultural norms and traditions of the project communities is crucial to mitigating these impacts.

- **Disagreements Arising from Sharing Land Proceeds**

Disagreements may arise from the sharing proceeds from converting public farmlands to industrial uses, particularly during the planning and preconstruction phases. Redistribution of these proceeds may lead to tensions within the community if perceived as unfair or lacking transparency. Such conflicts can strain community relationships and create tension among different groups. Establishing clear, fair, and transparent mechanisms for sharing the benefits of land conversion is essential to mitigate these potential conflicts.

- **Increased Risk of Sexually Transmitted Diseases (STDs)**

The influx of construction workers can intensify the spread of STDs, including HIV/AIDS, particularly during the construction phase. With more people coming into the area, there is a higher risk of communicable diseases spreading among both workers and the local population.

Health education and access to protection and medical services are necessary to address this issue.

- **Disruptions to Access Routes**

Disruptions to access routes due to construction activities can significantly impact all road users, including local farmers who depend on these routes to transport their produce. Blockages or diversions during the construction phase can hinder the efficient movement of goods and services, leading to potential losses in productivity and income, delays, and general inconvenience. These delays can also increase stress and frustration among affected individuals. For farmers, disruptions may induce feelings of helplessness and heightened anxiety about timely market access, given the perishable nature of farm produce. This stress can contribute to dissatisfaction with the project and affect community cohesion and morale. Ensuring that access routes remain functional and accessible throughout the project is crucial for maintaining productivity, income, and psychological well-being.

- **Increased Demand for Local Resources**

The increased demand for local resources such as water, electricity, healthcare, and sanitation facilities due to the influx of migrant workers and project activities during the operational phase can strain existing infrastructure. This heightened demand may lead to shortages or reduced quality of essential services, affecting both the incoming workers and the local residents. Effective resource management and infrastructure upgrades are necessary to accommodate the increased demand and ensure that the local population does not suffer from diminished access to critical services.

- **Increase in Illicit Activities**

Furthermore, the rise in population can lead to an increase in illicit activities such as prostitution, theft, and substance abuse, which can occur during both the construction and operational phases. This not only threatens the safety and security of local communities but also places additional burdens on local law enforcement and social services.

Overall, the socioeconomic impacts of the SAPZ project are extensive, affecting whole communities rather than just individual farm owners. Addressing these impacts requires comprehensive planning and intervention strategies, including community engagement, health education, security measures, resource management, maintaining access routes, and establishing fair benefit-sharing mechanisms to minimize disruptions to local livelihoods and daily activities.

5.3.7.8 Impacts on Health

The potential health risks of SAPZ are associated with increased noise, air pollution, water pollution and occupational hazards. Additionally, STDs and communicable diseases are significant. Health impacts can occur at different phases of the project:

- **Noise Pollution:** High noise levels from construction and operational activities can cause hearing loss, stress, sleep disturbances, and cardiovascular issues for both workers and residents.

- **Air Pollution:** Pollutants like particulate matter PM, NOx, SO_2 VOCs can lead to respiratory and cardiovascular conditions. Dust and emissions particularly impact vulnerable groups, including children and the elderly.
- **Water Pollution:** Contaminant runoff and seepage from construction and operations can degrade water quality, leading to gastrointestinal illnesses and skin irritations.
- **Occupational Hazards:** Workers face risks from accidents, hazardous substances, and machinery-related injuries. Proper safety measures and protective gear are essential to mitigate these risks.
- **STDs:** An influx of migrant workers may increase the risk of sexually transmitted diseases (STDs), including HIV/AIDS. Health education and access to protection are vital.
- **Communicable Diseases:** Higher population density and increased interactions can elevate the risk of communicable disease spread. Effective health measures and vaccination can help control this risk.
- **Community Health:** Strain on local resources and increased stress from changes in community dynamics may impact residents' well-being.
- **Mental Health:** Environmental and social changes, including increased noise and potential conflicts, can affect the mental health of local residents.

5.3.7.9 Impacts on Occupational Health and Safety

Occupational health and safety (OHS) is a critical consideration for any large-scale construction or industrial project. The SAPZ project poses various OHS risks that must be managed to ensure the well-being of workers, including

- **Accidents and Injuries:** The use of heavy machinery, such as bulldozers, cranes, and excavators, poses risks of accidents, including falls, crushing injuries, and collisions. Proper training and strict adherence to safety protocols are essential to minimise these risks. Construction activities, such as excavation, scaffolding, and working at heights, can also lead to accidents if not properly managed. Risks include falls from heights and injuries from falling objects.
- **Exposure to Hazardous Materials:** Workers may encounter hazardous chemicals, such as solvents and fuels, which can lead to acute or chronic health issues. Proper handling, storage, and the use of PPE are crucial. Additionally, construction activities generate dust and particulate matter that can cause respiratory issues if inhaled over prolonged periods. Implementing dust suppression techniques and providing respiratory protection are crucial in reducing exposures.
- **Noise and Vibration:** Prolonged exposure to high noise levels from machinery and equipment can lead to hearing loss. Implementing noise control measures and providing hearing protection are essential to mitigate this risk. Operating vibrating machinery or tools may cause hand-arm vibration syndrome (HAVS), affecting

circulation and nerve function. Monitoring and managing exposure levels are necessary to prevent long-term health effects.

- **Ergonomic Hazards:** Repetitive motions, awkward postures, and heavy lifting can lead to musculoskeletal disorders, such as back pain and joint injuries. Ergonomic assessments and adjustments can help mitigate these risks.
- **Heat Stress:** Exposure to warm temperatures can lead to heat stress stress, which has serious health implications. Providing adequate rest breaks, hydration, and appropriate clothing is essential to address these concerns.
- **Fatigue and Mental Health:** Long work hours and shift work can lead to fatigue, increasing the risk of accidents and impacting mental health. Managing work schedules and providing mental health support are crucial for addressing these issues.
- **Inadequate Emergency Preparedness:** The potential for emergencies, such as fires, chemical spills, or natural disasters, requires comprehensive

5.3.7.10 Impact from Traffic

The SAPZ project is expected to significantly impact local traffic throughout its lifecycle. During the pre-construction phase, traffic will increase due to the delivery of construction materials and equipment, which may lead to congestion, delays, mental stress and heightened safety risks on local roads. As the project progresses into the construction phase, these issues are exacerbated by frequent vehicle movements, including heavy trucks and machinery, which can cause severe congestion, potential road closures, and increased accident risks.

In the operational phase, ongoing traffic from deliveries, waste disposal, and staff commuting may lead to sustained congestion and affect road safety, especially if the infrastructure is not designed adequately to handle the increased load. Similarly, the decommissioning phase will see a resurgence of traffic-related issues akin to the construction phase, with heavy vehicles causing temporary congestion and safety concerns.

5.3.7.11 Impact on Vegetation and Wildlife

The impacts on vegetation and wildlife arise primarily from habitat destruction, alteration, and disturbance, which can have both immediate and long-term consequences for the area's biodiversity. These impacts can be direct or indirect.

5.3.7.11.1 Direct Impacts on Vegetation

The pre-construction and construction can lead to substantial vegetation loss and habitat alteration. Site clearance, including the removal of trees, shrubs, and grasses, can result in habitat destruction and fragmentation. This disruption can have a negative impact on plant communities, especially in areas of high ecological importance such as Ogboji, where the vegetation consists mainly of rainforest and secondary regrowth forests. Furthermore, the introduction of non-native plant species through construction activities or landscaping efforts can lead to competition with native species and alter local ecosystems.

5.3.7.11.2 Direct Impacts on Wildlife

The project can significantly affect wildlife, particularly during the site preparation and construction phases. Habitat destruction and fragmentation may displace wildlife, disrupting their behaviour, feeding, and reproduction. Species dependent on specific habitats or food sources are especially vulnerable. Construction-related lighting, noise, vibration, and increased human activity can further disturb wildlife, increasing stress and altering natural behaviours. For aquatic wildlife, sedimentation from construction activities can degrade water quality and negatively impact species that rely on clear water for breeding and feeding.

5.3.7.11.3 Indirect Impacts

Indirect impacts can stem from changes in land use and new infrastructure. Increased human activity may lead to pollution, affecting plant and animal life. Altered water flow due to construction can impact wetland ecosystems and the species dependent on them. Changes in land use can also increase access to previously undisturbed areas, potentially leading to habitat encroachment and more human-wildlife conflicts.

5.3.7.12 Impact from Waste

The project is anticipated to generate various waste streams throughout its phases. During the preconstruction phase, cleared vegetation will be the primary waste stream. The construction and decommissioning phases will predominantly produce concrete, wood, metals, and packaging materials. In the operational phase, processing by-products, effluents, hazardous chemicals, and agricultural waste like manures and crop residues will be generated. General solid waste, including food scraps and office waste, will be present in all phases.

If not managed properly, these wastes can cause significant environmental contamination. Wastewater from processing facilities may introduce pollutants into soil and water systems, harming aquatic life and degrading water quality. Hazardous wastes, such as solvents and oils, pose risks if they leach into groundwater or enter water bodies.

Waste management practices also pose direct health and safety risks. Exposure to toxic substances from hazardous materials can lead to respiratory issues, skin irritations, and other health problems. Improperly managed waste can attract pests, increasing disease spread.

The air quality and climate can be affected by waste management. Incineration can release pollutants, including particulate matter, dioxins, and greenhouse gases like CO2, contributing to air quality degradation and climate change impacts.

Open dumping of waste can alter landscapes, making them unsightly and emitting unpleasant odours that affect the aesthetics and living conditions of nearby communities.

5.3.7.13 Impact on Climate

The climate impacts of the SAPZ project span several phases, starting with pre-construction. In Ogboji, deforestation of rainforests and primary regrowth forests results in significant CO_2 emissions as stored carbon is released. This loss also reduces the area's carbon sequestration capacity and can alter local climate conditions by increasing temperatures and changing precipitation patterns.

During construction, the project's carbon footprint expands due to heavy machinery and fossil fuel use, leading to increased greenhouse gas emissions and soil disturbance. These activities not only release more CO2 but also enhance erosion, affecting the land's ability to sequester carbon. The creation of paved surfaces contributes to the heat island effect, further elevating local temperatures.

In the operational phase, the ongoing use of machinery, transportation, and energy consumption continues to contribute to greenhouse gas emissions. The reliance on non-renewable energy sources adds to the project's carbon footprint, compounded by the emissions from the pre-construction phase.

The decommissioning phase perpetuates climate impacts through emissions from demolition activities and machinery. Soil disturbance during dismantling and improper waste management can lead to additional carbon release and environmental contamination.

described qualitatively in the context of other existing or planned development Projects.

5.3.8 Summary and Rating of Identified Impacts

Table 5.8 summarises the environmental and social impacts associated with all phases of the SAPZ project. Each impact is described by the specific activities causing it, the affected receptors, and a calculated significance ranking (SR), which considers the impact's magnitude and probability of occurrence as outlined in Section 5.2.5. The table aims to identify key areas of concern and prioritise them for effective mitigation and management strategies to protect both the natural environment and local communities throughout the project's lifecycle.

The table includes both positive and negative impacts, categorised according to the phases where they occur. Some impacts, such as deterioration of air, among others, occur in multiple phases.

Table 5.8: Summary and Rating of Biophysical and Socioeconomic Impacts During All Project Phases

Impact	Activity	Receptor	A	B	C	D	P	SR
Preconstruction Phase								
			SR = (A+B+C+D) * P					
Changes in visual aesthetics	Engineering /Architectural Design Implementation	Local Community / Environment	1	3	2	3	5	45
Community concerns: safety, culture, and security	Influx of migrant workers	Local Communities	1	3	3	3	5	50
Disagreements Arising from Sharing Land Proceeds	Land Acquisition	Local Communities	3	3	3	3	5	60
Displacement and loss of fauna due to disturbance from excavation and site clearance	Site clearing leading to Deforestation	Biodiversity	3	3	3	3	5	60
Elevated noise levels	Clearing vegetation, grading, establishment of camps, use of heavy machinery	Fauna, Workers and Local Communities	3	3	3	1	5	50
Deterioration of Air Quality	Site clearance, excavation, and transport activities	Local Communities, Workers, Environment	3	3	3	1	5	50
GHG emissions from deforestation and vegetation removal	Site clearing leading to Deforestation	Climate	3	3	3	3	5	60
Loss of agricultural Land	Land acquisition	Local Farmers	3	3	3	3	5	60
Loss of Biodiversity	Deforestation / Site Preparation	Biodiversity	3	3	3	2	5	55
Reduction in carbon sinks	Site clearing leading to Deforestation	Climate	3	3	3	3	5	60
Resettlement impacts due to the acquisition of farmlands for industrial purposes	Land acquisition	Local Farmers	3	3	2	1	5	45
Risk of physical injury to wildlife species	Clearing of vegetation, grading, establishment of camps, use of heavy machinery	Biodiversity	3	3	2	1	5	45
Increased flood risk	Site clearance and grading, initial layout of stormwater management systems	Project site, local water bodies, soil, farmlands, properties	1	3	3	3	3	30
Increased risk of sexually transmitted diseases	Influx of migrant workers	Community / Workers' Health	1	3	3	1	5	40

Preconstruction Phase								
Impact	**Activity**	**Receptor**	**A**	**B**	**C**	**D**	**P**	**SR**
			SR = (A+B+C+D) * P					
Risks from inadequate emergency response	Project activities	Workers	3	3	2	1	5	45
GHG Emission from burning fossil fuel	Use of fossil fuel in machinery and generators	Climate	3	3	3	3	5	60
GHG emissions from soil and cleared vegetation	Site Preparation (Excavation and soil disturbance)	Climate	3	3	3	3	5	60
Involuntary migration of animal species	Noise generating activities	Biodiversity	3	3	3	1	5	50
Vibration affecting soil stability	Use of heavy machinery and equipment	Fauna, Flora, Workers and Local Residents	1	1	1	1	5	20
Water quality impairment due to sedimentation	Vegetation Removal, Site Clearance, excavation, levelling and grading	Surface Water	3	3	2	2	5	50
Changes in soil structure	Site preparation and grading activities	Soil, Local Ecosystem	3	3	2	2	5	50
Erosion of surface soil	Vegetation Clearing, Excavation and earthmoving	Soil, Surface Water	3	3	2	2	5	50
Employment Opportunities	Hiring of Labour for preconstruction and construction activities	Local Communities, Skilled and Unskilled Workers	1	-3	-2	-2	5	-30
Capacity Building / Skill Transfer	Training and development programs	Local Communities, Workers	1	-3	-2	-2	2	-12
Increase in Private Investment	Attracting investors to invest in the project	Local Communities, Local Businesses	1	-3	-3	-3	3	-24
Traffic congestion	Delivery of materials and equipment, frequent vehicle movements	Road Users, Workers and Local Community	1	3	2	1	5	35

Preconstruction / Construction Phases								
Impact	**Activity**	**Receptor**	**A**	**B**	**C**	**D**	**P**	**SR**
			SR = (A+B+C+D) * P					
Disruptions to access routes	Construction activities	Road Users, Workers and Local Community	1	3	3	2	5	45
GHG Emission from burning fossil fuel	Use of fossil fuel in machinery and generators	Climate	3	3	3	3	5	60
GHG emissions from soil and cleared vegetation	Site preparations (Excavation and soil disturbance)	Climate	3	3	3	3	5	60
Involuntary migration of animal species	Noise generating activities	Biodiversity	3	3	3	1	5	50
Vibration affecting soil stability	Use of heavy machinery and equipment	Fauna, Flora, Workers and Local Residents	1	1	1	1	5	20
Water quality impairment due to sedimentation	Vegetation Removal, Site Clearance, excavation, levelling and grading	Surface water	3	3	2	2	5	50
Changes in soil structure	Site preparation and grading activities	Soil, Local Ecosystem	3	3	2	2	5	50
Erosion of surface soil	Vegetation Clearing, Excavation and earthmoving	Soil, Surface water	3	3	2	2	5	50
Employment Opportunities	The hiring of Labour for preconstruction and construction activities	Local Communities, Skilled and Unskilled Workers	1	-3	-2	-2	5	-30
Capacity Building / Skill Transfer	Training and development programs	Local communities, Workers	1	-3	-2	-2	2	-12
Increase in Private Investment	Attracting investors to invest in the project	Local Communities, Local Businesses	1	-3	-3	-3	3	-24
Archaeological/Cultural Heritage Loss or Disturbance	Disturbance or destruction of archaeological and cultural heritage sites	Local Communities	3	3	3	1	3	30
Traffic congestion	Delivery of materials and equipment, frequent vehicle movements	Road users, Workers and Local community	1	3	2	1	5	35
Disruptions to access routes	Construction activities	Road users, Workers and Local community	1	3	3	2	5	45

Construction Phase								
Impact	Activity	Receptor	A	B	C	D	P	SR
			SR = (A+B+C+D) * P					
Deterioration of Air Quality	Emissions from the use of heavy machinery, transportation; and the use and application of materials such as cement, paint, and solvents in construction	Local Communities, Workers	3	3	3	1	5	50
Changes in the behaviour of Fauna Species	Nighttime lighting	Biodiversity	1	3	3	1	5	40
Changes to visual aesthetics	Construction of campsites, equipment mobilisation, nighttime lighting	Local community / Environment	3	1	1	3	5	40
Disruption of natural behaviours	Nighttime lighting	Fauna	3	3	3	3	5	60
Elevated noise levels	Operation of equipment, generators, and heavy vehicles	Fauna, Workers and Local Communities	3	3	3	1	5	50
Health implications from exposure to warm temperatures (Heat stress)	Heavy machinery operation / Physical labour	Workers	3	3	3	1	5	50
Hearing loss, hand-arm vibration syndrome	Use of generators and machinery generating noise and vibration	Workers	3	1	1	1	5	30
Increased flood risk	Excavation and earthworks, installation of drainage infrastructure	Project site, local water bodies, soil, farmlands, properties	1	3	3	2	3	30
Loss of Biodiversity	Poor waste disposal/management system	Biodiversity	3	3	3	1	5	50
Mental health impacts	Delivery of materials and equipment, frequent vehicle movements	Road users, Workers and Local community	1	3	3	1	5	40
Potential risks of falling from heights	Working at heights	Workers	3	3	3	1	5	50
Risk of exposure to faulty electrical devices, such as cables, cords, hand tools	During electrical works	Workers	3	3	2	1	5	45

Risk of fire due to use of faulty cables and plugs	During electrical works	Workers	3	3	2	1	5	45
Risk of increased incidence of invasive and alien plant species	Construction activities	Biodiversity	3	3	2	1	5	45
Risks to workers' health	Use of heavy machinery, exposure to hazardous materials, noise, vibration, ergonomic hazards, heat stress, fatigue	Workers	3	3	2	1	5	45

Construction / Operational Phases								
Impact	**Activity**	**Receptor**	**A**	**B**	**C**	**D**	**P**	**SR**
			SR = (A+B+C+D) * P					
Severe health impacts / Contamination of the environment	Use of /Exposure to hazardous materials	Workers / Local Communities / Biodiversity	3	3	3	2	5	55
Changes in local ecosystems	Change in Land use from agricultural to industrial	Agricultural Land	3	3	3	1	5	50
Changes in visual aesthetics	Engineering /Architectural Design Implementation	Local Community / Environment	3	1	1	3	5	40
Changes in visual aesthetics	Poor waste management at all phases of the project	Local Community / Environment	3	2	3	3	4	44
Changes to visual aesthetics	Lighting / Construction /Operation	Local Community / Environment	3	1	1	3	5	40
Community safety concerns	Influx of migrant workers	Local Communities	1	3	3	3	5	50
Decrease in agricultural productivity	Conversion of farmland to industrial use	Local Farmers	0	3	3	3	5	45
Elevated risk of communicable diseases	Increased population density	Community Health	3	3	3	3	5	60
Financial instability for farmers	Land acquisition	Local Farmers	3	3	3	3	3	36
Health impacts from air pollution	Burning of fossil fuels	Community / Workers' Health	3	3	3	3	5	60
Health impacts from noise pollution	Influx of migrant workers, increase in population density	Community / Workers' Health	3	3	3	1	5	50

Construction / Operational Phases								
Impact	**Activity**	**Receptor**	**A**	**B**	**C**	**D**	**P**	**SR**
			SR = (A+B+C+D) * P					
Increase pressure on local infrastructure and services including health facilities, water resources, etc.	Influx of migrant workers, increase in population density	Local Communities	1	3	3	2	5	45
Increased food security risk	Conversion of farmland to industrial use	Local Communities	1	3	3	3	5	50
Increased flood risk	Creation of impervious surfaces (roads, buildings), improper stormwater system maintenance	Project site, local water bodies, soil, farmlands, properties	1	3	3	3	3	30
Increased risk of accidents, injuries, and hazardous emissions due to poor maintenance of equipment and machinery	Construction activities	Workers	3	3	3	2	5	55
Increased risk of sexually transmitted diseases	Influx of migrant workers	Community / Workers' Health	1	3	3	1	5	40
Increased risk of vehicular collision due to increased traffic	Transportation activities	Road Users, Workers, Local Communities	3	3	3	1	5	50
Loss of viable aquatic species due to oil spillage	Accidental/Negligent discharge of diesel from operation of generators and heavy machinery	Biodiversity	3	3	3	1	5	50
Musculoskeletal disorders resulting from ergonomic hazards	Offloading and loading of products and materials	Workers	3	3	3	1	5	50
Risk of explosion due to unsafe storage of chemicals or Oil spills due to leakage of containers	Fuel and chemical storage	Workers	3	3	2	1	5	45
Health risks from chemicals	Poor storage, handling and use of chemicals	Workers/ Local Communities	3	3	2	2	5	50
Deterioration of Air Quality / GHG Emissions	Chemical fumes from Chemicals	Climate/Workers/ Local Communities	3	3	2	3	5	55

Construction / Operational Phases								
Impact	**Activity**	**Receptor**	**A**	**B**	**C**	**D**	**P**	**SR**
			SR = (A+B+C+D) * P					
Risk of loss of life due to lack of training or application of relevant PPEs	Construction/operation activities	Workers	3	3	2	1	5	45
Risks from inadequate emergency response	Construction activities	Workers	3	3	2	1	5	45
Strain on local infrastructure	Increased demand for local resources	Local Communities	1	3	2	3	5	45
Threats to community culture	Influx of migrant workers	Local Communities	1	3	2	3	5	45

Operational Phase								
Impact	Activity	Receptor	A	B	C	D	P	SR
			SR = (A+B+C+D) * P					
Elevated noise levels from operational activities	Operating of processing equipment	Fauna, Workers and Local Communities	3	3	3	1	5	50
Greenhouse gas emissions	Use of fossil fuel to power processing facility	Climate	3	3	3	3	5	60
Increased flood risk	Dismantling and removal of infrastructure, site restoration activities	Project site, local water bodies, soil, farmlands, properties	1	3	3	3	3	30
Deterioration of Air Quality	Machinery and equipment operation; processing activities and transportation and vehicular emissions	Local Communities, Workers, Environment	3	3	3	1	5	50
Unpleasant Odours from agro-produce processing, waste composting, wastewater treatment, and livestock sheds	Operational Activities		3	1	1	1	5	30
Health implications from exposure to warm temperatures (Heat stress)	Processing and Production Activities / Poor Ventilation	Workers	3	3	3	1	5	50
Hearing loss, hand-arm vibration syndrome	Use of generators and machinery generating noise and vibration	Workers	3	3	3	1	5	50

Operational Phase								
Impact	Activity	Receptor	A	B	C	D	P	SR
			SR = (A+B+C+D) * P					
Loss of Biodiversity	Waste disposal, Processing by-products	Biodiversity	3	3	3	2	5	55
Risks to workers' health	Use of heavy machinery, exposure to hazardous materials, noise, vibration, ergonomic hazards, heat stress, fatigue	Workers	3	3	2	1	5	45
Water quality impairment	Processing by-products, wastewater generation and seepages from contaminated soil	Groundwater/Surface Water	3	3	2	2	5	50
Health risks from chemicals	Poor storage, handling and use of chemicals	Workers/ Local Communities	3	3	2	2	5	50
Deterioration of Air Quality / GHG Emissions	Chemical fumes from Chemicals	Climate/Workers/ Local Communities	3	3	2	3	5	55
Risk of loss of life due to lack of training or application of relevant PPEs	Construction/operation activities	Workers	3	3	2	1	5	45
Product contamination	Chemical storage	Workers	3	3	2	1	5	45
Employment Opportunities	Operational activities leading to the growth of local businesses and ancillary services	Local Communities, Skilled and Unskilled Workers	1	-3	-2	-1	5	-25
Economic Growth	Increased business activities	Local Economy, Anambra State	3	-3	-3	-3	5	-30
Capacity Building / Skill Transfer	Ongoing training and upskilling	Local Communities, Workers	1	-3	-2	-2	2	-12
Increase in Agricultural Productivity	Improved farming techniques and technologies	Local Farmers	1	-3	-3	-3	3	-24
Enhanced Food Security	Increased food production and efficient processing and distribution of produce	Local Farmers, Local Communities, Local Consumers, Anambra State	1	-3	-3	-3	3	-24
Infrastructure Development	Construction of roads, utilities and facilities	Local Communities	1	-3	-3	-3	2	-16

Operational Phase								
Impact	Activity	Receptor	A	B	C	D	P	SR
			SR = (A+B+C+D) * P					
Increase in Public Revenue	Taxes and fees from economic activities	Affected LGAs, Anambra State Government	1	-3	-3	-3	3	-24
Elevated noise levels from operational activities	Operating of processing equipment and generators	Fauna, Workers and Local Communities	3	3	3	1	5	50
Greenhouse gas emissions	Use of fossil fuel to power processing facility	Climate	3	3	3	3	5	60
Deterioration of Air Quality	Machinery and equipment operation; processing activities and transportation and vehicular emissions	Local Communities, Workers, Environment	3	3	2	3	5	55
Health implications from exposure to warm temperatures (Heat stress)	Processing and Production Activities / Poor Ventilation	Workers	3	3	3	1	5	50

Decommissioning Phase Phase								
Impact	Activity	Receptor	A	B	C	D	P	SR
			SR = (A+B+C+D) * P					
Deterioration of Air Quality	Demolition and dismantling of structures, site clearance, excavation and transport activities	Local Communities, Workers, Environment	3	3	3	1	5	50
Changes in visual aesthetics	Poor waste management at all phases of the project	Local Community / Environment	3	2	3	3	4	44
Changes to visual aesthetics	Removal of architectural infrastructure	Local Community / Environment	3	2	-3	-3	2	-2
Community safety concerns	Influx of migrant workers	Local Communities	1	3	3	3	5	50
Elevated noise levels from decommissioning activities	Dismantling activities, use of generators, movement of demolition equipment	Fauna, Workers and Local Communities	3	3	3	1	5	50
Risks from inadequate emergency response	Operational activities	Workers	3	3	2	1	5	45

Decommissioning Phase Phase								
Impact	Activity	Receptor	A	B	C	D	P	SR
			SR = (A+B+C+D) * P					
Traffic congestions	Delivery of materials and equipment, frequent vehicle movements	Road Users, Workers and Local Community	1	3	2	1	5	35
Vibration affecting soil stability	Operation of heavy machinery and demolition work	Fauna, Flora, Workers and Local Community	1	1	1	1	5	20
Water quality impairment due to sedimentation	Dismantling infrastructure and excavation	Surface Water	3	3	2	2	5	50
Recovery of agricultural productivity	Restoration and site rehabilitation	Agricultural Land, Farmers	3	-3	-3	-3	2	-12
Creation of Green Spaces	Landscaping and restoration activities	Local Communities, Environment	3	-3	-3	-3	2	-12
Mental health impacts from transport activities	Delivery of materials and equipment, frequent vehicle movements	Road Users, Workers and Local Community	1	3	3	1	5	40
Increased risk of vehicular collision due to increased traffic	Transportation activities	Road Users, Workers, Local Communities	1	3	2	2	5	40
Loss of employment	Cessation of facility operations	Workers	1	3	2	2	5	40

5.3.4 Cumulative Impacts

Cumulative impacts and effects arise from the impact and effect of the project interacting with other relevant past, present, and reasonably foreseeable developments to create an additional impact and effect.

This includes unplanned but predictable activities that may occur later or at different locations due to the project's influence. Cumulative impacts can arise from individually minor but collectively significant activities over time, and they must be considered in an ESIA based on scientific concerns and/or the concerns of project-affected parties (AfDB ISS, 2023).

IFC Performance Standard 1 expands on this by defining the broader project area to include regions potentially impacted by cumulative effects from further planned developments, existing projects, and other related activities. It also includes potential transboundary effects, such as air pollution or the use of international waterways and global impacts like greenhouse gas emissions.

Cumulative impacts often result from the interaction of multiple activities affecting the same resources or receptors. These impacts can sometimes be more significant when combined, although, in some cases, they may simply be the sum of individual impacts. The complexity of effectively designing and implementing a Cumulative Impact Assessment (CIA) typically exceeds the technical and financial capacity of a single proponent, especially given the need for coordination with other developers and authorities in the region.

A CIA is a multi-stakeholder, iterative process that requires the involvement of multi-disciplinary teams and a robust governance structure. It is also time- and data-intensive, necessitating collaboration across different sectors to accurately assess and manage cumulative impacts.

5.3.4.1 Development Context

In addition to the direct impacts assessed, the project may experience cumulative impacts resulting from interactions with existing and planned third-party projects and activities within the project area. Identifying and understanding these projects are essential for a comprehensive assessment of potential cumulative effects. The key existing developments in the project vicinities are discussed below.

5.3.4.1.1 Oil Palm Processing Facilities in Ogboji

Ogboji hosts a small-scale palm processing facility that plays a crucial role in the local economy by processing oil palm fruits into palm oil for both domestic and commercial markets. It is the community’s sole oil palm processing unit, and there is no cassava processing facility in the area.

Potential Environmental and Social Impacts:

- **Environmental**: Issues include waste generation (palm kernel shells, effluents), air emissions from processing activities, and soil contamination from spilt palm oil.
- **Social**: Provides employment and potential for improved livelihoods but may also raise concerns related to working conditions and occupational health and safety.

5.3.4.1.2 Rice Mills in Omor and Ugbene

Omor and Ugbene host several rice milling facilities that process locally grown rice, contributing to the value chain of agricultural produce. These mills range from small-scale to larger operations and are seasonally active during harvest periods.

Potential Environmental and Social Impacts:

- **Environmental:** Issues include waste generation (rice husk), dust and noise pollution from milling, water usage, and potential wastewater discharge. CO2 emissions may result from generator use.
- **Social:** Provides employment, supports food security, reduces farm produce waste, supports regional economy and improves standards of living.

5.3.4.1.3 Fadama III Project in Ugbene

The Fadama III project, located near the proposed project site, is a World Bank-assisted initiative focused on enhancing agricultural productivity and livelihoods through sustainable practices. It is partially moribund but provides farming equipment and training when functional.

Potential Environmental and Social Impacts:

- **Environmental**: Potential benefits include improved agricultural productivity efficiency, food security and farmers' income. However, improper equipment use can lead to soil degradation, pollution and safety risks
- **Social**: Historically provided capacity building and increased agricultural yields, but challenges include maintaining project sustainability and continuous support.

5.3.4.1.4 Rural Electrification Project in Omor

Description: This solar farm project by the Federal Government provides electricity to Omor Town, enhancing living standards and supporting local economic activities through renewable energy.

Environmental and Social Impacts:

- Environmental: Positive impact includes reduced reliance on non-renewable energy and lower greenhouse gas emissions. Risks include the potential degradation of solar infrastructure if not maintained.
- Social: Improvements in economic productivity and quality of life. Challenges may include ensuring equitable distribution of benefits and maintaining infrastructure.

5.3.4.1.5 Infrastructure Projects

Ongoing and planned infrastructure projects, including the planned AMIC, rural road improvements and electrification schemes in Anambra State, enhance connectivity and service access.

- Potential Environmental and Social Impacts:
- Environmental: Potential land disturbance, habitat fragmentation, and increased deforestation.
- Social: Improves market and service access but may lead to displacement and changes in land use patterns.

5.3.4.1.6 Local Small-Scale Farming Activities

Numerous small-scale farmers in the region grow crops such as cassava, maize, and vegetables, forming the backbone of Anambra State's food system.

Potential Environmental and Social Impacts:

- Environmental: Includes habitat alteration and soil/water contamination due to land clearing and agrochemical use if not managed properly.
- Social: Provides subsistence and income, preserves traditional farming practices, and faces vulnerabilities to market and climate fluctuations.

5.3.4.1.7 Minor Agro-Processing Units

Small agro-processing units across the region process products like cassava into garri and other local staples.

Potential Environmental and Social Impacts:

- Environmental: Waste generation and localised pollution.
- Social: Supports local entrepreneurship and food diversity, and provides employment.

5.2.4.2 Identified Cumulative Impact

5.2.4.5.1 Cumulative Air Quality Impact

The SAPZ project may exacerbate existing air quality challenges in the region, particularly in Omor, where the average localised SO_2 level in one of the sampling stations was recorded as higher than regulatory ambient recommendations. This indicates a potential for further air quality degradation, especially as the area accommodates both new and existing industrial activities. Furthermore, small-scale facilities within the project areas, including those in Ogboji, Omor, and Ugbene, often rely on fossil fuels. The cumulative effect of these emissions can pose a challenge in managing air quality. Given these concerns, it is critical to implement robust monitoring and mitigation strategies to manage air quality, particularly in sensitive areas like Omor.

5.2.4.5.2 Cumulative Resource Exploitation Impact

The SAPZ project, when combined with ongoing agricultural and agro-processing activities, is likely to intensify the demand for natural resources, particularly water and land. This increased demand may heighten the risk of overexploitation, especially if existing facilities and practices are already exerting pressure on these resources. Optimising resource use within the SAPZ AIH and the ATCs will significantly reduce these cumulative impacts.

5.2.4.5.3 Cumulative Energy Impact

The integration of SAPZ's new infrastructure, including power supply and processing facilities, with existing energy initiatives, like the solar-powered rural electrification project in Omor, could offer benefits such as enhanced energy access and reduced dependence on non-renewable energy sources. Moreover, the plan to install substations and solar farms at AMIC will benefit the users of the facilities and residents who may be integrated into the planned infrastructure, leading to an overall positive cumulative impact.

5.2.4.5.4 Cumulative Socioeconomic Impact

The SAPZ project will create significant employment opportunities, complementing those generated by existing agro-processing activities and small-scale farming. The cumulative economic impact is expected to stimulate local economic growth and capacity building. However, this could also lead to challenges in workforce management, as the combined demand for labour might outstrip supply, leading to wage inflation or social tensions. Ensuring that the economic benefits are equitably distributed among the community is essential to preventing disparities that could arise from competition for jobs and resources.

Furthermore, the partial moribund state of the Fadama III project in Ugbene has led to scepticism among farmers regarding the sustainability and support of new initiatives. The introduction of SAPZ, if not managed, could compound these concerns. The community may fear a repeat of past failures, which could erode trust and engagement. To ensure the sustainability of SAPZ and maintain community support, it is crucial to integrate SAPZ efforts with existing initiatives, providing continuous capacity building and ensuring that the project delivers on its promises.

5.2.4.5.5 Cumulative Waste Management Impact

The cumulative waste generation from the SAPZ project, alongside waste from existing facilities, presents a significant environmental challenge. Current facilities already produce waste by-products like palm kernel shells, rice husks, and processing effluents. Adding SAPZ's waste streams could exacerbate soil and water pollution and increase greenhouse gas (methane) emissions if not properly managed. The cumulative impact on the region’s waste management infrastructure may overwhelm existing capacities, necessitating robust waste management strategies to prevent environmental degradation.

5.2.4.5.6 Cumulative Biodiversity Loss Impact

The large-scale development under SAPZ II, when combined with ongoing agricultural and industrial activities, may significantly accelerate habitat loss. Existing facilities have already contributed to land clearing, and further expansion through SAPZ could overlap with sensitive ecological areas, leading to a cumulative reduction in biodiversity. The cumulative impact on both terrestrial and aquatic ecosystems could be profound, necessitating coordinated conservation efforts to protect and increase natural vegetation cover.

5.2.4.5.7 Cumulative Land Use Impact

The SAPZ project's infrastructure developments, such as roads and processing facilities, will likely enhance market access and services, but they also risk contributing to cumulative land use changes. Existing and planned infrastructure projects are already altering land use patterns in Anambra State, leading to habitat fragmentation and deforestation. The cumulative effect of these developments could threaten the region's environmental sustainability if not carefully managed. Strategic land use planning that considers the cumulative impacts of all projects is essential to balancing development with conservation.

5.2.4.5.8 Cumulative Impact Conclusion

Accurately assessing cumulative impacts requires effective collaboration among project owners and access to comprehensive data on existing facilities and operations. The absence of complete data makes precise quantification challenging. However, leveraging expert knowledge and the detailed methodologies outlined in previous sections, combined with a comprehensive understanding of the current conditions in the project's area of influence, suggests that the cumulative impacts of the SAPZ project, in conjunction with existing operations, are assessed as moderate. This assessment considers factors such as resource utilisation, waste management, and potential pollution sources. Future data collection and ongoing monitoring will be crucial to refining these impact assessments and ensuring sustainable development.

CHAPTER 6 IMPACT MITIGATION

Once the significance of a given impact has been characterised, the next step is to evaluate what mitigation measures are warranted. According to the EU Directive 2014/52, mitigation is defined as measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements.

It is important to have a solid basis for recommending mitigation measures. The role of any given ESIA is to help develop a consentable project, and to help proponents responsibly meet their development objectives. Impact assessment is about identifying the aspects of a project that need to be managed, and demonstrating how these have been appropriately dealt with. As key influencers in the decision-making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high-quality evidence base.

Additionally, mitigation measures should not be declared for impacts rated as not significant unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a non-significant level; rather the objective is to reduce impacts to an as low as reasonably possible (ALARP) level.

6.1 Methodology for Impact Mitigation

The approach to managing significant environmental and social impacts throughout the project lifecycle is structured around a hierarchy of strategies designed to address potential adverse effects effectively (Morrison-Saunders, 2023; Glasson and Therivel, 2019). This approach includes:

1. **Avoidance:** The first step is to proactively avoid potential negative impacts by re-evaluating and adjusting project components to prevent adverse outcomes. For example, establishing a green buffer around the site perimeter will help mitigate impacts on neighbouring settlements, preventing environmental and social disturbances.
2. **Minimisation:** When avoidance is not feasible, the focus shifts to minimising the extent or severity of impacts. This involves implementing best practices and technologies to reduce the consequences of any adverse effects. For instance, using silt fences and sediment control measures during construction can significantly reduce sediment entering nearby water bodies.
3. **Rectification:** If an impact occurs despite avoidance and minimisation efforts, rectification measures are essential. This involves actively repairing or restoring the affected environment. For example, if soil contamination occurs, techniques such as bioremediation or soil washing are used to cleanse the impacted areas and restore environmental health.

4. **Compensation:** In cases where full mitigation is not achievable through the above steps, compensation measures will be implemented. These measures involve providing alternative benefits to offset adverse impacts. For example, resettlement plans will be developed for farmers displaced by the loss of agricultural land.
5. **Monitoring and Adaptive Management:** Effective mitigation requires ongoing oversight and adjustment. Continuous monitoring assesses the effectiveness of mitigation strategies and detects unforeseen impacts early. Adaptive management practices are then applied to make necessary adjustments and corrections, ensuring that mitigation efforts remain effective throughout the project's lifecycle. For instance, regular water quality assessments near construction sites will allow for prompt responses to any unexpected pollution issues.

In summary, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated project activity), and then to address the resultant effect on the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

6.2 Mitigation Preconstruction Procurement Risks

To manage potential impacts relating to contractor procurement and ensure the effective implementation of mitigation measures as outlined in the ESIA and the Environmental and Social Management Plan (ESMP), the following Environmental, Social, Health, and Safety (ESHS) conditions will be integrated into the bidding documents, as described in Tables 6.1 and 6.2. The following elements are included:

- **Past Contractor Performance:** Evaluation of contractors' previous performance related to ESHS aspects, including records on sexual exploitation, abuse, and gender-based violence.
- **ESHS Staff:** Contractors must adhere to specified requirements for ESHS staffing.
- **Performance Security:** Compliance with performance-related security measures is required.
- **Mitigation Measures**: Contractors must implement mitigation measures throughout the project lifecycle.
- **Contractor's Code of Conduct:** Adherence to a specified code of conduct is mandatory for contractors.
- **Management Strategies and Implementation Plans (MSIP):** Contractors must comply with MSIP requirements.

By integrating these conditions, the project will ensure that contractors are selected based on their ability to adhere to high ESHS standards, thereby minimising potential adverse impacts and promoting the successful execution of the project in line with established environmental and social safeguards.

Table 6.1: ESHS Management in the Bidding Documents

S/N	Condition	The rationale for the inclusion of this condition in the contract	Specifications to be included in the Bidding Documents	Responsibility	
				Bidders	**SPIU/AMIC/SAPZ**
1	Past performance of the Contractor on ESHS is one of the eligibility criteria for the shortlisting process	The contractor's past performance on compliance with ESHS is an indicator of the contractor's commitment and capability for implementation of this ESMP	The Bidder shall "declare any civil work contracts that have been suspended or terminated and/or performance security called by an employer for reasons related to the non-compliance of any environmental, or social (including sexual exploitation and abuse (SEA) and gender-based violence (GBV) or health or safety requirements or safeguard in the past five years".	Bidder to make the Declaration	Bidder to make the Declaration SPIU/AMIC/SAPZ use this information to seek further information or clarifications in carrying out its due diligence
2	The contractor shall propose and possess an ESHS	The Contractor's staff should include an ESHS specialist who is responsible for the implementation of all mitigation measures on ESHS risks and compliance with ESMP	The Bidder shall propose an Environmental, Social, Health and Safety (ESHS) Specialist as the Contractor's Key Personnel at the Site. The Bidder shall provide details of the proposed ESHS specialist including academic qualifications and work experience. The ESHS Specialist should have a minimum bachelor's degree in engineering or a master's degree in sciences related to environmental management. The Specialist should have 5 years of experience working on monitoring and managing ESHS risks related to airport projects or other similar infrastructure Projects	The Bidder shall propose an Environmental, Social, Health and Safety (ESHS) Specialist as the Contractor's Key Personnel at the Site. The Bidder shall provide details of the proposed ESHS specialist including academic qualifications and work experience. The ESHS Specialist should have a minimum bachelor's degree in engineering or a master's degree in sciences related to environmental management. The Specialist should have 5	The bidder shall submit the CV of the proposed ESHS Specialist

S/N	Condition	The rationale for the inclusion of this condition in the contract	Specifications to be included in the Bidding Documents	Responsibility	
				Bidders	SPIU/AMIC/SAPZ
				years of experience working on monitoring and managing ESHS risks related to airport projects or other similar infrastructure Projects	
3	The contractor shall submit ESHS Performance Security for compliance with ESHS obligations	The Contractor should have a financial implication if he could not comply with ESHS requirements. Hence performance security will be collected from the contractor	The Bidder shall submit the ESHS Performance Security in the form of a "demand guarantee" in the amount of one per cent (1 %) of the Contract Amount	The bidder will submit a Performance Security	
4	Implement Mitigation Measures to Address Construction-Related Impacts	The mitigation measures to address potential ESHS risks and impacts should be included in the bidding documents. The contractor shall be made responsible for the implementation of the mitigation measures through	AMIC/SAPZ will include mitigation, monitory and implementation plan in the General Specifications of the Bidding Document and the reference to these tables will be provided in the Conditions of the Contract as follows: ♦ The Contractor shall implement the mitigation and monitoring measures given in provided in the ESMP to address ESHS risks associated with the construction works. ♦ The Contractor shall comply with the African Development Bank Group's Environmental and Social Guidelines and Policies.		SPIU/AMIC/SAPZ shall include this requirement in the bidding document

S/N	Condition	The rationale for the inclusion of this condition in the contract	Specifications to be included in the Bidding Documents	Responsibility	
				Bidders	SPIU/AMIC/SAPZ
		the necessary conditions in the contract.			
5	Payments for Implementation of ESHS Mitigation and Monitoring Measures	The proposed measures to address ESHS risks are mainly related to workplace safety. Hence the cost of implementing the ESHS requirements shall be covered by Bidder's rates for the relevant works, and no separate payment will be made.	The cost of delivering the ESHS requirements shall be a subsidiary obligation of the Contractor covered under the prices quoted for other Bill of Quantity items. No separate payments will be made for the implementation of ESHS requirements.		SPIU/AMIC/SAPZ shall include this requirement in the bidding document
6	Code of Conduct for Contractor's Personnel	All workers hired by the Contractor should sign a code of conduct to ensure compliance with ESHS obligations of the Contract	The Bidder shall submit the Code of Conduct that will apply to the Contractor's employees and subcontractors. The Code of Conduct will state that the workers will comply with the following ESHS requirements: ♦ All workers hired by the Contractor should sign a code of conduct to ensure compliance with ESHS obligations of the Contract ♦ Wearing Personal Protective Equipment (PPE) in the workplace at all times ♦ Non-discrimination in dealing with the local community by race, ethnicity, gender, religion,	Bidder shall submit a code of Conduct with the bid documents	

S/N	Condition	The rationale for the inclusion of this condition in the contract	Specifications to be included in the Bidding Documents	Responsibility	
				Bidders	SPIU/AMIC/SAPZ
			disability, sexual orientation, gender identity, social, or health status ♦ Respectful attitude while interacting with the local community ♦ Prohibit sexual harassment, particularly towards women and children Prohibit violence, including sexual and/ or gender-based violence		
7	Contractor's Management Strategies and Implementation Plan (MSIP) to manage the ESHS Risk	The Contractor proposal should include his understanding of the ESHS requirements of the project and the proposed strategies to manage the ESHS risks	The Bidder shall submit Management Strategies and Implementation Plans (MSIP) to manage the following key ESHS risks: ♦ Strategy for the protection of workers and community (airport staff, passengers and other users) from the construction related hazards inside the terminal ♦ Pollution prevention (wastewater, air and noise emissions) and management ♦ A waste management plan for proper collection and disposal of waste ♦ Traffic management plan to ensure the safety of local communities from traffic ♦ Hazardous material management plan safe storage and handling ♦ Strategy to address labour influx impacts on the local communities ♦ Gender-based violence and sexual exploitation and abuse prevention and response action plan ♦ Emergency response plan and early warning system	The bidder will submit MSIP along with the bid documents	

S/N	Condition	The rationale for the inclusion of this condition in the contract	Specifications to be included in the Bidding Documents	Responsibility	
				Bidders	SPIU/AMIC/SAPZ
			♦ The Contractor shall be subsequently required to submit (before mobilisation) the Contractor's Environment and Social Management Plan (C-ESMP) by the above strategies and Condition 4 of this Table.		

Table 6.2 ESHS Conditions in the Pre-Construction Phase

S/N	Action	The rationale for the inclusion of this condition in the contract	Specifications to be included in the Bidding Documents	Responsibility
1	Preparation of Contractor's Environmental and Social Management Plan (C-ESMP)	The Contractor shall submit site-specific management plans to address ESHS risks following the ESMP requirements and MSIP proposed in the bid documents.	The Contractor to submit for approval and subsequently implement their Environment and Social Management Plan (C-ESMP). The C-ESMP should be submitted prior to the commencement of construction works and no construction activities will be carried out under the project until approval of the C-ESMP. The C-ESMP will include the following site-specific management plans on: ♦ Occupational health and safety management plan ♦ Community health and safety management plan; ♦ Waste management plan ♦ Wastewater discharges management plan; ♦ Air and noise emissions management plan; ♦ Hazardous material management and ♦ spill control plan ♦ Water supply and sanitation management at the worksites and ♦ workers' accommodations ♦ Management of labour influx and facilities for foreign workers ♦ Labour recruitment procedures and labour management ♦ Traffic management plan ♦ Training plan for ESHS risks including HIV/AIDS, sexual exploitation and abuse, and gender-based violence ♦ Emergency Response Plan ♦ Grievance Redress Mechanism	Bidders; SPIU/AMIC/SAPZ

S/N	Action	The rationale for the inclusion of this condition in the contract	Specifications to be included in the Bidding Documents	Responsibility
			♦ Demobilisation plan after ♦ completion of works	
2	Mobilisation of ESHS Specialist	The ESHS Specialist should be mobilised during preconstruction for the preparation of C-ESMP	The Contractor shall submit the CV of the ESHS Specialist for NIC/SAPZ review and approval. The ESHS Specialist should be present at the site throughout the construction period.	Contractor; AMIC/SAPZ; Environmental Specialist
3	Require Permits/ License for disposal of Commercial waste	Government permits/licenses are required for the disposal of commercial wastes generated from the construction activities at the government-operated landfill site.	The contractor shall obtain relevant permits and licenses from government authorities relating to waste disposal and construction authorisation	Contractor; AMIC/SAPZ and Environmental Specialist
4	The hiring of Construction Labour	OS 2: Labour and Working Condition – This safeguard establishes the Bank's requirements for its borrowers or clients concerning workers' conditions, rights and protection from abuse or exploitation. It covers working conditions, workers' organisations, occupational health and safety, and avoidance of child or forced labour.	The contractor is to develop and implement labour management procedures following Operational Standard 2 for the hiring of construction workers. The procedures will include terms and conditions of employment including hours of work, wages, overtime, compensation and benefits, holidays, leaves, and so on. The procedures will set out measures to prevent and address harassment, intimidation and/or exploitation.	Contractor; AMIC/SAPZ; Environmental Specialist
5	Temporary storage facilities and construction yard	The contractor will need areas for setting up temporary storage areas and construction yards.	The contractor shall set up temporary storage facilities and a construction yard within the AMIC/SAPZ facility boundary approved by the Master Plan	Contractor; AMIC/SAPZ

6.3 Mitigation Strategies for Negative Impact Categories

6.3.1 Voluntary/Involuntary Displacement

Impact Indicators: Loss of livelihoods, food security challenges, social disruption

Project Phase: Pre-construction

Mitigation Strategies:

- **Resettelement Action Plan (RAP):** Develop a detailed land acquisition and resettlement action plan that includes a thorough socio-economic survey of affected communities to identify projected affected persons (PAP), including vulnerable groups, such as women, youths, those living with disability, and the elderly and their specific needs.
- **Community Engagement:** Establish continuous engagement channels with affected communities, ensuring transparent communication and incorporating their feedback into the resettlement planning process.
- **Comprehensive Land Acquisition Planning:** Develop a detailed land acquisition and resettlement plan that includes a thorough socio-economic survey of affected communities to identify vulnerable groups and their specific needs.
- **Fair Compensation:** Ensure that compensation for land and assets is fair, transparent, and provided promptly. Offer additional support such as relocation assistance, housing, and access to social services.
- **Monitoring and Grievance Redress Mechanisms:** Set up a robust monitoring system to track the resettlement process and a grievance redress mechanism to address concerns and complaints from affected individuals promptly.

6.3.2 Livelihood Impacts

Impact Indicators: Changes in household income, employment rates, livelihood diversification, market access, food security, and access to quality education and health facilities.

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

- **Livelihood Restoration Programmes:** Implement tailored livelihood restoration Programmes that provide alternative income sources, vocational training, and microfinance support for small businesses. (Refer to Section 6.3.1 Voluntary/Involuntary Displacement).

- **Local Hiring:** Prioritise hiring local labour for project activities, providing training to build their capacity and enhance employability.

- **Market Access Facilitation:** Facilitate access to new markets for local products by improving infrastructure and providing market linkages.

- **Community Support and Development:** Invest in comprehensive community support and development initiatives. This includes funding and implementing corporate and social responsibility (CSR) programmes that strengthen social cohesion and support education and healthcare needs, as well as collaborating with businesses and NGOs to improve infrastructure and access to quality services.

- **Ongoing Monitoring and Support:** Continuously monitor the effectiveness of livelihood Programmes and adjust strategies based on community feedback and changing circumstances. (Refer to Section 6.3.1 Monitoring and Grievance Redress Mechanisms).

6.3.3 Economic Impacts

Impact Indicators: Impacts on local businesses, shifts in regional economic activities

Project Phases: Pre-construction, Operational

Mitigation Strategies:

- **Economic Impact Assessments:** Conduct comprehensive economic impact assessments to understand potential positive and negative effects on local businesses and the regional economy.
- **Local Business Integration:** Create a database of local companies and foster partnerships by integrating them into the project supply chain through capacity-building initiatives and preferential procurement policies. (Refer to Section 6.3.2 Livelihood Impacts).
- **Community Development Programmes:** Implement community development programmes that diversify the local economy, such as supporting agribusinesses, tourism, and other sustainable enterprises. (Refer to Section 6.3.2 Livelihood Restoration Programmes).
- **Capacity Building and Training:** Offer capacity-building workshops and training sessions on market trends, business management, and sustainable practices to help local entrepreneurs and farmers capitalise on new market opportunities. This strengthens the local economic fabric and ensures sustainable development.
- **Ongoing Economic Monitoring:** Establish an economic monitoring system to track the project's impact on local businesses and the regional economy, making adjustments as necessary to mitigate adverse effects.

6.3.4 Biodiversity Loss

Impact Indicators: Reduction in biodiversity, habitat loss, and species decline

Project Phases: Pre-construction, Construction, Operational

Mitigation Strategies:

- **Avoidance and Minimisation:** Prioritise project site selection and design to avoid areas of high ecological value and minimise habitat disturbance. Also, limit site clearance to the absolute minimum required for construction needs (Refer to Section 6.3.5 Soil Erosion/Land Degradation).
- **Biodiversity Management Plans:** Develop and implement biodiversity management and monitoring plans that include alien invasive species control, faunal handling procedures, and guidelines for ecological landscaping.
- **Habitat Restoration:** Conduct habitat restoration activities, such as reforestation to compensate for unavoidable habitat loss. (Refer to Section 6.3.5 Soil Erosion/Land Degradation, 6.3.13 Climate Change).
- **Spill/Pollution Prevention Design:** Incorporate pollution prevention measures into project design, such as impermeable liners for waste storage areas and runoff management systems, and minimising noise and light pollution to avoid disturbing wildlife.
- **Protected Areas and Wildlife Corridors:** Establish protected areas and wildlife corridors in consultation with local communities and conservation experts. (Refer to Section 6.3.14 Community Dynamics).
- **Community Involvement:** Engage local communities in biodiversity conservation efforts, providing education and incentives for sustainable practices. (Refer to Section 6.3.14 Community Dynamics, 6.3.2 Livelihood Impacts).
- **Monitoring and Adaptive Management:** Regularly monitor biodiversity indicators and adapt management strategies based on monitoring results and scientific advancements.

6.3.5 Soil Erosion/Land Degradation

Impact Indicators: Loss of topsoil, land use changes, increased gully erosion, increased sedimentation

Project Phases: Pre-construction, Construction, Operational

Mitigation Strategies:

- **Erosion Control Measures:** Implement erosion control measures such as silt fences, erosion control blankets, and terracing to prevent soil loss and sedimentation.
- **Vegetation Cover Maintenance:** Maintain natural vegetation cover where possible and restrict vegetation removal to necessary areas only, replanting promptly after disturbance. (Refer to Section 6.3.4 Biodiversity Loss).
- **Seasonal Timing:** Schedule land clearance and construction activities to avoid the rainy season, minimising erosion risk.

- **Soil Stabilisation:** Use soil stabilisation techniques such as replanting native vegetation and applying mulches or geotextiles to protect exposed soils.
- **Land Management Programmes:** Develop land management Programmes that include measures for sustainable land use, soil conservation, and rehabilitation of degraded lands. (Refer to Section 6.3.4 Biodiversity Loss).

Monitoring and Adaptive Management: Regularly monitor soil health and erosion control measures, adjusting strategies based on monitoring results and feedback from local stakeholders.

6.3.6 Soil Contamination

Impact Indicators: Elevated levels of contaminants in soil and groundwater, changes in soil pH, and the presence of faecal coliforms.

Project Phases: Pre-construction, Construction, Operational, Decommissioning.

Mitigation Strategies:

- **Pollution Prevention Design:** (Refer to Section 6.3.4 Biodiversity Loss).
- **Hazardous Material Management:** Implement strict protocols for handling, storing, and disposing of hazardous materials, including regular inspections and maintenance of storage facilities. (Refer to Section 6.3.7 Impairment of Water Quality, 6.3.15 Health and Safety Risks).
- **Use of Less Toxic Chemicals:** Opt for less toxic chemicals and safer alternatives wherever possible, minimising the risk of soil contamination. (Refer to Section 6.3.7 Impairment of Water Quality, 6.3.15 Health and Safety Risks).
- **Contaminated Soil Rehabilitation:** Promptly excavate and rehabilitate contaminated soil areas, using appropriate remediation techniques such as bioremediation or soil washing. (Refer to Section 6.3.4 Biodiversity Loss).
- **Monitoring and Training:** Continuously monitor soil quality and provide ongoing training for staff on best practices for hazardous material management and spill response. (Refer to Section 6.3.15 Health and Safety Risks).

6.3.7 Impairment of Water Quality

Impact Indicators: Increased levels of pollutants, changes in water chemistry, reduced aquatic life

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

- **Pollution Prevention Design**: (Refer to Section 6.3.4 Biodiversity Loss).
- **Erosion Control Measures:** (Refer to Section 6.3.5 Soil Erosion/Land Degradation).

- **Hazardous Material Management and Spill/Pollution Prevention:** (Refer to Section 6.3.6 Soil Contamination).
- **Wastewater Treatment:** Ensure that wastewater generated by the project is treated and recycled. Where discharge into surface water is permitted, treated wastewater must meet regulatory standards before discharge.
- **Buffer Zones:** Maintain buffer zones of natural vegetation along water bodies to filter pollutants and stabilise banks. (Refer to Section 6.3.4 Biodiversity Loss, Section 6.3.5 Soil Erosion/Land Degradation).
- **Monitoring and Response:** Regularly monitor water quality and establish response plans for addressing any detected contamination promptly. (Refer to Section 6.3.6 Soil Contamination, 6.3.4 Biodiversity Loss).

6.3.8 Impairment of Air Quality

Impact Indicators: Increased levels of dust, particulates, and emissions

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

- **Emissions Control**: Utilise low-emission technologies and equipment, and enforce maintenance schedules to minimise emissions from construction and operational activities. Cover vehicles carrying dusty materials and switch off machinery and vehicles when not in use to reduce emissions.
- **Dust Control Measures:** Implement dust control measures such as water spraying, dust suppressants, and covering of stockpiles to reduce airborne particulate matter. (Refer to Section 6.3.5 Soil Erosion/Land Degradation, 6.3.9 Noise Pollution)
- **Fuel Quality:** Use high-quality diesel fuel to reduce emissions.
- **Quality Monitoring:** Regularly monitor air quality in and around the project site and implement corrective actions if pollutant levels exceed acceptable limits. (Refer to Section 6.3.4 Biodiversity Loss)
- **Green Infrastructure:** Where feasible, incorporate green infrastructure, such as green roofs and walls, to absorb pollutants and improve air quality. (Refer to Section 6.3.4 Biodiversity Loss, 6.3.5 Soil Erosion/Land Degradation)
- Ensure equipment and machinery are well maintained as prescribed by the manufacturer

6.3.9 Noise Pollution

Impact Indicators: Elevated noise levels, impacts on local wildlife and communities

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

- **Noise Control Measures:** Install noise barriers, mufflers, and silencers on equipment, and restrict noisy activities to daytime hours to minimise disturbances to local communities and wildlife.

- **Machinery Maintenance:** Ensure regular maintenance of machinery and vehicles to reduce noise emissions. (Refer to Section 6.3.8 Impairment of Air Quality)

- **Community Engagement:** Engage with local communities to inform them of potential noise impacts and involve them in developing noise management plans.

- **Noise Monitoring:** Regularly monitor noise levels and adjust operations as necessary to comply with noise regulations. (Refer to Section 6.3.6 Soil Contamination, 6.3.8 Impairment of Air Quality)

6.3.10 Traffic Impacts

Impact Indicators: Traffic congestion, increased accident risk, road damage

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

- **Traffic Management Plans:** Develop and implement traffic management plans that include designated routes, schedules to avoid peak traffic times, and measures to enhance road safety.
- **Road Infrastructure Improvements:** Work with local authorities to improve road infrastructure and signage to accommodate increased traffic.
- **Community Awareness:** Conduct community awareness campaigns on traffic safety and project-related traffic changes.
- **Monitoring and Adjustment:** Continuously monitor traffic conditions and adjust plans as necessary to minimise congestion and safety risks. (Refer to Section 6.3.6 Soil Contamination, 6.3.9 Noise Pollution)

6.3.11 Visual Intrusion

Impact Indicators: Changes in landscape aesthetics, visual impacts on local communities

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

- **Aesthetic Design:** Incorporate aesthetic considerations into project design, such as landscaping and architectural features that blend with the natural environment.
- **Screening and Buffering:** Use natural screening, such as tree planting, to reduce visual impacts on local communities. (Refer to Section 6.3.4 Biodiversity Loss, 6.3.5 Soil Erosion/Land Degradation)

- **Community Engagement:** Engage with local communities to understand their visual impact concerns and incorporate their input into the design process.
- **Ongoing Maintenance:** Regularly maintain landscaping and visual mitigation measures to ensure their effectiveness. (Refer to Section 6.3.4 Biodiversity Loss, 6.3.5 Soil Erosion/Land Degradation)

6.3.12 Archaeological/Cultural Heritage Loss

Impact Indicators: Disturbance or destruction of archaeological and cultural heritage sites

Project Phases: Pre-construction, Construction

- **Mitigation Strategies:**
- **Heritage Assessments**: Conduct comprehensive archaeological and cultural heritage assessments before starting construction activities. (Refer to Section 6.3.14 Community Dynamics)
- **Site Avoidance**: Design project activities to avoid known archaeological and cultural heritage sites.
- **Monitoring and Contingency Plans:** Implement monitoring and contingency plans to address any unexpected discoveries of archaeological or cultural heritage materials during construction. (Refer to Section 6.3.14 Community Dynamics, 6.3.2 Livelihood Impacts)
- **Community Consultation:** Engage with local communities and cultural heritage experts to ensure that cultural heritage is respected and preserved. (Refer to Section 6.3.14 Community Dynamics)

6.3.13 Climate Change

Impact Indicators: Changes in temperature and precipitation patterns, extreme weather events

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

- **Climate Resilience Planning:** Integrate climate resilience considerations into project planning, design, and operations, ensuring that infrastructure and communities are prepared for potential climate impacts.
- **Energy Efficiency:** Implement energy-efficient technologies and practices to reduce greenhouse gas emissions.
- **Renewable Energy Integration:** Explore opportunities to integrate renewable energy sources, such as solar and wind, into project operations.
- **Carbon Offsetting:** Engage in carbon offsetting Programmes to mitigate the project's carbon footprint.

- **Climate Monitoring:** Regularly monitor climate-related indicators and adapt strategies as necessary to address changing climate conditions.

6.3.14 Community Dynamics

Impact Indicators: Social cohesion, cultural heritage preservation, public perception, and acceptance of the project

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

- **Community Engagement:** Establish and maintain transparent and inclusive communication channels with local communities throughout the project lifecycle. (Refer to Section 6.3.1 Voluntary/Involuntary Displacement, 6.3.12 Archaeological/Cultural Heritage Loss)

- **Participatory Planning:** Involve local communities in the planning and decision-making processes to ensure their concerns and aspirations are addressed.

- **Social Cohesion Programmes:** Implement Programmes that promote social cohesion and cultural heritage preservation, fostering a sense of community ownership and pride.

- **Community Investment:** Invest in community development projects that improve local infrastructure, education, and healthcare, enhancing the overall well-being of the community. (Refer to Section 6.3.2 Livelihood Impacts, 6.3.11 Visual Intrusion)

6.3.15 Flood Risk Mitigation Strategies

Impact Indicators: Elevated runoff, frequent and severe flooding

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

- **Flood Risk Assessments:** Conduct comprehensive flood risk assessments to identify areas vulnerable to flooding, especially in Ugbene and Omor. Use this data to inform the design and implementation of flood prevention measures.
- Install drainage systems to manage stormwater. Use silt fences, retention basins, and sediment traps to minimise soil erosion and manage runoff. (Refer to Erosion Control Measures Section 6.5 Soil Erosion/Land Degradation
- **Green Infrastructure and Vegetation:** Plant vegetation and create green spaces that can absorb excess water, reducing surface runoff. This is related to habitat restoration (Refer to Section 6.3.4 Biodiversity Loss).

- Use permeable pavements in construction areas to enhance groundwater recharge and reduce surface runoff.
- **Elevated Infrastructure:** Design and construct buildings and infrastructure elevated above expected flood levels. This includes raising the foundations of buildings and critical infrastructure to prevent flood damage.
- **Flood Barriers and Levees:** Consider installing flood barriers, levees, and embankments around vulnerable areas, particularly in Ugbene and Omor, to protect them from flooding.
- Implement routine maintenance schedules for drainage systems to prevent clogging and ensure efficient water flow.
- **Community Preparedness**: Inform residents about flood risks and safety measures and maintain communication with communities to address concerns. (Refer to Section 6.3.1 Community Engagement and Monitoring and Grievance Resolution
- **Resource Coordination:** Work with emergency agencies to ensure the availability of rescue equipment, medical supplies, and communication tools. (Refer to 6.3.1 Community Engagement and Monitoring and Grievance Resolution Mechanisms)

6.3.16 Health and Safety Risks

Impact Indicators: Occupational injuries, community health impacts, exposure to hazardous materials

Project Phases: Pre-construction, Construction, Operational, Decommissioning

Mitigation Strategies:

The following strategies apply:

- Spill/Pollution Prevention Design (refer to Section 6.3.4 Biodiversity Loss)
- Soil Contamination (Section 6.3.6)
- Impairment of Water Quality (Section 6.3.7)
- Impairment of Air Quality (Section 6.3.8)
- Increase Noise Levels (Section 6.3.9)
- Traffic Congestion (Section 6.3.10)
- **Emergency Preparedness Response Management**
  - **Hazard Identification:** Identify potential hazards, such as natural disasters, industrial accidents, or civil unrest.

- **Vulnerability Assessment:** Assess the vulnerability of the project and surrounding communities to these hazards.
- **Emergency Communication Systems:** Establish reliable communication systems for emergency responders, government agencies, and the public.
- **Fire Prevention:** Implement measures to prevent and control fires, such as fire detection systems and firebreaks.
- **Emergency Shutdown Procedures:** Develop procedures for safely shutting down project operations in case of an emergency.
- **Spill Response Plans:** Develop spill response plans for potential releases of hazardous materials.
- **Regular Monitoring:** Conduct regular monitoring of emergency response systems and procedures.
- **Evaluation**: Evaluate the effectiveness of emergency response efforts and make necessary adjustments.

♦ **Health and Safety Management Systems**

- Implement comprehensive health and safety management systems, including risk assessments, safety training, and emergency response plans.
- **Community Health Programmes:** Develop and implement community health Programmes that address potential health impacts of the project, including access to healthcare services and education on health and safety practices.
- **Regular Monitoring and Training:** Continuously monitor health and safety performance and ensure all accidents and incidents are recorded, investigated and follow-up actions implemented.

6.4 Residual Impact Assessment

Once mitigation measures have been identified, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps, considering the assumed implementation of the additional declared mitigation measures. Table 6.3 shows the residual impacts following the application of mitigation measures.

Table 6.3: Summary of Mitigation Measures for Identified Significant Impacts

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
Engineering /Architectural Design Implementation	Changes in visual aesthetics		The Anambra SAPZ SPIU shall ensure that: ♦ Aesthetic considerations, such as landscaping and architectural features that blend with the natural environment, are incorporated into the project design ♦ The use of natural screening, such as tree planting, to reduce visual impacts on local communities is implemented where possible ♦ They engage with local communities to understand their visual impact concerns and incorporate their input into the design process.	
Land Acquisition	♦ Disagreements Arising from Sharing Land Proceeds		The Anambra SAPZ SPIU shall ensure that: ♦ Agreement is reached on the amount and timeframe at which landowners/communities will be compensated; ♦ All necessary licenses, permits, and approvals are obtained; ♦ All relevant stakeholders are identified and engaged in the land acquisition process; ♦ All issues are resolved properly before mobilisation; ♦ Regular consultations are implemented with the local community and other stakeholders (government, community, NGOs, CBOs) for effective communication and social license; ♦ Traditional conflict resolution structures in the project communities are supported; ♦ Full compensation is provided for farm produce affected by the project.	
	♦ Voluntary/involuntary resettlement		The Anambra SAPZ SPIU shall: ♦ Establish continuous engagement channels with affected communities, ensuring transparent communication and incorporating their feedback into the resettlement planning process.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			♦ Develop a detailed land acquisition and resettlement action plan that includes a thorough socio-economic survey of affected communities to identify vulnerable groups and their specific needs. ♦ Ensure that compensation for land and assets is fair, transparent, and provided promptly. Offer additional support such as relocation assistance, housing, and access to social services. ♦ Set up a robust monitoring system to track the resettlement process and a grievance redress mechanism to address concerns and complaints from affected individuals promptly.	
	♦ Conversion of Agricultural Land to Industrial Uses		The Anambra SAPZ SPIU shall: ♦ Promote strategic land use planning to balance industrial development with the preservation of agricultural activities wherever possible. ♦ Incentivise farmers to supply raw materials to SAPZ facilities, ensuring they benefit from increased demand. ♦ promote environmentally sustainable practices, such as water recycling, renewable energy systems, and waste reduction, to minimise environmental impacts. ♦ Require contractors to restore any degraded land through reforestation and support biodiversity to counterbalance industrial activities. ♦ Consult with local communities to understand and address their concerns, ensuring social license and acceptance.	
	♦ Livelihood Impacts		The Anambra SAPZ SPIU shall: ♦ Implement tailored livelihood restoration Programmes that provide alternative income sources, vocational training, and microfinance support for small businesses.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			♦ Prioritise hiring local labour for project activities, providing training to build their capacity and enhance employability. ♦ Facilitate access to new markets for local products by improving infrastructure and providing market linkages. ♦ Invest in comprehensive community support and development initiatives, including CSR programmes that strengthen social cohesion and support education and healthcare needs. ♦ Continuously monitor the effectiveness of livelihood Programmes and adjust strategies based on community feedback and changing circumstances.	
Hiring of labour during the preconstruction phase	Increased opportunities for employment		The Anambra SAPZ SPIU shall require contractors to: ♦ Give preference to qualified local residents during the recruitment of labour. ♦ Provide training to locals to enhance their employability. ♦ Make prompt payment to engaged labour; Ensure agreement with the community before mobilisation on modalities of promoting local entrepreneurship in the provision of housing and transport.	
Site Clearing and Preparation / Construction of campsite	Deforestation/ Loss of Biodiversity (fauna and flora)		The Anambra SAPZ SPIU shall: ♦ Prioritise project site selection and design to avoid areas of high ecological value and minimise habitat disturbance. ♦ Require contractors to limit site clearance to the absolute minimum required for construction needs ♦ Develop and implement biodiversity management and monitoring plans that include alien invasive species control, faunal handling procedures, and guidelines for ecological landscaping.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			♦ Require contractors to conduct habitat restoration activities, such as reforestation to compensate for unavoidable habitat loss. ♦ Require contractors to establish protected areas and wildlife corridors in consultation with local communities and conservation experts. ♦ Engage local communities in biodiversity conservation efforts, providing education and incentives for sustainable practices. ♦ Regularly monitor biodiversity indicators and adapt management strategies based on monitoring results and scientific advancements.	
	Climate Impact (Reduction in Carbon Sinks)		The Anambra SPIU shall: ♦ Ensure the implementation of mitigation measures for vegetation and biodiversity loss. ♦ Require contractors to retain some natural vegetation in strategic areas, such as windbreaks or along water bodies, to support ongoing carbon sequestration during and after construction. ♦ Encourage farmers to practice agroforestry, promoting carbon sequestration alongside agricultural productivity. ♦ Where feasible, implement or invest in carbon offset programs, such as reforestation projects in other parts of the state, to compensate for carbon sink losses.	
	Deterioration of air quality from the release of particulates		The Anambra State SPIU shall require contractors to: ♦ Regularly spray water on cleared areas and dust-prone surfaces to suppress dust and minimise airborne particulates. ♦ Clear vegetation in phases rather than all at once, reducing the area exposed to dust generation at any one time. ♦ Schedule clearing activities during periods of low wind to reduce particulate spread.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			♦ Enforce speed limits for vehicles on site to reduce dust generation. ♦ Make nose masks available to all workers on the site. ♦ Use environmentally safe dust suppressants, such as calcium chloride, to stabilise dust-prone areas. ♦ Regularly monitor air quality at the site to identify high particulate levels and adjust practices as needed.	
	Loss of Topsoil/Erosion/ Land Degradation / Surface water quality impairment due to sedimentation		The Anambra SAPZ SPIU shall: ♦ Implement erosion control measures such as silt fences, erosion control blankets, and terracing to prevent soil loss and sedimentation. ♦ Maintain natural vegetation cover where possible and restrict vegetation removal to necessary areas only, replanting promptly after disturbance. ♦ Schedule land clearance and construction activities to avoid the rainy season, minimising erosion risk. ♦ Use soil stabilisation techniques such as replanting native vegetation and applying mulches or geotextiles to protect exposed soils. ♦ Develop land management programmes that include measures for sustainable land use, soil conservation, and rehabilitation of degraded lands. ♦ Regularly monitor soil health and erosion control measures, adjusting strategies based on monitoring results and feedback from local stakeholders.	
	Increased flood risks		The Anambra SAPZ SPIU shall: ♦ Conduct comprehensive flood risk assessments to identify areas vulnerable to flooding, especially in Ugbene and Omor. Use this data to inform the design and implementation of flood prevention measures. ♦ Require contractors to install drainage systems to manage stormwater. Use silt fences, retention	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			basins, and sediment traps to minimise soil erosion and manage runoff. ♦ Require contractors to plant vegetation and create green spaces that can absorb excess water, reducing surface runoff. ♦ Require contractors to install permeable pavements in construction areas to enhance groundwater recharge and reduce surface runoff. ♦ Require contractors to ensure that the design, building constructions and infrastructure are elevated above expected flood levels. This includes raising the foundations of buildings and critical infrastructure to prevent flood damage. ♦ Consider installing flood barriers, levees, and embankments around vulnerable areas, particularly in Ugbene and Omor, to protect them from flooding. ♦ Implement routine maintenance schedules for drainage systems to prevent clogging and ensure efficient water flow. ♦ Inform residents about flood risks and safety measures and maintain communication with communities to address concerns ♦ Work with emergency agencies to ensure the availability of rescue equipment, medical supplies, and communication tools.	
	Archaeological/Cultural Heritage Loss or Disturbance		The Anambra SAPZ SPIU shall: ♦ Ensure that design project activities avoid known archaeological and cultural heritage sites. ♦ Require contractors to conduct comprehensive archaeological and cultural heritage assessments before the commencement of any pre-construction/construction activities	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			♦ Implement monitoring and contingency plans to address any unexpected discoveries of archaeological or cultural heritage materials during construction. ♦ Engage with local communities and cultural heritage experts to ensure that cultural heritage is respected and preserved.	
	Influx of migrant		The Anambra SAPZ SPIU shall: ♦ Require contractors to prioritise hiring locals with the uppermost consideration for competence and qualification to reduce the impact of population influx.	
	Waste Generation		The Anambra SAPZ SPIU shall require contractors to: ♦ Develop and implement a waste management plan before site preparation begins, including provisions for hazardous and non-hazardous waste. ♦ Provide receptacles for different types of waste. ♦ Segregate, recycle, and dispose of waste responsibly. ♦ Conduct a thorough assessment of materials needed for clearing and construction to minimise waste generation. ♦ Ensure proper storage and containment of hazardous materials such as fuels and oils used in machinery. ♦ Implement segregation practices on-site to separate recyclable materials from general waste. ♦ Sell reusable waste like crops and wood to reduce the amount of waste generated. ♦ Compost organic waste and other biodegradable materials to create nutrient-rich soil amendments. ♦ Train personnel on waste management protocols, emphasising the safe handling and disposal of hazardous materials. ♦ Monitor waste generation throughout the project and adjust procedures as needed to improve efficiency and reduce waste.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			♦ Ensure waste is handled and disposed of by qualified and accredited waste contractors.	
Use of generators and heavy machinery and equipment	Deterioration of Air Quality / Climate Impact (GHG Emissions)		The Anambra SAPZ SPIU shall: ♦ Encourage contractors to opt for equipment and machinery with lower emissions, such as electric or hybrid-powered machinery. ♦ Require contractors to ensure that all construction equipment and machinery are maintained per the manufacturer's instructions to minimise emissions from construction and operational activities. ♦ Implement dust control measures such as water spraying, dust suppressants, and covering of stockpiles to reduce airborne particulate matter. ♦ Require contractors to use high-quality diesel fuel to reduce emissions. ♦ Regularly monitor air quality in and around the project site and implement corrective actions if pollutant levels exceed acceptable limits. ♦ That nose masks and earmuffs are worn by site workers during excavation. ♦ Encourage contractors to use alternative fuels like compressed natural gas (CNG) for generators and construction equipment where possible. ♦ Encourage contractors to connect to the national grid as soon as possible to reduce reliance on diesel or petrol-powered generators.	
	Elevated noise levels		The Anambra SAPZ SPIU shall: ♦ Require contractors to install noise barriers, mufflers, and silencers on equipment, and restrict noisy activities to daytime hours to minimise disturbances to local communities and wildlife.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			♦ Require contractors to regularly maintain equipment and machinery to reduce noise emissions. ♦ Engage with local communities to inform them of potential noise impacts and involve them in developing noise management plans. ♦ Regularly monitor noise levels and adjust operations as necessary to comply with noise regulations.	
	Waste Generation		The Anambra SAPZ SPIU shall require contractors to: ♦ Develop and implement a comprehensive waste management plan before site preparation begins, addressing both hazardous and non-hazardous waste. ♦ Provide receptacles for different types of waste. ♦ Conduct a thorough assessment of materials and consumables, including oils and filters, to minimise excess and avoid unnecessary waste. ♦ Segregate and safely dispose of hazardous waste, such as batteries, hydraulic fluids, fuel residues, and used oils, in designated containers at licensed facilities. ♦ Ensure proper storage and containment of fuels and oils used in machinery to prevent spills and contamination. ♦ Train personnel on waste management protocols, emphasising the safe handling and disposal of all hazardous materials. ♦ Monitor waste generation throughout the project and adjust procedures as necessary to improve efficiency and reduce waste. ♦ Ensure that all waste is managed and disposed of by qualified and accredited waste contractors.	
	Health and safety risks, including musculoskeletal injuries, noise-induced		The Anambra SAPZ SPIU shall require contractors to: ♦ Provide proper ergonomics training for physical labour.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
	hearing loss, and accidents from machinery		♦ Ensure regular maintenance of machinery to prevent mechanical failures. ♦ Use noise protection PPE (earplugs) and reduce exposure to noisy equipment. ♦ Train operators in safe machinery operation practices. ♦ Ensure compliance with all relevant occupational health and safety regulations.	
Hiring of migrant workers	Increased risk of sexually transmitted diseases		The SAPZ SPIU shall: ♦ Require contractors to prioritise local hiring where possible to reduce the number of temporary workers moving into project areas ♦ Implement health education programs to educate migrant workers and local communities on STDs and prevention methods ♦ Ensure easy access to healthcare services, including STD testing and treatment for migrant workers ♦ When possible, conduct regular health screenings and STD testing for migrant workers ♦ Partner with health-focused NGOs to deliver targeted interventions and support, including the distribution of free condoms and other protective measures to migrant workers and local communities	
	Threat to community culture, safety and security		The Anambra SAPZ SPIU shall: ♦ Activate the Grievance Redress Mechanism (GRM) and ensure that community members are informed about its processes and how to access it. ♦ Require contractors to prioritise local hiring where possible. ♦ Establish and maintain open, two-way communication channels with local communities throughout the project lifecycle to ensure continuous engagement and feedback, addressing their concerns	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			and aspirations while involving them in decision-making. ♦ Provide cultural sensitivity training for both migrant workers and local communities to foster mutual understanding of customs, traditions, and cultural norms. ♦ Facilitate community integration programmes that promote positive interactions and mutual respect between migrant workers and local residents. ♦ Enhance security by improving lighting, promoting community policing, and installing surveillance in areas with high concentrations of migrant workers, with an emphasis on trust-building and crime prevention. ♦ Establish accessible conflict resolution mechanisms, including formal mediation and community-led initiatives, to promptly address any disputes or tensions between migrant workers and local residents.	
	Increase pressure on local infrastructure/amenities and services including health facilities, water resources, etc.		The Anambra SAPZ shall: ♦ Require contractors to prioritise local hiring where possible. ♦ Require contractors to provide food, water and campsites to reduce pressure on local resources ♦ If needed, work with local authorities to extend the operating hours of local infra, such as health clinics and community centres, to accommodate increased demand. ♦ Create a simple feedback system (like suggestion boxes or online forms) for local residents and migrant workers to identify issues with amenities. ♦ Run awareness campaigns to educate both locals and migrant workers on the responsible use of local amenities.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
Increased transport activities due to preconstruction activities (material and workforce transportation)	Traffic Congestion / Mental health stress for commuters due to delays		The Anambra SAPZ SPIU shall: ♦ Require contractors to develop and implement traffic management plans, including designated routes, schedules to avoid peak traffic times, and measures to enhance road safety. ♦ Require contractors to provide commuters with real-time traffic information through mobile apps or radio/tv announcements, allowing them to plan alternative routes or adjust travel times. ♦ Require contractors to limit noise and other disturbances during peak commute hours to prevent added stress for commuters stuck in traffic. ♦ Require contractors to work with local authorities to improve road infrastructure and signage to accommodate increased traffic. ♦ Require contractors to conduct community awareness campaigns on traffic safety and project-related traffic changes. ♦ Continuously monitor traffic conditions and adjust plans as necessary to minimise congestion and safety risks.	
	Climate Impact (GHG Emissions) / Deterioration of Air Quality		The Anambra SAPZ SPIU shall: ♦ Encourage contractors to opt for vehicles with lower emissions, such as hybrid-powered machinery. ♦ Require contractors to ensure that construction vehicle engines comply with international standards for exhaust gases. ♦ Require contractors to ensure the maintenance of engines as specified by the manufacturer. ♦ Require contractors to adopt regular exhaust gas checks and an engine-off policy at the construction site. ♦ Require contractors to use the cleanest economically available fuel.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			♦ Encourage contractors to plan and optimise transportation routes to reduce fuel consumption and emissions from vehicles transporting staff, material and equipment.	
	Increased Road Accidents Risks		The Anambra SAPZ SPIU shall require contractors to: ♦ Develop and enforce a detailed journey management policy that includes risk assessment procedures, route planning, and emergency response plans. ♦ Ensure all construction vehicles are pre-mobbed, and issue pre-mobilisation compliance certificates after conducting thorough safety checks. ♦ Establish a regular maintenance schedule for construction vehicles, specifying maintenance frequency and adherence to safety standards. ♦ Ensure drivers are qualified, experienced, and trained in defensive driving techniques and accident prevention strategies, with demonstrable evidence of compliance with driving rules and regulations. ♦ Mandate the use of seat belts for drivers and all passengers in construction vehicles to enhance safety. ♦ Provide first aid training for the workforce, along with the provision of fully stocked first aid kits in all construction vehicles. ♦ Maintain comprehensive accident and near-miss logs to identify trends and implement improvements in safety practices. ♦ Consider the incorporation of technology solutions such as GPS tracking and telematics to monitor vehicle performance and driver behaviour, enhancing safety and accountability. ♦ Conduct regular safety audits and inspections to ensure compliance with all safety measures and address any identified issues promptly. ♦ Establish an emergency response plan that outlines	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Preconstruction Phase				
			procedures for various types of accidents, ensuring all workers are familiar with the plan.	
Community and local Business Engagement/ **Increased investment by public and private Investors**	Economic Improvement for local businesses, Positive shifts in regional economic activities		The Anambra SAPZ SPIU shall: ♦ Conduct comprehensive economic impact assessments to understand potential positive and negative effects on local businesses and the regional economy. ♦ Encourage contractors to foster partnerships with local businesses, integrating them into the project supply chain through capacity-building initiatives and preferential procurement policies. ♦ Implement community development programmes that diversify the local economy, such as supporting agribusinesses, tourism, and other sustainable enterprises. ♦ Offer capacity-building workshops and training sessions on market trends, business management, and sustainable practices to help local entrepreneurs and farmers capitalise on new market opportunities. ♦ Establish an economic monitoring system to track the project's impact on local businesses and the regional economy, making adjustments as necessary to mitigate adverse effects.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
Engineering /Architectural Design Implementation	Changes in visual aesthetics		The Anambra SAPZ SPIU shall ensure that: ♦ Aesthetic considerations, such as landscaping and architectural features that blend with the natural environment, are incorporated into the project design ♦ The use of natural screening, such as tree planting, to reduce visual impacts on local communities is implemented where possible	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ They engage with local communities to understand their visual impact concerns and incorporate their input into the design process.	
Mobilisation of equipment, personnel, and construction modules to the site / Increased transport activities due to construction activities	Increased opportunities for employment		The Anambra SAPZ SPIU shall require contractors to: ♦ Give preference to qualified local residents during the recruitment of labour. ♦ Provide training to locals to enhance their employability. ♦ Make prompt payment to engaged labour; ♦ Ensure agreement with the community before mobilisation on modalities of promoting local entrepreneurship in the provision of housing and transport.	
	Influx of migrant workers due to increased labour demand		The Anambra SAPZ SPIU shall: ♦ Require contractors to prioritise hiring locals with the uppermost consideration for competence and qualification to reduce the impact of population influx.	
	Traffic congestion from increased vehicular movements		The Anambra SAPZ SPIU shall: ♦ Require contractors to develop and implement traffic management plans, including designated routes, schedules to avoid peak traffic times, and measures to enhance road safety. ♦ Require contractors to provide commuters with real-time traffic information through mobile apps or radio/tv announcements, allowing them to plan alternative routes or adjust travel times. ♦ Require contractors to limit noise and other disturbances during peak commute hours to prevent added stress for commuters stuck in traffic. ♦ Require contractors to work with local authorities to improve road infrastructure and signage to accommodate increased traffic.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ Require contractors to conduct community awareness campaigns on traffic safety and project-related traffic changes. Continuously monitor traffic conditions and adjust plans as necessary to minimise congestion and safety risks.	
	Noise pollution from the transportation of heavy machinery and equipment		The Anambra SAPZ SPIU shall: ♦ Require contractors to install noise barriers, mufflers, and silencers on equipment, and restrict noisy activities to daytime hours to minimise disturbances to local communities and wildlife. ♦ Require contractors to regularly maintain equipment and machinery to reduce noise emissions. ♦ Engage with local communities to inform them of potential noise impacts and involve them in developing noise management plans. ♦ Regularly monitor noise levels and adjust operations as necessary to comply with noise regulations.	
	Air quality deterioration from emissions during transportation / Climate Impact (GHG Emissions)		The Anambra SAPZ SPIU shall: ♦ Encourage contractors to opt for equipment and machinery with lower emissions, such as electric or hybrid-powered machinery. ♦ Require contractors to ensure that all construction equipment and machinery are maintained per the manufacturer's instructions to minimise emissions from construction and operational activities. ♦ Implement dust control measures such as water spraying, dust suppressants, and covering of stockpiles to reduce airborne particulate matter. ♦ Require contractors to use high-quality diesel fuel to reduce emissions. ♦ Regularly monitor air quality in and around the project site and implement corrective actions if pollutant levels exceed acceptable limits.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ That nose masks and earmuffs are worn by site workers during excavation. ♦ Encourage contractors to use alternative fuels like compressed natural gas (CNG) for generators and construction equipment where possible. ♦ Encourage contractors to connect to the national grid as soon as possible to reduce reliance on diesel or petrol-powered generators.	
	Safety risks associated with the movement of heavy machinery and equipment		The Anambra SAPZ SPIU shall require contractors to: ♦ Develop and implement comprehensive health and safety management systems, including risk assessments, safety training, and emergency response plans. ♦ Develop and enforce a detailed journey management policy. ♦ Place warning signs and signals along transport routes, especially on site to alert both workers and the public about the presence of heavy machinery. ♦ Ensure regular maintenance and inspections of heavy machinery and construction vehicles to prevent mechanical failures that could lead to accidents. ♦ Mandate the use of appropriate PPE for all personnel involved in the movement of heavy machinery to enhance safety. ♦ Provide training sessions for operators and personnel on safe operation practices, traffic management, and emergency response procedures. ♦ Maintain comprehensive accident and near-miss logs to identify trends and implement improvements in safety practices. ♦ Conduct regular safety audits and inspections to ensure	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			compliance with all safety measures and address any identified issues promptly. ♦ Ensure all accidents and incidents are recorded, investigated, and follow-up actions implemented. ♦ Ensure compliance with all relevant occupational health and safety regulations.	
	Increased road accident risks from Vehicular Movements		The Anambra SAPZ SPIU shall require contractors to: ♦ Implement the mitigation measures for safety risks associated with moving heavy machinery. ♦ Ensure all construction vehicles are pre-mobbed, and issue pre-mobilisation compliance certificates after conducting thorough safety checks. ♦ Establish a regular maintenance schedule for construction vehicles, specifying maintenance frequency and adherence to safety standards. ♦ Ensure drivers are qualified, experienced, and trained in defensive driving techniques and accident prevention strategies, with demonstrable evidence of compliance with driving rules and regulations. ♦ Mandate the use of seat belts for drivers and all passengers in construction vehicles to enhance safety. ♦ Provide first aid training for the workforce, along with the provision of fully stocked first aid kits in all construction vehicles. ♦ Consider the incorporation of technology solutions such as GPS tracking and telematics to monitor vehicle performance and driver behaviour, enhancing safety and accountability. ♦ Establish an emergency response plan that outlines procedures for various types of accidents, ensuring all workers are familiar with the plan.	
Use of generators and heavy machinery and equipment	Deterioration of Air Quality / Climate Impact (GHG Emissions)		The Anambra SAPZ SPIU shall:	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ Encourage contractors to opt for equipment and machinery with lower emissions, such as electric or hybrid-powered machinery. ♦ Require contractors to ensure that all construction equipment and machinery are maintained per the manufacturer's instructions to minimise emissions from construction and operational activities. ♦ Implement dust control measures such as water spraying, dust suppressants, and covering of stockpiles to reduce airborne particulate matter. ♦ Require contractors to use high-quality diesel fuel to reduce emissions. ♦ Regularly monitor air quality in and around the project site and implement corrective actions if pollutant levels exceed acceptable limits. ♦ That nose masks and earmuffs are worn by site workers during excavation. ♦ Encourage contractors to use alternative fuels like compressed natural gas (CNG) for generators and construction equipment where possible. ♦ Encourage contractors to connect to the national grid as soon as possible to reduce reliance on diesel or petrol-powered generators.	
	Elevated noise levels		The Anambra SAPZ SPIU shall: ♦ Require contractors to install noise barriers, mufflers, and silencers on equipment, and restrict noisy activities to daytime hours to minimise disturbances to local communities and wildlife. ♦ Require contractors to regularly maintain equipment and machinery to reduce noise emissions. ♦ Engage with local communities to inform them of potential noise impacts and involve them in developing noise management plans.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ Regularly monitor noise levels and adjust operations as necessary to comply with noise regulations.	
	Waste Generation		The Anambra SAPZ SPIU shall require contractors to: ♦ Develop and implement a comprehensive waste management plan before site preparation begins, addressing both hazardous and non-hazardous waste. ♦ Provide receptacles for different types of waste. ♦ Segregate, recycle, and dispose of waste responsibly. ♦ Conduct a thorough assessment of materials and consumables, including oils and filters, to minimise excess and avoid unnecessary waste. ♦ Segregate and safely dispose of hazardous waste, such as batteries, hydraulic fluids, fuel residues, and used oils, in designated containers at licensed facilities. ♦ Ensure proper storage and containment of fuels and oils used in machinery to prevent spills and contamination. ♦ Train personnel on waste management protocols, emphasising the safe handling and disposal of all hazardous materials. ♦ Monitor waste generation throughout the project and adjust procedures as necessary to improve efficiency and reduce waste. ♦ Ensure that all waste is managed and disposed of by qualified and accredited waste contractors.	
	Health and safety risks, including musculoskeletal injuries, noise-induced hearing loss, and accidents from machinery		The Anambra SAPZ SPIU shall require contractors to: ♦ Provide proper ergonomics training for physical labour. ♦ Ensure regular maintenance of machinery to prevent mechanical failures. ♦ Use noise protection PPE (earplugs) and reduce exposure to noisy equipment. ♦ Train operators in safe machinery operation practices. ♦ Ensure compliance with all relevant occupational health and safety regulations.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
Hiring of migrant workers	Increased risk of sexually transmitted diseases		The SAPZ SPIU shall: ♦ Require contractors to prioritise local hiring where possible to reduce the number of temporary workers moving into project areas ♦ Implement health education programs to educate migrant workers and local communities on STDs and prevention methods ♦ Ensure easy access to healthcare services, including STD testing and treatment for migrant workers ♦ When possible, conduct regular health screenings and STD testing for migrant workers ♦ Partner with health-focused NGOs to deliver targeted interventions and support, including the distribution of free condoms and other protective measures to migrant workers and local communities	
	Threat to community culture, safety and security		The Anambra SAPZ SPIU shall: ♦ Activate the Grievance Redress Mechanism (GRM) and ensure that community members are informed about its processes and how to access it. ♦ Require contractors to prioritise local hiring where possible. ♦ Establish and maintain open, two-way communication channels with local communities throughout the project lifecycle to ensure continuous engagement and feedback, addressing their concerns and aspirations while involving them in decision-making. ♦ Provide cultural sensitivity training for both migrant workers and local communities to foster mutual understanding of customs, traditions, and cultural norms. ♦ Facilitate community integration programmes that promote positive interactions and mutual respect between migrant workers and local residents.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ Enhance security by improving lighting, promoting community policing, and installing surveillance in areas with high concentrations of migrant workers, with an emphasis on trust-building and crime prevention. ♦ Establish accessible conflict resolution mechanisms, including formal mediation and community-led initiatives, to promptly address any disputes or tensions between migrant workers and local residents.	
	Increase pressure on local infrastructure/amenities and services including health facilities, water resources, etc.		The Anambra SAPZ shall: ♦ Require contractors to prioritise local hiring where possible. ♦ Require contractors to provide food, water and campsites to reduce pressure on local resources ♦ If needed, work with local authorities to extend the operating hours of local infra, such as health clinics and community centres, to accommodate increased demand. ♦ Create a simple feedback system (like suggestion boxes or online forms) for local residents and migrant workers to identify issues with amenities. ♦ Run awareness campaigns to educate both locals and migrant workers on the responsible use of local amenities.	
Increased transport activities due to construction activities (material and workforce transportation)	Traffic Congestion / Mental health stress for commuters due to delays		The Anambra SAPZ SPIU shall: ♦ Require contractors to develop and implement traffic management plans, including designated routes, schedules to avoid peak traffic times, and measures to enhance road safety. ♦ Require contractors to provide commuters with real-time traffic information through mobile apps or radio/tv announcements, allowing them to plan alternative routes or adjust travel times. ♦ Require contractors to limit noise and other disturbances during peak commute hours to prevent	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			added stress for commuters stuck in traffic. ♦ Require contractors to work with local authorities to improve road infrastructure and signage to accommodate increased traffic. ♦ Require contractors to conduct community awareness campaigns on traffic safety and project-related traffic changes. ♦ Continuously monitor traffic conditions and adjust plans as necessary to minimise congestion and safety risks.	
	Climate Impact (GHG Emissions) / Deterioration of Air Quality		The Anambra SAPZ SPIU shall: ♦ Encourage contractors to opt for vehicles with lower emissions, such as hybrid-powered machinery. ♦ Require contractors to ensure that construction vehicle engines comply with international standards for exhaust gases. ♦ Require contractors to ensure the maintenance of engines as specified by the manufacturer. ♦ Require contractors to adopt regular exhaust gas checks and an engine-off policy at the construction site. ♦ Require contractors to use the cleanest economically available fuel. ♦ Encourage contractors to plan and optimise transportation routes to reduce fuel consumption and emissions from vehicles transporting staff, material and equipment.	
	Increased Road Accidents Risks		The Anambra SAPZ SPIU shall require contractors to: ♦ Develop and enforce a detailed journey management policy that includes risk assessment procedures, route planning, and emergency response plans. ♦ Ensure all construction vehicles are pre-mobbed, and issue pre-mobilisation compliance certificates after conducting thorough safety checks. ♦ Establish a regular maintenance schedule for construction vehicles, specifying maintenance	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			frequency and adherence to safety standards. ♦ Ensure drivers are qualified, experienced, and trained in defensive driving techniques and accident prevention strategies, with demonstrable evidence of compliance with driving rules and regulations. ♦ Mandate the use of seat belts for drivers and all passengers in construction vehicles to enhance safety. ♦ Provide first aid training for the workforce, along with the provision of fully stocked first aid kits in all construction vehicles. ♦ Maintain comprehensive accident and near-miss logs to identify trends and implement improvements in safety practices. ♦ Consider the incorporation of technology solutions such as GPS tracking and telematics to monitor vehicle performance and driver behaviour, enhancing safety and accountability. ♦ Conduct regular safety audits and inspections to ensure compliance with all safety measures and address any identified issues promptly. ♦ Establish an emergency response plan that outlines procedures for various types of accidents, ensuring all workers are familiar with the plan.	
Nighttime lighting	Changes in the behaviour of Fauna Species		The Anambra SAPZ SPIU shall: ♦ Require contractors to use wildlife-friendly lighting, such as LED lights, with lower colour temperatures to minimise disruption to nocturnal animals ♦ Require contractors to install directional lighting to focus light downward and prevent spillover into natural areas ♦ Require contractors to limit nighttime lighting hours, especially during wildlife breeding or migration seasons ♦ Require contractors to establish buffer zones with natural vegetation to reduce wildlife exposure to artificial light	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ Monitor wildlife behaviour regularly and provide advice to the contractor based on findings ♦	
	Changes to visual aesthetics		The Anambra SAPZ SPIU shall require contractors to: ♦ Incorporate dimmable lighting to adjust brightness levels based on need, maintaining safety while preserving aesthetic value ♦ Design lighting to blend with landscape features, minimising visual disruption and aligning with community preferences	
Use and application of materials such as cement, paint, and solvents in construction	♦ Deterioration of Air Quality		The Anambra SAPZ SPIU shall require contractors to: ♦ Use low-VOC paints and solvents to reduce harmful emissions. ♦ Implement dust control measures like water sprays and dust suppressants during construction. ♦ Ensure proper ventilation when using materials that release fumes. ♦ Interdict the burning of construction waste	
	♦ Soil Contamination		The Anambra SAPZ SPIU shall require contractors to: ♦ Store paints and solvents in designated areas to prevent leaks and spills. ♦ Use spill containment measures for hazardous materials to protect the soil. ♦ Regularly inspect and maintain storage containers to prevent deterioration. ♦ Prevent unauthorised personnel from inadvertently causing spills or contamination ♦ Store paints and solvents on impervious surfaces in covered areas, equipped with spill trays to contain any accidental spills and prevent soil contamination.	
	♦ Water Quality Impairment		The Anambra SAPZ SPIU shall: ♦ Require contractors to implement mitigation measures for soil contamination.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ Require contractors to prohibit disposing of paint, solvents, and other chemicals in drains or water bodies	
	♦ Health Hazards		The Anambra SAPZ SPIU shall require contractors to: ♦ Use trained and experienced personnel to minimise risks and ensure safe handling of materials. ♦ Establish safety protocols for working with cement and chemicals to minimise exposure to dust and chemicals. ♦ Conduct regular health and safety training for workers. ♦ Mandate compulsory use of PPE for the workforce ♦ Limit and control access to paint and other chemical storage areas to prevent unauthorised personnel from inadvertently causing spills or contamination. ♦ Establish an emergency response plan that outlines procedures for various types of accidents, ensuring all workers are familiar with the plan. ♦ Ensure compliance with all relevant occupational health and safety regulations.	
	♦ Hazardous waste generation from painting and cement operations such as leftover paints, solvents, and cement slurry.		The Anambra SAPZ SPIU shall require contractors to: ♦ Establish a waste management policy for the safe disposal of hazardous waste, aligning with FMEnv standards and using approved disposal sites. ♦ Provide receptacles for different types of waste. ♦ Segregate, recycle, and dispose of waste responsibly. ♦ Implement a waste reduction strategy by ordering only the necessary amount of materials. ♦ Train workers on proper disposal methods for hazardous waste to ensure compliance with regulations. ♦ Ensure hazardous waste is handled and disposed of by qualified and accredited waste contractors.	
Offloading and loading of products and materials	♦ Risk of injuries from improper handling, falls, or equipment malfunction during offloading and loading		The Anambra SAPZ SPIU shall require contractors to: ♦ Provide training on safe material handling and lifting techniques. ♦ Mandate the use of appropriate PPE (gloves, helmets, boots).	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ Use mechanical aids (e.g., forklifts, hand trucks) to reduce the need for manual lifting. ♦ Encourage team lifting for heavy or awkward loads, ensuring proper coordination between workers. ♦ Implement safe loading/unloading protocols, including designated loading zones. ♦ Rotate tasks to prevent repetitive strain on specific muscle groups. ♦ Regularly inspect equipment used for loading/unloading to ensure they are in good working condition. ♦ Ensure ergonomic workstation design, with adjustable height platforms to reduce bending and overreaching. ♦ Schedule regular breaks to prevent fatigue and muscle strain during prolonged periods of loading/offloading.	
Working at height	Risk of falls leading to serious injuries or fatalities ♦		The Anambra State SPIU shall require contractors to: ♦ Ensure proper use of fall protection systems, such as safety harnesses and guardrails ♦ Provide training for working at heights ♦ Conduct regular inspections of scaffolding and other height-related equipment ♦ Establish criteria for use of 100 per cent fall protection (typically when working over 2 metres above the working surface. ♦ Ensure the proper rating for the hoisting equipment; ♦ Ensure proper maintenance of hoisting equipment and properly train hoist operators. ♦ Use Safety belts that are not less than 16 millimetres (mm) (5/8 inch) of two-in-one nylon or material of equivalent strength. ♦ Ensure workers use a second (backup) safety strap when operating power tools at height,	
Electrical works	Risk of electrocution, fire hazards, and injuries due to faulty electrical connections		The Anambra PIS shall require contractors to: ♦ Employ only qualified and certified electricians for all electrical works.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Construction Phase				
			♦ Provide electrical safety training. ♦ Implement lockout/tagout procedures. ♦ Ensure electrical systems are regularly inspected and maintained. ♦ Put up signs to warn the public and workers about energised areas, and where possible, install barriers, such as locks and fencing, to prevent unauthorised access to potentially dangerous equipment and areas. ♦ Provide and enforce the use of appropriate PPE for all workers.	
Community and local Business Engagement / **Increased investment by public and private Investors**	Economic Improvement for local businesses, Positive shifts in regional economic activities		The Anambra SAPZ SPIU shall: ♦ Conduct comprehensive economic impact assessments to understand potential positive and negative effects on local businesses and the regional economy. ♦ Encourage contractors to foster partnerships with local businesses, integrating them into the project supply chain through capacity-building initiatives and preferential procurement policies. ♦ Implement community development programmes that diversify the local economy, such as supporting agribusinesses, tourism, and other sustainable enterprises. ♦ Offer capacity-building workshops and training sessions on market trends, business management, and sustainable practices to help local entrepreneurs and farmers capitalise on new market opportunities. Establish an economic monitoring system to track the project's impact on local businesses and the regional economy, making adjustments as necessary to mitigate adverse effects.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
Operation of the SAPZ processing facilities/ equipment	Elevated Noise Levels		The Anambra SAPZ SPIU shall require facility owners to: ♦ Install noise barriers, mufflers, and silencers on equipment, and restrict noisy activities to daytime hours to minimise disturbances to local communities and wildlife. ♦ Where technically feasible, ensure machinery and equipment are sound-proof ♦ Ensure regular maintenance of machinery and equipment to reduce noise emissions. ♦ Provide PPE for facility workers and visitors to the facility. ♦ Regularly monitor noise levels and adjust operations as necessary to comply with noise regulations.	
	Deterioration of Air Quality / Climate Impact (GHG Emissions)		The Anambra SAPZ SPIU shall require facility owners to: ♦ Use of low-emission processing equipment. ♦ Implement dust suppression techniques, such as water spraying or using dust suppressants. ♦ Ensure Stack height is at 30 m ♦ Regularly monitor air quality and take corrective actions if pollutant levels exceed acceptable limits.	
	Increased Demand for Water Resources		The Anambra SAPZ shall: ♦ Promote water conservation by recycling and reusing water where feasible, including the implementation of a wastewater recycling system to treat and repurpose water for non-potable uses. ♦ Implement efficient water-use technologies and equipment, such as smart metering to encourage responsible use of water resources. ♦ Ensure that water storage systems, pipes, and distribution systems are regularly inspected and maintained to prevent leaks and promote water efficiency and conservation. ♦ Regularly monitor water usage to avoid overconsumption.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
	Soil and Water Contamination		The Anambra SAPZ SPIU shall require facility owners to: ♦ Ensure proper storage and containment of chemicals, oils, and other hazardous materials. ♦ Regularly inspect equipment for leaks to prevent contamination. ♦ Ensure proper collection and transfer of wastewater to the treatment plant, following guidelines to prevent leakage and ensure compliance with environmental standards.	
	Waste Generation		The Anambra SAPZ SPIU shall require facility owners to: ♦ Implement the SAPZ waste management plan as it relates to their activities within the SAPZ AIH/ATC. ♦ Provide receptacles for different types of waste. ♦ Segregate, recycle, and dispose of waste responsibly. ♦ Implement processes for converting reusable waste, such as cassava peels, into high-quality animal feed to promote resource efficiency and minimise waste. ♦ Compost non-reusable organic waste and other biodegradable materials to create nutrient-rich soil amendments. ♦ Monitor waste generation and adjust procedures as necessary to minimise waste. ♦ Ensure waste is disposed of by qualified and accredited waste contractors. ♦ Ensure proper collection and transfer of wastewater to the treatment plant, following guidelines to prevent leakage and ensure compliance with environmental standards.	
	Unpleasant Odours from agro-produce processing, waste composting, wastewater treatment, and livestock sheds		The Anambra SAPZ SPIU shall ensure that unpleasant odours from various are properly mitigated: i. Agro-produce Processing: Facility owners shall: ♦ Confine processing activities to enclosed, well-ventilated areas with efficient exhaust systems. ♦ Use natural or synthetic odour-neutralising agents or air fresheners specifically designed for	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
			food processing environments. ♦ Regularly clean and sanitise equipment and facilities to prevent odour-causing residue build-up. ♦ Maintain appropriate temperature and humidity levels to control microbial activity and reduce odour production. ♦ Monitor odour levels and engage local communities about potential impacts. ii. Waste Composting: Facility owners shall: ♦ Ensure proper aeration of compost piles to promote aerobic decomposition and reduce anaerobic processes that produce foul odours. ♦ Cover compost piles to prevent odours from escaping. ♦ Add wood chips or charcoal to the compost pile to absorb odours. ♦ Ensure composite sites are situated away from residential areas and sensitive locations. iii. Wastewater Treatment: The Anambra SPIU shall: ♦ Implement effective biological treatment processes, such as activated sludge or trickling filters, to break down organic matter and reduce odours. ♦ Use chemicals to neutralise or mask odours. ♦ Install odour control systems, such as scrubbers or biofilters, to capture and treat odorous gases. ♦ Ensure regular maintenance of wastewater treatment equipment to prevent malfunctions and odour issues. iv. Livestock Sheds: Facility Owners shall: ♦ Provide adequate ventilation to remove moisture, ammonia, and other odorous gases.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
			♦ Use appropriate bedding materials and manage litter properly to reduce odour production. ♦ Add sawdust or lime to the bedding to absorb odours. ♦ Clean and disinfect livestock sheds regularly to prevent odour-causing residue build-up.	
	Health and Safety Risks		The Anambra SAPZ SPIU shall require facility owners to: ♦ Conduct risk assessments and develop and implement an emergency response plan to address accidents, spills, and other emergencies. ♦ Ensure only qualified and trained personnel operate facility equipment ♦ Provide regular training to employees on health and safety procedures, including emergency response, first aid, and the proper use of personal protective equipment (PPE). ♦ Provide and mandate workers to use appropriate PPE. ♦ Install ventilation systems to disperse heat and maintain safe working temperatures. ♦ Use energy-efficient equipment to reduce excessive heat production. ♦ Maintain equipment and machinery in good working condition to prevent accidents and injuries. ♦ Monitor temperatures to ensure compliance with health and safety standards. ♦ Ensure proper machine guarding and safety protocols for operating processing equipment. ♦ Maintain high standards of hygiene and sanitation in the facility to prevent the spread of diseases. ♦ Provide adequate ventilation in all work areas to ensure good air quality and reduce exposure to harmful fumes and gases. ♦ Conduct regular inspections of the facility to identify and address potential hazards before they lead to accidents or injuries.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
			♦ Ensure all accidents and incidents are recorded, investigated, and follow-up actions implemented. ♦ Ensure compliance with all relevant occupational health and safety regulations.	
Hiring of labour during operational phase	Increased opportunities for employment		The Anambra SAPZ SPIU shall require contractors to: ♦ Give preference to qualified local residents during the recruitment of labour. ♦ Provide training to locals to enhance their employability. ♦ Make prompt payment to engaged labour; Ensure agreement with the community before mobilisation on modalities of promoting local entrepreneurship in the provision of housing and transport.	
Hiring of migrant workers	Increased risk of sexually transmitted diseases		The SAPZ SPIU shall: ♦ Require contractors to prioritise local hiring where possible to reduce the number of temporary workers moving into project areas ♦ Implement health education programs to educate migrant workers and local communities on STDs and prevention methods ♦ Ensure easy access to healthcare services, including STD testing and treatment for migrant workers ♦ When possible, conduct regular health screenings and STD testing for migrant workers ♦ Partner with health-focused NGOs to deliver targeted interventions and support, including the distribution of free condoms and other protective measures to migrant workers and local communities	
	Threat to community culture, safety and security		The Anambra SAPZ SPIU shall: ♦ Activate the Grievance Redress Mechanism (GRM) and ensure that community members are informed about its processes and how to access it. ♦ Require contractors to prioritise local hiring where possible.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
			♦ Establish and maintain open, two-way communication channels with local communities throughout the project lifecycle to ensure continuous engagement and feedback, addressing their concerns and aspirations while involving them in decision-making. ♦ Provide cultural sensitivity training for both migrant workers and local communities to foster mutual understanding of customs, traditions, and cultural norms. ♦ Facilitate community integration programmes that promote positive interactions and mutual respect between migrant workers and local residents. ♦ Enhance security by improving lighting, promoting community policing, and installing surveillance in areas with high concentrations of migrant workers, with an emphasis on trust-building and crime prevention. ♦ Establish accessible conflict resolution mechanisms, including formal mediation and community-led initiatives, to promptly address any disputes or tensions between migrant workers and local residents.	
	Increase pressure on local infrastructure/amenities and services including health facilities, water resources, etc.		The Anambra SAPZ shall: ♦ Require contractors to prioritise local hiring where possible. ♦ Require contractors to provide food, water and campsites to reduce pressure on local resources ♦ If needed, work with local authorities to extend the operating hours of local infra, such as health clinics and community centres, to accommodate increased demand. ♦ Create a simple feedback system (like suggestion boxes or online forms) for local residents and migrant workers to identify issues with amenities. ♦ Run awareness campaigns to educate both locals and migrant workers on the responsible use of local amenities.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
Increased transport activities due to operational activities (material and produce transportation)	Climate Impact (GHG Emissions) / Deterioration of Air Quality		The Anambra SAPZ SPIU shall require facility owners to: ♦ Opt for vehicles with lower emissions, such as hybrid-powered machinery. ♦ Ensure that operational vehicle engines comply with international standards for exhaust gases. ♦ Ensure the maintenance of engines as specified by the manufacturer. ♦ Adopt regular exhaust gas checks and an engine-off policy at the construction site. ♦ Use the cleanest economically available fuel. ♦ Plan and optimise transportation routes to reduce fuel consumption and emissions from vehicles transporting staff, material and equipment.	
	Increased Road Accidents Risks		The Anambra SAPZ SPIU shall require facility owners to: ♦ Develop and enforce a detailed journey management policy that includes risk assessment procedures, route planning, and emergency response plans. ♦ Ensure all operation vehicles are pre-mobbed, and issue pre-mobilisation compliance certificates after conducting thorough safety checks. ♦ Establish a regular maintenance schedule for all vehicles, specifying maintenance frequency and adherence to safety standards. ♦ Ensure drivers are qualified, experienced, and trained in defensive driving techniques and accident prevention strategies, with demonstrable evidence of compliance with driving rules and regulations. ♦ Mandate the use of seat belts for drivers and all passengers in construction vehicles to enhance safety. ♦ Provide first aid training for the workforce, along with the provision of fully stocked first aid kits in all construction vehicles. ♦ Maintain comprehensive accident and near-miss logs to identify trends and implement improvements in safety	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
			practices. ♦ Consider the incorporation of technology solutions such as GPS tracking and telematics to monitor vehicle performance and driver behaviour, enhancing safety and accountability. ♦ Conduct regular safety audits and inspections to ensure compliance with all safety measures and address any identified issues promptly. ♦ Establish an emergency response plan that outlines procedures for various types of accidents, ensuring all workers are familiar with the plan.	
Nighttime lighting	Changes in the behaviour of Fauna Species		The Anambra SAPZ SPIU shall: ♦ Require contractors to use wildlife-friendly lighting, such as LED lights, with lower colour temperatures to minimise disruption to nocturnal animals ♦ Require contractors to install directional lighting to focus light downward and prevent spillover into natural areas ♦ Require contractors to limit nighttime lighting hours, especially during wildlife breeding or migration seasons ♦ Require contractors to establish buffer zones with natural vegetation to reduce wildlife exposure to artificial light ♦ Monitor wildlife behaviour regularly and provide advice to the contractor based on findings	
	Changes to visual aesthetics		The Anambra SAPZ SPIU shall require contractors to: ♦ Incorporate dimmable lighting to adjust brightness levels based on need, maintaining safety while preserving aesthetic value ♦ Design lighting to blend with landscape features, minimising visual disruption and aligning with community preferences	
Offloading and loading of products and materials	Risk of injuries from improper handling, falls, or equipment malfunction during offloading and loading		The Anambra SAPZ SPIU shall require contractors to: ♦ Provide training on safe material handling and lifting techniques.	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
			♦ Mandate the use of appropriate PPE (gloves, helmets, boots). ♦ Use mechanical aids (e.g., forklifts, hand trucks) to reduce the need for manual lifting. ♦ Encourage team lifting for heavy or awkward loads, ensuring proper coordination between workers. ♦ Implement safe loading/unloading protocols, including designated loading zones. ♦ Rotate tasks to prevent repetitive strain on specific muscle groups. ♦ Regularly inspect equipment used for loading/unloading to ensure they are in good working condition. ♦ Ensure ergonomic workstation design, with adjustable height platforms to reduce bending and overreaching. ♦ Schedule regular breaks to prevent fatigue and muscle strain during prolonged periods of loading/offloading.	
Storage, handling and use of chemicals	Soil and Water Contamination from Chemical leakages or spills/ Health and Safety Risks/ Air quality deterioration from the release of harmful fumes / Product Contamination		The Anambra State SPIU shall require facility owners to: i. **Storage:** ♦ Store chemicals in designated, well-ventilated areas, away from heat sources, ignition points, and incompatible materials. ♦ Ensure bund containment systems are in place in chemical storage areas to prevent leaks or spills. ♦ Clearly label all chemical containers with the chemical name, hazard warnings, and proper storage instructions. ♦ Develop and implement emergency response plans for chemical spills, fires, or other accidents. ♦ Conduct regular inspections of chemical storage areas to identify and mitigate potential hazards. ♦ Restrict access to chemical storage areas to authorised personnel only. ♦	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
			ii. **Handling:** ♦ Provide comprehensive training to all employees on safe handling, storage, and disposal of chemicals. ♦ Conduct regular emergency response drills to ensure preparedness and identify areas for improvement. ♦ Ensure compliance with relevant chemical handling regulations and industry best practices. iii. **Uses:** ♦ Establish and follow safe handling procedures for all chemicals used at the facility. ♦ Ensure workers use appropriate PPE when handling chemicals. ♦ Provide adequate ventilation in areas where chemicals are used to minimise exposure to harmful fumes. ♦ Whenever feasible, opt for less hazardous chemical alternatives. iv. **General Measures:** ♦ Conduct regular risk assessments to identify hazards and implement necessary control measures. ♦ Ensure spill kits are available in strategic locations for prompt containment and clean-up of spills. ♦ Implement proper waste management procedures for chemical waste disposal. ♦ Install air quality monitoring systems in chemical storage or usage areas to detect hazardous vapours. ♦ Maintain an up-to-date emergency response plan for chemical-related incidents. ♦ Ensure compliance with all relevant occupational	

Project Activity	Potential and Associated Impact	RBM	Mitigation Measures	RAM
Operational / Maintenance Phase				
			health and safety regulations relating to chemical storage, handling and usage. ♦ Ensure all accidents and incidents are recorded, investigated, and follow-up actions implemented.	
Community and local Business Engagement **Increased investment by public and private Investors/** **Increased investment by public and private Investors**	Economic Improvement for local businesses, Positive shifts in regional economic activities		The Anambra SAPZ SPIU shall: ♦ Conduct comprehensive economic impact assessments to understand potential positive and negative effects on local businesses and the regional economy. ♦ Encourage facility owners to foster partnerships with local businesses, integrating them into the project supply chain through capacity-building initiatives and preferential procurement policies. ♦ Implement community development programmes that diversify the local economy, such as supporting agribusinesses, tourism, and other sustainable enterprises. ♦ Offer capacity-building workshops and training sessions on market trends, business management, and sustainable practices to help local entrepreneurs and farmers capitalise on new market opportunities. ♦ Establish an economic monitoring system to track the project's impact on local businesses and the regional economy, making adjustments as necessary to mitigate adverse effects.	

RBM = Rating Before Mitigation; RAM = Rating After Mitigation

Source: Anambra SAPZ ESIA (2024)

6.5 Mitigation During Decommissioning Phase

The decommissioning phase will be triggered when the Anambra State SAPZ II project nears the end of its lifecycle or if it is abandoned. This phase includes all activities associated with the demolition of the facilities, restoring the project sites to their original state or repurposing them. Ensuring personnel safety and responsibly managing potential impacts is crucial during this stage.

The demolition activities during the decommissioning phase will have similar environmental impacts as those identified during the preconstruction and construction phases, including the influx of migrant workers, removal of topsoil/erosion, impairment of air quality, surface water contamination, visual impacts, and noise pollution, risks of fires and explosions, safety and security concerns, and traffic impacts. Additionally, decommissioning will have socioeconomic impacts, including loss of employment, decreased patronage of local businesses, reduced tax revenue for the government, and potential negative effects on nearby communities.

A strategic approach to mitigation measures during the decommissioning phase will focus on waste management, engineering practices, safety protocols, and mitigating socioeconomic impacts.

Issues to consider:

- Human health and safety
- Potential negative effects on the environment
- Compliance with all stated environmental laws and regulations
- Timely initiation of activities before the cessation of project activities
- Stakeholder engagement throughout the decommissioning process
- Community development and economic diversification in affected areas
- Legacy projects (if appropriate)
- Monitoring and evaluation of mitigation measures
- Contingency planning for unexpected challenges

The SAPZ SPIU will develop a Decommissioning Plan, which will be submitted to the FMEnv. This plan will contain the following information:

- Affected Stakeholders
- Identification of the project components that will be removed
- Proposed methods for the removal, disposal, or reuse of any project equipment/material where applicable
- Mitigation plans for all foreseeable environmental and social impacts associated with the decommissioning process
- An appropriate site rehabilitation program developed in consultation with affected communities and other stakeholders
- Timeline for completion

Upon approval, the Decommissioning Plan will guide the decommissioning of the affected project facility(ies).

CHAPTER 7 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 Introduction

An Environmental and Social Management Plan (ESMP) outlines the necessary measures to mitigate, monitor, and enhance the environmental and social impacts of a project. Its primary purpose is to ensure these impacts are effectively managed to prevent, minimise, or compensate for adverse effects while enhancing positive outcomes. This approach ensures compliance with regulatory standards and aligns with best practices in environmental and social management.

For the Anambra State Special Agro-Industrial Processing Zone (SAPZ) project, the ESMP addresses the significant environmental and social risks identified during the Environmental and Social Impact Assessment (ESIA). It provides a framework to guide the implementation of measures that support the project's sustainability goals, ensuring that development and operations are conducted responsibly.

7.2 Scope of the ESMP

The ESMP for the Anambra SAPZ project covers all major components, including the Agro-Industrial Hubs (AIHs), Agricultural Transformation Centres (ATCs) and their supporting infrastructure:

- **AIHs**: Management of environmental and social impacts related to the development and operation of AIHs, ensuring sustainable agricultural and industrial activities.
- **ATCs**: Measures to manage impacts associated with ATCs, focusing on resource sustainability, ecosystem protection, and community well-being.
- **Supporting Infrastructure**: Provisions for managing the environmental and social impacts of essential infrastructure, including roads, water supply, power generation, and waste management.

The ESMP is crucial for ensuring that the Anambra SAPZ project is implemented in a manner that protects the environment, enhances social outcomes, and supports the project's long-term sustainability.

7.3. Objectives of the ESMP

The primary objective of the ESMP is to provide a structured framework for implementing measures identified in the impact assessment to avoid, mitigate, or offset adverse environmental and social impacts. This plan aims to minimise risks to the environment, project personnel, and local communities, covering:

1. **Environmental Protection:**
    i. Ensure compliance with national legislation, the National Investment HSE Policy and AfDB Environmental and Social Guidelines to achieve the highest environmental protection standards.
    ii. Prevent environmental damages and protect third-party properties.

2. **Social Safeguards:**
    i. Maintain high standards in working conditions, ensuring the health, safety, and well-being of all personnel.
    ii. Identify and mitigate work-related hazards to reduce associated risks.
3. **Contractor Management:**
    i. Clearly define the roles and responsibilities of contractors.
    ii. Establish a robust monitoring and supervision framework for SPIU to oversee contractors' performance.
    iii. Provide contractors with the necessary support to effectively implement mitigation measures.
4. **Monitoring Program:**
    i. Establish a monitoring programme to track the effectiveness of mitigation measures and ensure ongoing compliance with environmental and social standards. The program will include regular assessments and reporting mechanisms to facilitate adaptive management as needed.

7.4 Responsibilities and Accountability

The ESMP also establishes clear responsibilities and accountability mechanisms to ensure that all stakeholders, including contractors, government agencies, regulators, the State Programme Implementation Unit (SPIU), AfDB and all third parties are held accountable for their roles in managing environmental and social impacts. This includes ensuring that all actions comply with regulatory standards and align with international best practices and that monitoring programs are carried out effectively and transparently. Table 7.1 outlines stakeholders' roles and responsibilities in implementing the ESMP.

Table 7.1: Stakeholders ESMP Implementation Roles and Responsibilities

S/N	Stakeholder Category	Roles & Responsibilities
1	Federal Ministry of Environment (FMEnv)	♦ Lead role provision of advice on screening, scoping, review of draft ESMP report (in liaison with State Ministry of Environment and Water Resources), receiving stakeholder comments, public hearing of project proposals, social liability investigations, and monitoring and evaluation processes.
2	Anambra State Investment Promotion and Protection Agency (ANSIPPA) (Part of the SPIU)	♦ Overseeing Contractor Compliance: ANSIPPA is responsible for ensuring that contractors adhere to the ESMP requirements, including implementing mitigation measures and maintaining environmental and social standards. ♦ Monitoring and Supervision: The agency monitors project activities to ensure compliance with the ESMP and addresses any issues that arise, ensuring that both environmental and social impacts are managed effectively. ♦ Regulatory Coordination: ANSIPPA ensures that all project activities comply with relevant regulations and standards, coordinating with regulatory bodies as needed.
3	Anambra State Ministry of Agriculture and (ANSMA) (Part of the SPIU)	♦ Coordinate overall implementation of the SLPZ. ♦ Ensure investor compliance with environmental laws and policies in line with FMAFS Safeguard Unit.

S/N	Stakeholder Category	Roles & Responsibilities
4.	Federal Ministry of Agriculture and Food Security (FMAFS)	♦ Provide overall leadership and direction to MDAs, engaging critical stakeholders to support and comply with SAPZ policy. ♦ Ensure investors comply with environmental laws and policies.
5.	Anambra State Ministry of Environment (ANSME) (Part of the SPIU)	♦ Environmental monitoring and compliance at the state level. ♦ Site assessment and monitoring of ESMMP implementation.
6.	Anambra State Waste Management Authority (ASWAMA) (Part of the SPIU)	♦ Support ANSME in safeguards due diligence. ♦ Monitor ESMMP implementation, particularly waste management and pollution control.
7	Safeguard Unit of the SPIU (Constituted from the (Part of the SPIU)	♦ Environmental Safeguards: ♦ Collate environmental baseline data for project sites. ♦ Analyse community/individual sub-projects and their environmental impacts. ♦ Ensure project activities adhere to Environmental and Social Management and Monitoring Plan (ESMMP) best practices. ♦ Liaise with stakeholders on environmental issues and monitor mitigation measures and impacts. ♦ Social Safeguards: ♦ Develop and coordinate the implementation of social aspects of the ESMMP ♦ Liaise with stakeholders on social issues. ♦ Conduct impact evaluation and beneficiary assessments. ♦ Establish partnerships with organisations, including Civil Society Organisations (CSOs), Non-Governmental Organisations (NGOs) and Community-Based Organisations (CBOs).
8	Other State MDAs (Ministry of Women and Social Welfare [ANSMWSW], Ministry of Health [ANSMoH])	♦ Monitor mitigation measures and project impacts related to gender and health. ♦ Establish partnerships and liaise with relevant NGOs, CBOs, and CSOs.
9.	E&S Consultant	♦ Develop ESMMP. ♦ Train staff, regulators, MDAs, and contractors on ESMMP implementation and monitoring.
10.	Contractors	♦ Ensure compliance with bill of quantities (BOQ) specifications in procurement and construction. ♦ Implement ESMMP during project execution. ♦ Ensure contractors and workers sign and are trained on the Code of Conduct (CoC). ♦ Prepare and implement C-ESMP. ♦ Train construction personnel on Contractor ESMP (C-ESMP) requirements. ♦ Prepare the OHS manual and adhere to labour laws. ♦ Provide and enforce the use of PPEs. ♦ Maintain records and submit required ESMMP reporting data to the Supervising Consultant.
11	Awka North LGA, Orumba South LGA, Ayamelum LGA	♦ Provide oversight on ESMMP compliance within jurisdiction. ♦ Monitor activities related to public health, sanitation, and waste management.
12.	Host Communities	♦ Promote environmental awareness. ♦ Review environmental and social performance reports. ♦ Provide feedback on nonconformity issues. ♦ Attend public meetings organized by the project developer.
13.	NGOs/CSOs	♦ Assist in ensuring effective response actions. ♦ Conduct scientific research with government groups to develop sustainable environmental strategies.

S/N	Stakeholder Category	Roles & Responsibilities
14.	AfDB	♦ Recommend additional measures for strengthening the management framework and implementation performance. ♦ Conduct implementation support missions and ensure SAPZ subprojects comply with AfDB's E&S loan conditions. ♦ Provides technical support and Capacity Building to the Borrower.
15	General Public	♦ Identify issues that could derail the project and support project impacts and mitigation measures, Awareness campaigns.

7.5 Institutional Capacities

7.5.1 The State Programme Implementation Unit (SPIU)

The SPIU, established by the Anambra State Government (ANSG) and the African Development Bank (AfDB) is tasked with overseeing the implementation of the Anambra SAPZ II project. It is led by a Project Manager/Coordinator, with technical experts, environmental and social officers, and two liaison officers drawn from the state's relevant MDAs.

The AN SPIU holds responsibility for the overall planning and execution of the project. This includes the preparation of bidding documents, hiring project management consultants and SAPZ contractors, and supervising the works. The SPIU ensures the proper implementation of the environmental and social management measures outlined in the ESMP and resettlement action plan (RAP), including monitoring and reporting.

To bolster oversight, the SPIU will establish an internal Environmental & Social (E&S) Unit to manage the RAP and ESMP implementation, including the compensation disbursement. Additionally, the SPIU may engage an independent consultant to provide external expertise and support as needed. Relevant NGOs may also be invited to monitor and ensure the effective implementation of the RAP. The SPIU will ensure that the project's detailed ESMP is aligned with the final detailed engineering design. All necessary environmental measures and technical specifications will be incorporated into the bidding documents and contractual obligations with the winning bidder for each contracted project element.

7.5.2 Contractual Management

Many of the mitigation measures outlined in the ESMP are the responsibility of the Contractors, especially during the pre-construction and construction phases of the project. Therefore, contractors will need to incorporate these measures into their proposals as outlined in Table 7.2.

Table 7.2: Contractual Obligations for ESMP Compliance

Action	Remarks
♦ The measures described in this ESMP shall be included in the tender documents with appropriate flexibility to adjust to site-specific circumstances. Contractors must prepare their proposals considering these measures.	♦ Non-inclusion of these measures in the proposal will result in disqualification of the proponent.
♦ The contract with the successful bidder should incorporate these environmental and social management measures as firm conditions. These measures should be detailed in environmental specifications that align with the language and format of the rest of the contract document.	♦ This approach ensures that environmental and social controls are integrated seamlessly into the tender document and presented in a familiar format to the Contractor.
♦ The cost of implementing mitigation measures must be included in the overall cost of the contractual document.	♦ Contractors must account for and incorporate the costs associated with environmental and social requirements specified in the ESMP.
♦ Contractor ESMP (C-ESMP)	♦ The contractor is required to prepare a Contractor ESMP (C-ESMP) detailing how they will implement the ESMP measures on-site.

Source: Anambra SAPZ ESIA (2024)

7.5.3 Organisational Capacity and Competency

Training is crucial for the efficient and effective implementation of the ESMP. It is essential that the SPIU and all institutions involved in the ESMP's execution possess the necessary competence, whether through education, training, or experience. Engagement with ANSIPPA, the ANSMA and ANSME revealed a lack of a dedicated Environmental and Social (E&S) safeguard unit and relevant staff. Therefore, it is recommended that 3-4 competent E&S Safeguard personnel be recruited for the project. Alternatively, competent staff may be seconded from relevant state agencies, such as the Anambra State Ministry of Environment, Anambra State Ministry of Women and Social Welfare and Anambra State Waste Management Authority, and trained to fill this gap in compliance with the AfDB ISS requirements for EMSP implementation management. An initial capacity assessment has indicated that many institutions involved in the ESMP are not fully familiar with the AfDB Integrated Safeguards System (ISS) or with key aspects of ESMP implementation, such as gender-based issues, labour influx, climate change and grievance redress mechanisms (GRM). As a result, the training program outlined in Table 7.3 is proposed to enhance the capacities of those responsible for implementing the ESMP.

Table 7.3: Proposed Training to Build Organisational E&S Competence

Module ID	Capacity Building Activity	Proposed Topics	Objectives	Target Audience	Duration	Estimated Budget (NGN)
Module 1	AfDB's ISS and Nigeria's Extant Laws on Environmental Protection	1. Introduction to E&S policies and laws in Nigeria 2. AfDB's ISS & OS 3. Operational Safeguards triggered by project activities. 4. The roles and responsibilities of regulators and the AfDB during project implementation	To enhance awareness of AfDB's OS and applicable national regulatory requirements for project activities	SPIU, ANSIPPA, ANSMA, FMEnv, ANSME, ASWAMA, ANSWSA, ANSMoH, Contractors, E&S and OHS Managers and Officers, NESREA, project LGA officials	1 day	1,750,000.00
Module 2	Training on ESMP Implementation	1. Overview of ESMP 2. Potential Impacts of Project 3. Pollution & Control Measures 4. Environmental Management 5. Labour influx, GBV, Code of Conduct, vulnerable people etc. 6. Environmental Performance Monitoring 7. Environmental Reporting	To enhance competence in environmental sustainability and regulatory practice	Same as above	1day	1,750,000.00
Module 3	Climate Smart Agriculture	1. Introduction to primary production and climate change 2. Climate-smart strategies for agricultural production 3. 4) Creation of an enabling environment for climate-smart crop production	To mainstream climate change adaptation strategies to enhance project sustainability.	Same as above	1 day	1,750,000.00
Module 4	Waste Management	1. Agriculture and agro-processing waste streams and management 2. Waste recycling strategies 3. Composting 4. Biogas Production	To develop & implement eco-friendly and modern methods of waste recycling to prevent environmental degradation and enhance profitability	Same as above	1 day	1,750,000.00

Module ID	Capacity Building Activity	Proposed Topics	Objectives	Target Audience	Duration	Estimated Budget (NGN)
Module 5	Training on Construction and Operational HSE	1. Introduction to Occupational HSE 2. Overview of Health and Safety Hazards in Construction and Operational Activities 3. Incidents: Causation, Investigation & Reporting 4. Safety Procedures and Emergency Response preparedness 5. First Aid, Defensive Driving etc. 6. Project/Site Specific OHS 7. Site Inspection and risk assessment 8. Personal Protective Equipment	To ensure completion of the project with zero fatalities, zero Lost Time Injuries (LTI) or occupational illness by promoting safe & healthy working conditions for workers and monitoring officers	Same as above	1 day	1,750,000.00
		Total				**8,750,000.00**

Source: Anambra SAPZ ESIA (2024)

7.6 Management Plans

Management Plans encompass a range of detailed strategies and procedures designed to ensure compliance with specific environmental and social elements of the project. These plans outline the processes required for carrying out necessary activities and are integral to managing the environmental and social impacts identified in the ESIA report. Table 7.4 provides an overview of the key management plans, including their relevance to the activities and impacts discussed in the ESIA report and the designated lead responsibilities.

Table 7.4: Types of Environmental Management Plans

S/N	Plan Name	Includes	Plan Owner
1	Project Overall ESMP	Overarching plan linking all other plans to the project ESMP	SAPZ Project Coordinator
2	Occupational Health and Safety Management Plan	Policies, procedures, and plans to manage health and safety at work and minimise risks	OHS Manager
3	Environmental Monitoring Plan	Groundwater monitoring, routine effluent and discharge monitoring, air quality monitoring, noise monitoring	Environmental Safeguard Officer
4	Waste Management Plan	Procedures for handling hazardous and non-hazardous solid wastes, including chemical handling procedures	Environmental Safeguard Officer
5	Emergency Preparedness and Response Plan	Administration, emergency area organisation, policy distribution, and definitions	OHS Manager
6	Traffic Management Plan	Routes, driver training, vehicle maintenance, speed restrictions, road safety signage, and loading measures	Transport Manager

Source: Anambra SAPZ ESIA (2024)

7.6.1 Occupational Health and Safety Management Plan

Responsibility

The Anambra SAPZ SPIU and ANSMA, as project owners, will have overall responsibility for ensuring that a comprehensive Occupational Health and Safety Plan (OHSP) is developed, implemented, and maintained throughout the project phases. The OHSP will comply with relevant state and federal OHS legal and administrative frameworks as well as AfDB's OS5: Labour Conditions, Health and Safety. The contractor will be responsible for the implementation of this plan on-site, while the OHS Manager and the E&S Safeguard Unit will monitor compliance and ensure alignment with established health and safety standards. The OHS manager, appointed by the Anambra SAPZ SPIU, will oversee the preparation, execution, and periodic evaluation of the safety program.

Management Measures

- Providing safety devices to protect employees from injuries or hazardous conditions.
- Ensuring access to clean and safe drinking water for all employees.
- Providing immunisation services as applicable, to protect against specific health risks.
- Providing hygienic spaces for eating.
- Adequately equipped first aid stations accessible to all staff and ensuring a trained and competent first aider is on the site at all times

- Maintaining cleanliness and hygiene in all facilities.
- Including proper disposal procedures for bathrooms and other waste-generating areas.
- Displaying marked and visible signs indicating safety protocols.
- Provide facilities, training, and awareness programmes to prevent and respond to fires.
- Providing and enforcing the use of necessary PPE.
- Boldly displaying functional emergency numbers in case of need.

OHS Manager Responsibilities:

The OHS manager will develop the safety program, conduct regular safety training, perform safety inspections, and ensure that all personnel are aware of the correct storage, handling, and disposal of hazardous materials. The manager will also lead incidence and accident investigations and ensure that contingency plans are in place for accidents, spills, and fires. A safety committee, formed by the Anambra SAPZ SPIU, ANSMA, ANSME and ASWAMA, will support the OHS manager by organising regular safety meetings and reviewing safety protocols.

7.6.1.1 Estimated Budget for Implementing OHS Mitigations

Table 7.5 shows the estimated cost of implementing the identified OHS mitigations in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.5: Estimated Cost of Implementing OHS Management Plan

OHS Mitigation Strategy	Cost Estimate (NGN)
Provision of safety devices, first aid, firefighting equipment, signages	Captured in Contractors' Cost
Training and awareness programs	2,500,000.00
Immunisation services	1,500,000.00
Hygiene and sanitation maintenance	500,000.00
Personal Protective Equipment (PPE)	Captured in Contractors' Cost
Total	**4,500,000.00**

Source: Anambra SAPZ ESIA (2024)

7.6.2 Development of an Emergency Preparedness Response Plan (EPRP)

Responsibility

The SAPZ SPIU and ANSMA will be responsible for the development and overall implementation of the Emergency Preparedness and Response Plan (EPRP). The contractor and site operators will be responsible for executing the plan on-site, while the OHS Manager will monitor and ensure compliance with the plan. The engineer will provide technical oversight, particularly in designing and implementing the emergency alarm systems and evacuation protocols.

Management Measures:

- Clearly defined roles for emergency personnel, including site managers, response teams, and coordinators.

- Procedures for interaction with local and regional emergency authorities, and the establishment of reliable communication channels.
- Specific emergency procedures and actions to be taken in various emergency scenarios, including spill response, fire response, and medical emergencies.
- Design and installation of emergency alarms that can be heard across the entire site, especially at substations.
- Comprehensive evacuation plan outlining escape routes, procedures for accounting for personnel post-evacuation, and roles and responsibilities during an evacuation.
- and inventory of all emergency equipment and supplies, ensuring they are readily available when needed.
- A robust training plan that includes regular drills for emergency response teams, rescue operations, medical duties, spill response, and fire response.

Implementation and Coordination

In the event of an emergency, all personnel on-site will be immediately notified, and coordination with local communities will be initiated to mitigate impacts. For slowly developing emergencies or potential risks, the SAPZ SPIU, ANSME, ANSEPA, contractor, and other authorities will be alerted and consulted on preventative actions. The SAPZ SPIU and ANSMA will maintain an up-to-date inventory of emergency response equipment and supplies to ensure readiness.

Evacuation Procedures

- Mobilise the team to assist in the evacuation.
- Employ alarms, loudspeakers, or other methods depending on the incident.
- Provide concise and clear instructions, e.g., "We have a [type of emergency]. Evacuate to [assembly point]."
- If possible, power down equipment before evacuating.
- Ensure all personnel are accounted for at the assembly point.
- Remain at the assembly point until additional guidance is provided.

The ERP will include specific protocols for fire safety and explosion response, with detailed instructions tailored to these types of emergencies.

7.6.3.2 Estimated Budget for Implementing EPRP Mitigations

Table 7.6 shows the estimated cost of implementing the identified EPRP mitigations in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.6: Estimated Cost of Implementing EPRP

EPRP Mitigations Strategy	Cost Estimate (NGN)
Salaries for ERP development team, OHS Manager, engineers, and site operators.	Captured in Staff Remuneration
Expenses for emergency response drills, training sessions, and materials.	500,000.00
Procurement and installation of emergency alarms, communication tools, and evacuation equipment.	Captured in OHS Management Plans
Regular updates and maintenance of emergency equipment and communication systems.	500,000.00
Total	**1,000,000.00**

Source: Anambra SAPZ ESIA (2024)

7.6.3 Contractor Management

Responsibility

The Anambra SAPZ SPIU and ANSMA, as project owners, hold the ultimate responsibility for ensuring that all contractors comply with environmental, social, health, and safety (ESHS) standards throughout the project. The OHS Manager and E&S Safeguard unit will monitor contractor compliance and ensure compliance with all contractual requirements related to ESHS. Contractors are responsible for implementing the required measures and maintaining compliance with the standards and guidelines provided. Regular audits and inspections will be conducted by the SPIU to ensure adherence to these standards.

Management Measures

The SAPZ SPIU and ANSMA will require its contractors to strictly follow the OHSP and the EPRP. To support this, AMIC/SAPZ will issue a comprehensive set of Environmental, Social, Health, and Safety (ESHS) safeguards to the construction contractors, which will include the following key elements:

- Contractors are expected to establish and maintain an Environmental Health and Safety Management System (EHSMS) in alignment with AfDB's OS5: Labour Conditions, Health and Safety. This system should include risk assessments, emergency preparedness plans, and procedures for continuous monitoring and improvement.
- Contractors must adhere to the ESHS standards specified by AMIC/SAPZ, including those related to waste management, spill prevention, noise control, and hazardous materials management. Contractors will also be required to comply with national and international regulations governing environmental and occupational health and safety practices.
- Contractors are responsible for ensuring that all personnel are adequately trained in ESHS requirements, including the proper use of personal protective equipment (PPE), emergency response protocols, and waste management procedures. AMIC/SAPZ will provide oversight to ensure that these training programs are effective and comprehensive.

- Contractors must maintain detailed records of all ESHS activities, including incident reports, safety inspections, and waste disposal logs. These records will be regularly reviewed by the SPIU to ensure compliance and identify areas for improvement.
- The SPIU will conduct regular audits and inspections of contractor operations to verify compliance with ESHS standards. Any non-compliance issues will be addressed immediately, with corrective actions enforced as necessary.

7.6.3.1 Estimated Budget for Implementing Contract Management Mitigations

Table 7.7 shows the estimated cost of implementing the identified Contract Management mitigations in the first year. The mitigation costs are captured in other areas, hence showing zero naira. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.7: Estimated Cost of Implementing Contract Management

Contract Management Mitigation Strategy	Cost Estimate (NGN)
Training sessions for contractors on ESHS standards and procedures.	Captured in Organisational Capacity and Competency
Expenses related to addressing non-compliance issues.	Captured in Contractor's Cost
Total	**-**

Source: Anambra SAPZ ESIA (2024)

7.6.4 Noise Management Plan

Responsibility

The SAPZ SPIU and ANSMA, as project owners, will assume overall responsibility for ensuring effective noise management throughout the project life cycle. During construction and operational phases, the contractor and facility operators will be responsible for the implementation and execution of noise control measures. The E&S Safeguard Unit will be responsible for monitoring and ensuring compliance with the noise management plan, while the engineer will provide technical oversight and ensure that noise mitigation measures are integrated into project planning and design.

Management Measures

Mitigation measures to be enforced during construction to minimise noise levels include:

- **Equipment and Machinery Management:**
  - Select inherently quiet equipment to minimise noise generation at the source.
  - Ensure all mechanical equipment is well-maintained and operated efficiently.
  - Keep equipment speed as low as possible to reduce noise output.
  - Shut down or throttle down intermittent-use equipment between work periods.
  - Utilize and properly maintain silencers or mufflers to reduce vibration and noise on construction equipment.
- **Site Logistics and Planning:**

  - Utilise material stockpiles, barriers, and other structures to act as noise shields where feasible.
  - Restrict access to the site for truck traffic outside of normal working hours to minimise noise disturbance.
  - Limit site working hours to morning hours, particularly for noisy activities.
  - Schedule noisy activities strictly during the morning hours to minimise disruption.
  - Consider the use of acoustic insulating materials, isolation of the noise source, and other engineering controls to minimise noise impact.
- **Community Engagement:**
  - Consult with local communities to inform them of planned noisy activities and engage them in dialogue to address any concerns.
  - Provide timely notifications to affected communities before the commencement of particularly noisy activities.

- **Noise Monitoring and Compliance:**
  - Enforce regular noise monitoring to ensure compliance with established noise limits.
  - Install warning signs in areas where high noise levels are expected.
  - Enforce the use of hearing protection when the equivalent sound level over 8 hours reaches 85 dB(A), peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110 dB(A).

Compliance and Enforcement

The noise control measures will be incorporated into construction contracts and will be mandatory requirements for all contractors. The E&S Safeguard Unit will have the responsibility of ensuring the implementation and enforcement of these measures, with regular reports submitted to the SAPZ SPIU and ANSME for review.

7.6.4.1 Estimated Budget for Noise Management Mitigations

Table 7.8 shows the estimated cost of implementing the identified Noise mitigations in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.8: Estimated Cost of Implementing Noise Mitigations

Noise Mitigation Strategy	Cost Estimate (NGN)
Purchase and maintenance of noise control equipment, such as silencers and mufflers.	Sample Monitoring
Expenses for implementing noise barriers	Sample Monitoring
Costs for community notifications and consultations.	1,500,000.00
Regular noise monitoring and compliance checks.	Captured in Environmental Sample Monitoring
Provision of personal protective equipment for workers.	Captured in OHS Management
Total	**1,500,000.00**

Source: Anambra SAPZ ESIA (2024)

7.6.5 Air Quality Management Plan

Responsibility

The Anambra SAPZ SPIU and ANSMA shall assume responsibility for ensuring the air quality management system throughout the life of the Project. During construction and operational phases, the contractor and facility operators will be responsible for the implementation and execution of air quality mitigation measures. The E&S Safeguard Unit will be responsible for monitoring and ensuring compliance with the air quality management plan, while the engineer will provide technical oversight and ensure that air quality mitigation measures are integrated into project planning and design,

7.6.5.1 Control of Air Emissions

To minimise air emissions during construction, several control techniques will be employed:

- **Particulate Matter (PM) Management:** Surface stabilisation methods such as watering, chemical stabilisation, and windbreaks will be used to control temporary PM emissions. Long-term controls include surface improvements, such as covering dirt roads with gravel or slag and regular grading of gravel roads to maintain larger aggregate sizes, which reduces surface dust content.
- **Good Housekeeping Practices:** Simple, low-cost measures will be implemented, including:
    - Proper site enclosure with appropriate hoarding and screening.
    - Controlled on-site mixing, unloading operations, and cement handling.
    - Maintaining minimal traffic speeds on-site and on access roads.
    - Covering vehicles hauling dust-prone materials.
    - Regular maintenance and repair of construction machinery and vehicles.
    - Avoiding the burning of cleared materials.
    - Covering excavated or stockpiled dusty materials with impervious sheeting.
    - Applying water spraying as needed.

7.6.5.2 Emissions from Vehicles and Equipment

Construction activities will generate emissions from diesel engine-driven equipment, including CO_2, CO, NO_2, SO_x, and hydrocarbons. To mitigate these emissions:

- Ensure proper maintenance of trucks, engines, and construction equipment.
- Implement a traffic management plan to avoid congested routes.
- Use high-quality diesel fuel to reduce harmful emissions.
- Turn off equipment when not in use to minimise power consumption and pollutant emissions and improve operational efficiency.

7.6.5.3 Estimated Budget for Implementing Air Quality Mitigations

Table 7.9 shows the estimated cost of implementing the identified Air Quality mitigations in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.9: Estimated Cost of Implementing Air Quality Mitigation Measures

Air Quality Mitigation Strategy	Cost Estimate (NGN)
Watering, chemical stabilisation, and dust suppression materials.	Captured in Environmental Sample Monitoring
Regular maintenance to reduce emissions	Captured in Contractors' Cost
Implementing traffic plans to minimise congestion.	NA
Costs for site enclosures and controlling on-site mixing and handling.	Captured in Contractors' Cost
Regular air quality monitoring and compliance checks	Captured in Environmental Sample Monitoring
Total	**-**

NA: Not applicable; captured in traffic mitigations
Source: Anambra SAPZ ESIA (2024)

7.6.6 Water Quality Management Plan

Responsibility

The Anambra SAPZ SPIU and ANSMA shall assume responsibility for ensuring the water quality management system throughout the life of the Project. During construction and operational phases, the contractor and facility operators will be responsible for the implementation and execution of noise control measures. The E&S Safeguard Unit will be responsible for monitoring and ensuring compliance with the water quality management plan, while the engineer will provide technical oversight and ensure that water quality mitigation measures are integrated into project planning and design.

7.6.6.1 Degradation of Water Quality Due to Stormwater Runoff

Construction activities, including vegetation removal and soil disturbance, can lead to erosion, sedimentation, and increased turbidity in nearby water bodies, including Eso Stream (Ogboji), Rivers Otakpu (Omor), Nnamuzu (Ugbene) and Uruokpukpo (Ogbunka). Additionally, pollutants from material and equipment storage areas, as well as spills and leaks from construction equipment, may degrade water quality

To address these concerns, AMIC/SAPZ will require contractors to develop and implement an Erosion and Sediment Control Plan before construction begins. This plan will outline best management practices (BMPs) to control stormwater runoff and prevent water quality degradation, especially during the rainy season. Key measures include:

- Limiting land clearing to essential work areas, access points, and material storage sites.
- Minimising exposure of erodible land to stormwater runoff during the rainy season.
- Maintaining a 15-metre Riparian Management Zone (RMZ) between construction areas and surface water bodies to filter sediments from runoff.

- Covering open stockpiles of construction materials with tarpaulin or similar fabric during rainstorms.
- Compacting soil promptly after tower foundation construction to prevent erosion.
- Restoring construction areas as soon as possible after completing work at each site.

7.6.6.2 Degradation of Water Quality Due to Accidental Spills and Leaks

To prevent and mitigate the impact of spills or leaks of oils and hazardous materials on surface and groundwater, The AN SAPZ SPIU will develop and implement a Spill Contingency Plan. Key provisions include:

- Prohibiting the storage of fuel and hazardous materials within 30 metres of surface water bodies.
- Ensuring pumps used within 30 metres of marshlands or wetlands are equipped with proper secondary containment.
- Promptly containing and cleaning up any oil leaks or spills.
- Collecting and storing spent oil and lubricants for recycling or proper disposal.
- Securing all fuel tanks and chemical storage areas with locks and secondary containment structures.
- Installing oil/water separators in stormwater channels to remove oils from

7.6.5.3 Estimated Budget for Implementing Water Quality Mitigations

Table 7.10 shows the estimated cost of implementing the identified water quality mitigations in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.10: Estimated Cost of Implementing Water Quality Mitigation Strategies

Water Quality Mitigation Strategy	
Implementation of erosion and sediment control measures	Captured in Contractor's cost
Equipment and materials for spill containment and clean-up	Captured in Spill Management Plan
Secure storage for fuels and hazardous materials.	Captured in Environmental Sample Monitoring
Regular monitoring and analysis of water quality.	Captured in Environmental Sample Monitoring
Costs for restoring construction areas and managing riparian zones.	Captured in Contractor's cost
Total	**-**

7.6.7 Soil and Erosion Management Plan

Responsibility

The Anambra SAPZ SPIU and ANSMA shall assume responsibility for managing soil and land degradation due to erosion. During construction and operational phases, the contractor and facility operators will be responsible for the implementation and execution of soil and erosion control measures. The E&S Safeguard Unit will be responsible for monitoring and ensuring compliance with the plan, while the engineer will provide technical oversight and ensure that erosion mitigation measures are integrated into project planning and design.

Management Measures

Before the commencement of construction activities, the Anambra SAPZ SPIU and the ANSMA will implement an erosion and sediment control plan to prevent soil contamination and erosion. This plan will ensure, to the satisfaction of the ANSME, that there is no substantial risk of increased sediment discharge from the project sites at any stage of the project.

Key measures include:

- Limited Vegetation Clearing: Vegetation removal will be restricted to areas where it is strictly necessary, reducing the risk of soil erosion and minimising disruption to local habitats. A Riparian Management Zone (RMZ) with a minimum width of 15 metres will be maintained between construction areas and surface water bodies to filter sediments in stormwater runoff and protect aquatic ecosystems.
- Grading of Unpaved Roads: Unpaved roads will be graded to reduce the risk of erosion during rainstorms, thereby protecting surrounding vegetation and wildlife habitats.
- Soil Reuse and Protection: Soils excavated for tower foundations will be reused for refilling and will not be left exposed to wind or water for extended periods, preventing soil degradation and preserving the integrity of the local ecosystem.
- Alternative Transport Routes: The contractor will avoid steep terrain during material transportation by using alternative routes or light vehicles where appropriate, minimising soil disturbance and its impact on nearby habitats.
- Minimised Soil Compaction: Heavy machinery use will be limited to essential areas in construction work zones to minimise soil compaction, which can make soil more susceptible to erosion and reduce its ability to support plant life.
- Protection of Vegetation Near Water Bodies: Vegetation associated with riverine and surface water bodies will be minimally disturbed during construction to reduce soil erosion, safeguard bank protection, and maintain critical habitats for aquatic and terrestrial species.
- Revegetation: Disturbed areas will be replanted with local species common in the area to complement natural vegetation regeneration, improve cover, and support biodiversity conservation.
- Sediment Binding Grasses: In areas prone to soil erosion, suitable sediment-binding grasses will be planted in degraded substrates to stabilise the soil and prevent habitat loss.

7.6.7.1 Estimated Budget for Soil and Erosion Control Mitigations

Table 7.11 shows the estimated cost of implementing the identified air quality mitigations in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.11: Estimated Cost of Implementing Soil and Erosion Control Mitigation Strategies

Soil and Erosion Mitigation Strategy	Cost Estimate (NGN)
Costs for limited vegetation clearing and revegetation efforts	Captured in Contractor's cost
Grading of unpaved roads to prevent erosion	Captured in Contractor's cost
Implementation of sediment-binding grasses and other erosion control measures	Captured in Contractor's cost
Measures to protect and reuse excavated soils	Captured in Contractor's cost
Alternative transport routes and vehicles for minimising soil disturbance	NA
Total	-

NA: Not applicable; captured in traffic mitigations
Source: Anambra SAZP ESIA (2024)

7.6.8 Spill Contingency Management Plan

Responsibility

The Anambra SAPZ SPIU and ANSMA shall assume responsibility for ensuring the spill contingency management plan is maintained throughout the life of the Project. The AN SAPZ SPIU will develop and implement a Spill Contingency Management Plan designed to prevent, contain, clean up, and report spills or releases of fuel oil and other hazardous materials. During construction and operational phases, the contractor and facility operators will be responsible for the implementation of spill contingency management measures. The E&S Safeguard Unit and the OHS manager will be responsible for monitoring and ensuring compliance. The primary goal of this plan is to prevent contamination by ensuring that hazardous materials are not released into the environment. Key mitigation measures include:

- Regular maintenance of equipment.
- Inspection of equipment and containers for signs of spills, leaks, corrosion, or other deterioration.
- Construction of containment bunds around storage areas to contain spillage
- Placement of spill response equipment near material storage areas and on heavy machinery.
- Training employees on material storage, transfer, transportation procedures, spill response, and reporting requirements.

In the event of an oil spill at project sites, immediate action will be taken to contain the leakage. All combustible, flammable, and ignition sources (e.g., running engines) will be removed from the vicinity to prevent fire hazards, and personnel will be instructed to stay upwind. Spill kits will be available at project sites and in transport vehicles for quick clean-up of small spills. Contaminated soil will be excavated and disposed of following AMIC/SAPZ hazardous waste management procedures. For larger spills, a berm will be constructed around the affected area to control runoff to surface water.

7.6.8.1 Estimated Budget for Implementing Spill Mitigations

Table 7.12 shows the estimated cost of implementing the identified spill mitigations in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.12: Estimated Cost of Implementing Spill Mitigation Strategies

7.7.8 Spill Contingency Mitigation Strategy	Cost Estimate (NGN)
Training employees on material storage, transfer, transportation procedures, spill response, and reporting requirements	Captured in Contractor's Cost
Costs for spill kits, including procurement and maintenance	Captured in Contractor's Cost
Excavation and disposal of contaminated soil	Captured in Contractor's Cost
Construction of containment bund around storage areas	Captured in Contractor's Cost
Construction of berms for larger spills to control runoff	Captured in Contractor's Cost
Total	**-**

Source: Anambra SAPZ ESIA (2024)

7.6.9 Hazardous Materials Management Plan

Responsibility

The Anambra SAPZ SPIU will hold overall responsibility for ensuring the implementation of the Hazardous Materials Management Plan. The contractor is responsible for preparing and executing the Spill Contingency Plan, managing the storage, handling, and disposal of hazardous materials, and ensuring compliance with all relevant regulations. AMIC/SAPZ will oversee and verify that the contractor complies with these requirements and that all hazardous materials management practices align with Nigerian environmental laws and international standards.

Implementation

AMIC/SAPZ will require its contractor to prepare and implement a Spill Contingency Plan that outlines procedures to prevent, contain, clean up, and report spills and releases of oil and hazardous materials. Key mitigation measures will include:

- Storing oil and hazardous materials within secondary containment structures (containment bunds) in designated areas.
  Using portable oil collection pans during refuelling operations.
- Storing pesticides and herbicides in designated areas according to FAO Guideline standards. Any pesticides used must meet the minimum standards of FAO's Guidelines for packaging, storage, labelling, handling, disposal, and application.
- Ensuring that no storage of oil and hazardous materials occurs within 30 meters of a surface water body.
- Keeping equipment well-maintained to prevent leaks or spills.
- Regularly inspecting equipment and containers for spills, leaks, corrosion, or other signs of deterioration.

- Maintaining spill response equipment near material storage areas and on heavy equipment.
- Ensuring all workers handling hazardous materials are adequately trained and informed about the risks, material storage, transfer, transportation procedures, spill response, and reporting requirements.
- Maintain an accurate inventory of all oil, hazardous materials, and waste stored on-site. Material Safety Data Sheets (MSDS) will be readily available for all hazardous substances.

7.6.7.1 Estimated Budget for Implementing Hazardous Material Mitigations

Table 7.13 shows the estimated cost of implementing the identified hazardous materials mitigations in the first year. The mitigation costs are captured in other areas, hence showing zero naira. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.13: Estimated Cost of Implementing Hazardous Materials Mitigation Strategies

7.7.9 Hazardous Materials Mitigation Strategy	Cost Estimate (NGN)
Secondary containment structures for oil and hazardous materials.	Captured in Contractor's Cost
Designated storage areas for pesticides and herbicides according to FAO guidelines.	Captured in Contractor's Cost
Maintenance costs for equipment to prevent leaks or spills.	Captured in Spill Contingency Management Plan
Regular inspections of equipment and containers.	NA
Spill response equipment near material storage and on heavy equipment.	NA
Training for workers handling hazardous materials.	Captured in Spill Contingency Management Plan
Construction of containment bund around storage areas	Captured in Contractor's Cost
Inventory management, including maintaining Material Safety Data Sheets (MSDS).	NA
Total	**-**

NA = Not applicable. Cost captured elsewhere

Source: Anambra SAPZ ESIA (2024)

7.6.10 Waste Management Plan

Responsibility:

- ANSIPPA/ANSMA, as project owners, shall ensure the Waste Management Plan (WMP) is developed and implemented in alignment with Nigerian laws and relevant international standards. During construction, the Contractor will be responsible for the field implementation, management, storage, and disposal of construction wastes. Users of the SAPZ AIG and ATC are also responsible for complying with the WMP.

WMP Implementation

The Anambra SAPZ SPIU will develop a project-specific WMP to ensure that all waste from project activities is managed properly in compliance with applicable laws and regulations. The WMP include:

- Description of the types of waste generated
- Waste minimisation opportunities.
- Waste management methods
- Provision of waste receptacles, clearly marked for different waste types
- Good housekeeping practices, including manifest and waste tracking forms.

Waste Categories

Hazardous Waste: Waste that possesses one or more characteristics that make it potentially harmful to human health and/or capable of causing environmental damage to air, land, water, or natural ecosystems. These wastes may be corrosive, reactive, toxic, mutagenic, teratogenic, infectious, carcinogenic, ecotoxic, flammable, or explosive. Examples include of hazardous waste are unused paint, lubricants, batteries, and chemicals with flammability, corrosiveness, or reactivity. Hazardous waste can be solid or liquid.

Non-Hazardous Wastes: Wastes that do not exhibit hazardous properties and pose relatively low risk to human health and the environment. This category includes materials such as cassava peels that can be converted into grits (animal feed), recycled or safely disposed of in a landfill.

- **Liquid Waste:** Sanitary wastewater, grey water, macerated food waste.
- **Solid Waste:** Packaging materials, containers, used PPE.
- **Special and Recyclable Waste:** Batteries, used oil, paper, aluminium cans, plastics, fluorescent and mercury light bulbs.
- **Electronic Waste (E-waste):** Includes discarded electronic devices such as computers, mobile phones, and batteries, containing hazardous substances like heavy metals. Managed by state-certified e-waste handlers.
- **Domestic Waste:** General refuse.

Storage, Handling, and Disposal of Waste

The WMP will specify the proper procedures for the storage, handling, and disposal of each waste type, ensuring safe and compliant management of all materials throughout the project lifecycle.

7.6.7.1 Estimated Budget for Implementing Waste Mitigation Strategies

Table 7.14 shows the estimated cost of implementing the identified waste mitigation measures in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.14: Estimated Cost of Implementing Waste Mitigation Strategies

Waste Mitigation Strategy	Cost Estimate (NGN)
Costs for developing and implementing the WMP	Captured in Contractor's Cost
Provision of Waste receptacles	Captured in Contractor's Cost
Total	**-**

Source: Anambra SAPZ ESIA (2024)

7.6.11 Traffic Management Plan

Responsibility

Anambra SAPZ SPIU, ANSMA, and ANSME will oversee the development and implementation of the Traffic Management Plan (TMP) throughout all project phases. Traffic Manager will handle day-to-day execution, coordination with local authorities, and monitoring. The contractor will implement traffic management measures on-site. E&S Safeguard Unit will monitor compliance and adjust plans as needed.

Management Measures

1. **Traffic Management Measures Actions:**
    - Develop and implement a TMP with designated routes, schedules to avoid peak times, and safety measures.
    - Enhance road safety with signage, barriers, and traffic control personnel.
    - Coordinate with local traffic authorities for alignment with municipal regulations.
    - Provide training to project drivers.
    - Work with ANSG and local government authorities to assess and improve road infrastructure and signage.
    - Implement necessary improvements to handle increased traffic and reduce road damage.
2. **Community Awareness Actions:**
    - Conduct public service announcements (PSA) to inform the community about traffic changes and safety measures.
    - Use local media, social media, and community meetings to disseminate information.
3. **Monitoring and Reporting Actions:**

- Monitor traffic conditions with cameras and manual observations.
- Adjust TMP measures based on real-time data and safety concerns.
- Collaborate with local authorities to address traffic issues and implement corrective actions.
- Regular reports on traffic conditions, TMP effectiveness, and incidents will be provided by the Traffic Manager to Anambra SAPZ SPIU, ANSMA, and ANSME.
- Conduct an annual review of the TMP to assess performance and implement corrective measures.

7.6.7.1 Estimated Budget for Implementing Traffic Mitigation Strategies

Table 7.15 shows the estimated cost of implementing the identified traffic mitigation measures in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.15: Estimated Cost of Implementing Traffic Mitigation Strategies

Traffic Mitigation Strategy	Cost Estimate (NGN)
Development and implementation of the Traffic Mitigation Strategy (TMP), including designated routes and safety measures	Captured in Contractor's Cost
Road safety enhancements, such as signage and barriers	Captured in Contractor's Cost
Coordination with local traffic authorities and training for project drivers	1,500,000.00
Community awareness campaigns through public service announcements and local media	500,000.00
Monitoring traffic conditions with cameras and manual observations	NA
Reporting on traffic conditions, TMP effectiveness, and incidents	NA
Total	**2,000,000.00**

NA = Not applicable. Cost captured elsewhere
Source: Anambra SAPZ ESIA (2024)

7.6.12 Biodiversity Management Plan

The clearing of vegetation in construction work areas may significantly impact terrestrial habitats, particularly in regions with tree cover. Hence, it is crucial to consider critical habitats, including forest patches and wetlands, which support biodiversity dependent on roadside habitats. The biodiversity management plan involves applying the following mitigations: Mitigation Measures:

- Limit vegetation clearing to areas where construction will take place while minimising disturbance and avoiding critical habitats.
- Avoid construction activities during sensitive periods, such as breeding seasons, to minimise disruption to local wildlife.
- Revegetate disturbed areas with native plant species. Implement habitat restoration activities, such as reforestation, to compensate for unavoidable habitat loss.
- Develop and implement a Biodiversity Management Plan that includes alien invasive species control, faunal handling procedures, and ecological landscaping guidelines.
- Establish protected areas and wildlife corridors in consultation with local communities and conservation experts to preserve biodiversity and facilitate species movement.
- Maintain a Riparian Management Zone between construction work areas and surface water bodies to protect aquatic ecosystems.
- Engage local communities in biodiversity conservation efforts by providing education and incentives for sustainable practices.
- Incorporate pollution prevention measures into the project design, such as impermeable liners for waste storage areas and runoff management systems. These measures are vital for protecting both soil and water quality.

- Regularly monitor biodiversity indicators and adapt management strategies based on monitoring results and scientific advancements to ensure long-term ecological sustainability.
- Offer the community priority access to removed vegetation for use as wood fuel, construction materials, or other purposes, promoting sustainable resource use.

7.6.12.1 Estimated Budget for Implementing Biodiversity Loss Mitigation Strategies

Table 7.16 shows the estimated cost of implementing the identified biodiversity loss mitigation measures in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.16: Estimated Cost of Implementing Biodiversity Loss Mitigation Strategies

7712 Biodiversity Mitigation Strategy	Cost Estimate (NGN)
Limiting vegetation clearing and avoiding critical habitats	Captured in Contractor's cost
Timing construction activities to avoid sensitive periods	Captured in Contractor's cost
Revegetation with native plant species and habitat restoration	Captured in Contractor's cost
Development Biodiversity Plan	5,000,000.00
Establishment of protected areas and wildlife corridors	Captured in Contractor's cost
Riparian Management Zone maintenance	500,000.00
Community engagement and education for biodiversity conservation	2,500,000.00
Pollution prevention measures for soil and water quality protection	NA
Regular monitoring of biodiversity indicators and adaptation of strategies	Captured in Monitoring Cost
Total	**8,000,000.00**

NA = Not applicable. Cost captured elsewhere
Source: Anambra SAPZ ESIA (2024)

7.6.13 Climate Change Mitigation Plan

Responsibility

The Anambra SAPZ SPIU, ANSMA, and ANSME will oversee the development and implementation of the Climate Change Mitigation Plan (CCMP) throughout all project phases. The Project Manager and Engineer will coordinate the integration of climate resilience measures into project planning and operations. The Environmental Manager and the E&S Safeguard Unit will be responsible for executing energy efficiency measures, integrating renewable energy, managing carbon offsetting programs, tracking climate-related indicators, and ensuring that adaptive strategies are in place.

Management Measures

1. **Climate Resilience Planning Actions**:
    - Conduct a climate risk assessment to identify potential climate impacts on the project.

- Integrate resilience measures into project design and planning to enhance infrastructure and community preparedness.
- Develop and implement adaptation plans to address identified climate risks during the construction and operational phases.

2. **Energy Efficiency Actions:**
   - Implement energy-efficient technologies and practices to reduce energy consumption and greenhouse gas emissions.
   - Conduct energy audits to identify and prioritise opportunities for energy savings.
   - Promote the use of energy-efficient equipment and materials.
   - Assess the feasibility of integrating renewable energy sources (e.g., solar, wind, biomass) into project operations.
   - Develop and execute plans for incorporating renewable energy technologies where feasible.
   - Monitor, track, and report on energy usage and the performance of renewable energy systems.
3. **Carbon Offsetting Actions:**
   - Identify and engage in carbon offsetting programs to mitigate the project's residual carbon footprint.
   - Select verified carbon offset projects that align with the project's sustainability goals, such as reforestation and habitat rehabilitation initiatives.
   - Track and report quarterly on the amount of carbon offset and the impact of offset projects.

7.6.13.1 Estimated Budget for Implementing Climate Change Mitigation Strategies

Table 7.17 shows the estimated cost of implementing the identified climate change mitigation measures in the first year. The mitigation costs are captured in other areas, hence showing zero naira. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.17: Estimated Cost of Implementing Climate Change Mitigation Strategies

Climate Change Mitigation Plan	**Cost Estimate (NGN)**
Climate risk assessment and integration of resilience measures	Captured in Contractor's cost
Implementation of energy-efficient technologies and practices	Captured in Contractor's cost
Energy audits and promotion of renewable energy sources	Captured in Normal Operational Cost
Carbon offsetting programs and tracking of offset impacts	TBD
Reporting on energy usage and performance of renewable energy systems	Captioned
Total	-

TBD = To Be Determined

Source: Anambra SAPZ ESIA (2024)

7.6.14 Social Management Plan

Responsibility

- Anambra SAPZ SPIU, ANSMA, ANSME and ANSMWSW will oversee the development, implementation, and monitoring of the Social Management Plan (SMP) throughout all project phases.
- The Community Liaison Officer (CLO) will coordinate the execution of social management measures, including community engagement and program implementation.
- The Grievance Officer (GO) will process reported grievances and collaborate with relevant project departments and the grievance redress committee (GRC) to facilitate resolution.
- E&S Safeguard Unit will support the CLO and GO in monitoring compliance and addressing issues related to livelihood impacts, economic impacts, and cultural heritage and project-related grievances.
- NGOs, CSOs and CBOs will advocate for the inclusion and rights of vulnerable groups; facilitate local communities' participation, empower local communities through training and capacity-building initiatives, monitor social impacts and provide independent feedback on SMP implementation and assist in addressing community grievances, ensuring fair treatment for vulnerable groups.

7.6.14.1 Voluntary/Involuntary Displacement

Responsibility

Anambra SAPZ SPIU, ANSMA, ANSMWSW, CLO, GO, E&S Safeguard Unit, NGOs, CSOs, CBOs

Management Measures

- Ensure the development of RAP to manage displacement and livelihood-related impacts.
- Establish continuous engagement and communication channels with affected communities and integrate their feedback into resettlement planning.
- Develop a detailed plan with socio-economic surveys to identify and support vulnerable groups affected by land acquisition.
- Ensure transparent, fair and prompt compensation, including relocation assistance and access to social services for affected persons
- Set up systems to track resettlement progress and address grievances effectively.

7.6.14.2 Livelihood Impacts

Responsibility

Anambra SAPZ SPIU, ANSMA, ANSMWSW, CLO, GO, E&S Safeguard Unit, NGOs, CSOs, CBOs

Management Measures

- Implement programmes for alternative income sources, vocational training, and microfinance.
- Priorates local hiring and provide training to enhance employability.
- Improve market access for local products.
- Invest in CSR programmes for social cohesion, education, and healthcare.
- Continuously evaluate and adjust livelihood programmes based on feedback and evolving needs.

7.6.14.3 Economic Impacts

Responsibility: Anambra SAPZ SPIU, ANSMA, ANSMWSW, CLO and E&S Safeguard Unit

Management Measures

- Conduct assessments to understand the impacts on local businesses and the regional economy.
- Develop a database and partnerships with local companies to integrate them into the project supply chain.
- Support initiatives that diversify the local economy, such as agribusinesses and tourism.
- Provide training on market trends and business management to local entrepreneurs.
- Track economic impacts and adjust strategies as needed to mitigate negative effects.

7.6.14.4 Archaeological/Cultural Heritage Loss

Responsibility: CLO and E&S Safeguard Unit

Management Measures

- Conduct assessments before construction to identify and protect cultural sites.
- Plan activities to avoid known archaeological and cultural heritage sites.
- Implement plans to address unexpected discoveries during construction.
- Engage local communities and experts to ensure the preservation of cultural heritage.

7.6.14.5 Community Dynamics and Inclusivity Management Plan

Responsibility

Anambra SAPZ SPIU, ANSMA, ANSMWSW, CLO and E&S Safeguard Unit, NGOs, CBOs, CSOs

Management Measures

- Maintain transparent communication and involve communities in planning and decision-making.
- Ensure that the planning and decision-making processes are inclusive and accessible to all community members, with particular attention to the needs of vulnerable groups, including people with disabilities, women and young adults.
- Develop and implement measures to prevent discrimination against vulnerable groups, including those with disabilities and women. This could include awareness campaigns, training sessions, and the establishment of a grievance redress mechanism to handle discrimination complaints.
- Social Cohesion Programs: Implement programs that promote social cohesion and inclusivity, including enhancing the active participation of vulnerable groups in community life.
- Fund projects that not only improve infrastructure, education, and healthcare but also specifically support vulnerable groups, ensuring their full participation and benefit from project activities.

7.6.14.6 Reporting

- Regular updates on the effectiveness of social management measures and community feedback will be provided by the Community Liaison Officer and the E&S Safeguard Unit to Anambra SAPZ SPIU, ANSMA, ANSMWSW and ANSME E&S Safeguard Unit
- Annual reviews of the Social Management Plan will be conducted for performance assessment and improvements.

7.6.15.1 Estimated Budget for Implementing Social Impact Mitigation Strategies

Table 7.18 shows the estimated cost of implementing the identified social impact mitigation measures in the first year. It excludes the cost of monitoring programmes and staff remunerations, which are captured in Section 7.9 of the report.

Table 7.18: Estimated Cost of Implementing Social Impact Mitigation Strategies

Social Mitigation Strategy	Cost Estimate (NGN)
Livelihood impact mitigation measures	TBD
Economic impact assessments and local business integration	8,0000,000.00
Archaeological and cultural heritage assessments and protection measures	TBD
Training programmes and stakeholder engagements	17,000,000.00
Regular reporting on the effectiveness of social management measures and annual reviews	Captured in Normal Monitoring Cost
Total	**25,000,000.00**

TBD = To be Determined

Source: Anambra SAPZ ESIA (2024)

7.6.15 Summary of Estimated Mitigation Strategies Implementations

Table 7.19 shows the estimated cost for mitigation strategies for the 14 management plans proposed to manage the environmental and social impacts of the Anambra SAPZ II programme. The costs exclude the monitoring programme, staff remuneration, organisation competency training and ESMP disclosures, which were calculated separately costs and presented in Section 7.9.

Table 7.19: Summary of Costs of Mitigation Strategies for Management Plans

S/N	Mitigation Management Plan	Estimated Budget Per Annum
1	Occupational Health and Safety Management	4,500,000.00
2	Emergency Preparedness Response Plan (ERP)	1,000,000.00
3	Contractor Management	-
4	Noise Management	1,500,000.00
5	Air Quality Management	-
6	Water Quality Management	-
7	Soil and Erosion Management	-
8	Spill Contingency Management	-
9	Hazardous Materials Management	-
10	Waste Management	-
11	Traffic Management	2,000,000.00
12	Biodiversity Management	8,000,000.00
13	Climate Change Mitigation	-
14	Social Management	50,000,000.00
	Total	**67,000,000.00**

TBD = To Be Determined

Source: Anambra SAPZ ESIA (2024)

7.7 Grievance Redress Mechanism (GRM)

The African Development Bank (AfDB) defines a project grievance redress mechanism (GRM) as a systematic process for receiving, assessing, and resolving concerns, complaints, and grievances related to the project's social and environmental performance. This aligns with AfDB's Operational Safeguard (OS) 1 and 10 requirements for addressing issues related to compensation, resettlement, or livelihood restoration early in the project lifecycle. An effective GRM ensures stakeholders have accessible and culturally appropriate channels to voice concerns, with timely responses from the project owners. This includes ensuring all grievances received are acknowledged, logged, and tracked and enables complainants to know what to expect in terms of response and timing.

7.7.1 Nature of Grievances

Grievances may include specific complaints about damages or injuries, concerns about routine project activities, real or perceived incidents or impacts, or requests for more information. In resettlement contexts, complaints may relate to compensation, land issues, resettlement assistance, housing, or other relevant concerns. The GRM allows stakeholders to submit complaints and comments at no cost, without retribution, and with the assurance of a timely response.

7.7.2 Importance of GRM for Anambra SAPZ II

For the Anambra SAPZ II program, establishing a robust GRM is crucial for fostering sustainable community relations and enhancing project accountability. The GRM will serve as a proactive tool to resolve issues before escalation, offering several key advantages:

- **Fostering Positive Development Conditions:** Promotes community trust and supports sustainable development.
- **Minimising Disruption Risks:** Addresses grievances promptly to prevent potential social or economic conflicts.
- **Protecting Vulnerable Groups:** Ensures fair channels for their concerns, helping to safeguard their interests.
- **Preventing Dispute Escalation:** Offers early resolutions, reducing the likelihood of disputes needing intervention by the Independent Recourse Mechanism (IRM).

7.7.3 GRM Structure and Functionality

The GRM for the Anambra SAPZ II project is designed to be non-hierarchical, allowing stakeholders the flexibility to choose between the project-level mechanism or the Independent Recourse Mechanism (IRM) as needed. However, there is a structured escalation pathway within the Project-Level GRM that encourages stakeholders to resolve complaints at the most immediate level before escalating to more formal structures.

- **Project-Level Grievance Mechanism:** Managed by the State Programme Implementation Unit (SPIU), this mechanism focuses on grievances specifically related to the SAPZ II project. It ensures community-level grievances are addressed locally through a transparent process that includes culturally appropriate methods for lodging complaints, such as community meetings, designated contact points, and confidential submissions. The mechanism provides a clear, step-by-step pathway that promotes resolving grievances as close to their source as possible. Stakeholders can approach the Community Liaison Officer (CLO) and Resettlement Coordinators (RC) first. If unresolved, complaints can escalate to the Community Resettlement Committee (CRC) and finally the Resettlement Steering Committee (RSC), each aiming to provide timely and culturally sensitive responses.
- **Independent Recourse Mechanism (IRM):** This offers an external, independent pathway primarily for grievances related to the Bank's policy compliance. It is available for stakeholders who prefer an independent review or if issues remain unresolved through the Project-Level GRM. The IRM serves as an additional option for stakeholders seeking accountability regarding AfDB policy standards.

Guidance for Stakeholders

Stakeholders can select either pathway based on their preferences or specific needs. While the Project-Level GRM is designed to manage most complaints efficiently, they have the right to escalate to the IRM at any point independently of the project-level process.

7.7.4 Key Attributes of the GRM

The key principles and overview of an effective grievance mechanism are: -

- **Culturally appropriate:** Tailored to the local language.
- **Accessible:** Accessible to all settlements and stakeholder groups within the project area.
- **Inclusive of vulnerable groups:** Available to those less likely to have the means to voice their concerns or opinions within the Nigerian context (e.g., women, the poor, youths and elderly)
- **Reliable:** The developer will respond to grievances within an agreed timeframe to manage expectations.
- **Publicised:** The project owner will publicise the grievance mechanism through engagement activities and advertisements to ensure that stakeholders are aware of and understand the process.
- **Logged:** Grievances will be logged and tracked.

7.7.5 Framework for Grievance Redress Mechanism (GRM)

The Grievance Redress Mechanism (GRM) framework provides a structured, multi-level approach to managing grievances within the project community, prioritising accountability, transparency, and cultural sensitivity. Central to this framework is the Grievance Redress Committee (GRC) structure, which operates at different levels to address and escalate grievances efficiently. The GRC is integral to the GRM, providing dedicated committees at the community, ministry, and independent levels. Each committee is designed to approach issues with tailored strategies that reflect local customs and align with project objectives.

The GRC members are selected for their qualifications, experience, and ability to engage effectively with the affected communities, earning their respect and confidence. By ensuring that each grievance is managed with sensitivity and professionalism, the GRM aims to build trust in the process and deliver transparent, equitable resolutions.

The GRM framework aims to:

- **Facilitate Responsive Grievance Management:** Define clear roles, responsibilities, and processes across the GRC levels to ensure efficient intake, handling, and resolution of grievances.
- **Adapt to Local Cultural Norms:** Align grievance processes with community-established practices to foster familiarity and trust among local residents.
- **Provide Escalation Pathways:** Outline a clear progression for unresolved grievances, beginning with the Community Resettlement Committee (CRC) as the local GRC, advancing to the Resettlement Steering Committee (RSC) at the ministry level,

and, if necessary, allowing for independent recourse through the Independent Recourse Mechanism (IRM).

- **Ensure Accountability Through Monitoring**: Establish a system for continual feedback and evaluation to maintain accountability and improve GRM processes.

7.7.5.1 Project-Level Grievance Mechanism

The Project-Level GRM is structured to handle complaints systematically, with responsibilities distributed across personnel and committees for efficient grievance processing:

1. Community Liaison Officer (CLO)

This role serves as the first point of contact for grievances from community members, such as concerns related to property damage or resettlement. The CLO logs each grievance, acknowledges receipt with the complainant, and forwards it to the Grievance Officer (GO). The CLO and RC ensure grievances are formally recorded and receive timely attention.

2. Grievance Officer (GO)

The GO manages grievance processing and collaborates with relevant project departments to facilitate resolution. For example, if a grievance pertains to land allocation. The GO coordinates with the Community Resettlement Committee (CRC) to inform the complainant and engage community leaders when needed.

3. Community Resettlement Committee (CRC) as the Community-Level GRC:

Acting as the community-level grievance redress committee (GRC), the CRC is designed to reflect and adapt the community's existing grievance mechanisms. It comprises representatives from key community segments, fostering inclusivity and cultural alignment. Typical CRC members include:

- Chairman or Representative from the Village Union (CBO): Often the first point of contact for grievances, responsible for community-level awareness and initial grievance escalation.

- President General (PG) of the Town Union: Plays a leadership role and may escalate cases to the traditional ruler or form an investigative committee if needed.

- Traditional Ruler or Representative: Intervenes at the highest community level for grievances requiring authority and cultural recognition.

- Committee Members: Representatives from key community groups to ensure inclusivity and comprehensive investigation, specifically:

    - One member from the town union for institutional support,
    - One representative from the affected person's village for localized insight,
    - One women's group representative to ensure gender inclusivity,

- One youth group representative to ensure generational representation,
- One representative from the SPIU to maintain alignment with project policies and commitments.

5. Resettlement Steering Committee (RSC) as the Ministry-Level GRC

The RSC operates at the Ministry/State level, offering advisory support and intervening when grievances remain unresolved at the CRC level. Headed by the Commissioner of Anambra State Ministry of Agriculture, with the Project Coordinator as the Secretary, the RSC provides high-level oversight, supporting grievance resolution with input from senior representatives from the State Ministries of Agriculture, Environment, Women and Social Welfare, and the Anambra State Investment Promotion and Protection Agency (ANSIPPA).

7.7.5.2 Cultural Appropriateness

The composition and functioning of the CRC are modelled on existing grievance resolution mechanisms within the project communities in Ogboji, Ogbunka, Omor and Ugbene. In these cultures, grievance resolution typically involves the chairman or representative of the village town union (Community-Based Organisation), who may escalate issues to the town union led by a President General (PG). If necessary, grievances can be further escalated to the traditional ruler. Depending on the nature of the grievance, the traditional ruler or the PG may form a committee to investigate and resolve the issue. This committee generally includes representatives from key community groups, such as the town union, the complainant's village, and women and youth groups. The leadership of this committee usually consists of an elected official from the town union or a member of the traditional ruling council. This structure has been effectively adapted to constitute the CRC project-level grievance redress mechanism, ensuring alignment with local customs and fostering community engagement.

7.7.5.3 Escalation Process

In the SAPZ II project GRM, if a PAP remains unsatisfied with the resolution provided by the Community Resettlement Committee (CRC) and has expressed this in person, writing or via a third-party like an attorney or an NGO, the CRC must escalate the matter to the Resettlement Steering Committee (RSC), with the State Project Implementation Unit (SPIU) copied and informed. This requirement for escalation ensures higher-level oversight, holding the CRC accountable for effectively addressing complaints and providing a clear pathway for grievances that remain unresolved after CRC intervention. This approach helps mitigate frustration among community members and fosters confidence in the grievance process.

Complainants will be advised of their option to approach the RSC or the IRM for further assistance. Informing individuals about this option empowers them by outlining the next steps they can take if they feel their concerns have not been adequately addressed. The CRC will also offer assistance to help them navigate this escalation process, demonstrating the project's commitment to addressing grievances fairly and supporting community members who may be unfamiliar with the procedures.

7.7.5.4 Independent Recourse Mechanism (IRM) Beyond the Project Level

The IRM provides an impartial review and resolution pathway for grievances beyond the project level. Key features of the IRM include:

- **Initiating a Review:** Stakeholders can submit unresolved grievances to the IRM for an independent review. For instance, grievances related to policy non-compliance may be escalated here.
- **Independent Investigation:** The IRM conducts thorough reviews of unresolved grievances, verifying compliance and recommending corrective action if necessary.
- **Outcome Communication:** Final decisions are communicated to both the complainant and project management to ensure transparency and closure.

7.7.5.5 Grievance Redress Process Procedure

The Grievance Redress Process (GRP) outlines the step-by-step approach for managing grievances within the GRM framework, ensuring clear communication, efficient processing, and accountability in addressing community concerns.

1. Grievance Submission

- **Method of Submission:** Grievances can be submitted verbally, in writing, or through designated digital channels to the Community Liaison Officer (CLO) or directly to the Grievance Officer (GO). Community members may submit grievances at community meetings, by visiting the project office, or through specified community representatives.
- **Required Information:** Complainants should include their contact information, a detailed description of the grievance, any relevant documents, and suggestions (if any) for resolution.

2. Acknowledgment and Logging

- **Logging:** Each grievance is logged into a central registry by the GO, assigned a unique identification number, and categorised based on the nature of the issue (e.g., livelihood, resettlement).

Acknowledgement: Within five working days of receipt, the CLO will acknowledge the grievance with an official communication to the complainant, detailing the initial steps and timeframe for a response. Typically, the resolution should be reached within 28 days from the date the grievance was registered.

3. Screening and Categorisation

- **Screening:** The GO, with the support of the CLO, screens grievances to determine if they fall within the scope of project-related issues.
- **Categorisation:** Grievances are categorised by type, urgency, and complexity, which informs the required timeframe and resources for resolution. Urgent matters impacting safety or immediate welfare are prioritised.

4. Resolution Process

- **Assessment and Investigation:** The GO collaborates with relevant departments, such as resettlement, environmental, or land use, to conduct an initial assessment and, if necessary, an in-depth investigation. For instance, grievances related to property damage might require collaboration with the Land Use and Allocation Committee.
- **CRC Involvement:** The Community Resettlement Committee (CRC) plays a facilitative role, helping complainants access the grievance system and advising on potential resolutions in culturally appropriate ways. For higher-level grievances, the CRC may conduct its own investigation and recommend a resolution to the GO.
- **Decision-Making:** Following investigation, a resolution proposal is developed by the GO in consultation with the CRC and, where necessary, requires approval from the Resettlement Manager (RM).

5. Escalation Pathways

- **CRC Escalation to RSC:** If the CRC is unable to resolve a grievance satisfactorily, the matter is escalated to the Resettlement Steering Committee (RSC), with the SPIU copied to ensure transparency.
- **Independent Recourse Mechanism (IRM):** In cases where the complainant remains unsatisfied or issues remain unresolved at the RSC level, the complainant is informed of their right to escalate the grievance to the IRM. The CRC or SPIU may assist the complainant in this process to ensure they have access to independent redress.

6. Communication and Feedback

- **Outcome Communication:** Once a resolution is reached, the GO communicates the outcome to the complainant in writing, detailing any actions taken and further steps if they wish to appeal. The complainant is informed of their right to escalate unresolved issues to the IRM.
- **Continuous Feedback:** The GO and CRC periodically check in with the complainant to confirm the issue's resolution, addressing any follow-up concerns that may arise.

7. Documentation and Monitoring

- **Record-Keeping:** All grievances, actions taken, and outcomes are documented in the project’s grievance log, ensuring transparency and accountability. Documentation also includes any escalations to the RSC or IRM and their respective resolutions.

- **Review and Monitoring:** The GRM framework undergoes periodic review to assess its effectiveness, incorporating feedback from community stakeholders and revising procedures as needed to improve responsiveness and cultural relevance.

7.7.6 Grievance Redress Mechanism (GRM) Budget

To ensure the effective implementation of the GRM, a dedicated budget of twenty-three million, five hundred thousand naira (NGN23,500,000.00) will be allocated to cover the various activities, training, and logistical requirements necessary for grievance management at the project, community, and state levels. This budget is structured around critical categories, each of which addresses specific operational needs for the GRM, as shown in Table 7.20.

Table 7.20: Summary of Estimated Budget for GRM Implementation

Budget Category	Description	Estimated Cost NGN)
CLO and GO Compensation	Remuneration for personnel managing grievance receipt and resolution.	Captured in Personnel Remuneration (Table 7.24)
CRC and RSC Member Stipends	Allowances for community representatives and travel reimbursements for meetings.	5,000,000.00
Training Sessions	Initial and ongoing training costs for GRM members on procedures and conflict resolution.	2,500,000.00
Awareness Campaigns	Budget for community awareness initiatives about the GRM process and available support channels.	3,500,000.00
Communication Costs	Expenses for telecommunication, printing, and stationery for grievance documentation.	1,500,000.00
Meeting Expenses	Costs for venue rental, refreshments, and materials for meetings and consultations.	2,500,000.00
Field Visits	Transportation costs for on-site investigations.	5,000,000.00
Reporting and Documentation	Budget for monthly and quarterly reports on grievance resolution outcomes and effectiveness.	500,000.00
Feedback Mechanism	Costs for collecting and analysing community feedback to improve GRM processes.	500,000.00
Escalation and Legal Support	Provision for handling escalations to the IRM, including documentation and legal support services.	500,000.00
Independent Review Costs	Budget for independent investigations or mediation services for unresolved grievances.	2,000,000.00
Total		**23,500,000.00**

7.8. Environmental and Social Management Plan (ESMP) Implementation

The Environmental and Social Management Plan (ESMP) for the Anambra SAPZ II project, detailed in Table 7.21, provides a structured framework for managing environmental and social impacts across all project phases, including potential issues like biodiversity conservation, water resources, air quality, and land acquisition and resettlement. It outlines specific mitigation measures, stakeholder engagement strategies, and monitoring requirements to ensure compliance with AfDB standards and local regulations. By proactively addressing these impacts, the project aims to promote sustainable development and support community well-being. A comprehensive monitoring and evaluation program will track the implementation of mitigation actions and assess the project's success in achieving its environmental and social objectives.

Table 7.21: Environmental and Social Management Plan (ESMP)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
Land Acquisition	Disagreements over Land Proceeds	♦ Activate the Grievance Redress Mechanism (GRM) and ensure that community members are informed about its processes and how to access it. ♦ Reach an agreement on the amount and timeframe for compensating landowners/communities. ♦ Obtain all necessary licenses, permits, and approvals. ♦ Identify and engage all relevant stakeholders in the land acquisition process. ♦ Resolve all issues properly before mobilisation. ♦ Implement regular consultations with the local community and other stakeholders (government, community, NGOs, CBOs) to ensure effective communication and social license. ♦ Support traditional conflict resolution structures in the project communities. ♦ Provide full compensation for farm produce affected by the project.	30,000,000.00	- Number of completed and executed agreements with affected landowners - Timeline of agreement execution - Number of grievances/ complaints filed	- 100% of landowners have fully executed agreements - 100% of agreements executed within the agreed timeframe - 100% of grievances settled within the agreed time frame	E&S Safeguard Unit	FMEnv; ANSMA; ANSME; ANSIPPA; SPIU	Captured in Personnel Remuneration (Table 7.24) and in GRM Budget (Table 7.20)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
	Involuntary/ Voluntary Resettlement	♦ Activate the Grievance Redress Mechanism (GRM) and ensure that community members are informed about its processes and how to access it. ♦ Establish continuous engagement channels with affected communities, ensuring transparent communication and incorporating their feedback into the resettlement planning process. ♦ Develop a detailed land acquisition and resettlement plan that includes a thorough socio-economic survey of affected communities to identify vulnerable groups and their specific needs. ♦ Ensure that compensation for land and assets is fair, transparent, and provided promptly. Offer additional support such as relocation assistance, housing, and access to social services. ♦ Set up a robust monitoring system to track the resettlement process and a grievance redress mechanism to address	10,000,000.00	- Number of households to be resettled - Number of grievances/ complaints filed - Timeliness of resettlement completion	- 100% of households resettled - 100% of grievances/ complaints resolved - 100% of resettlement completed within agreed timeframe	E&S Safeguard Unit	FMEnv; ANSMA; ANSME; ANSIPPA; SPIU	Captured in Personnel Remuneration (Table 7.24) and in GRM Budget (Table 7.20)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		concerns and complaints from affected individuals promptly.						
	Livelihood Impacts	♦ Activate the Grievance Redress Mechanism (GRM) and ensure that community members are informed about its processes and how to access it. ♦ Implement tailored livelihood restoration Programmes that provide alternative income sources, vocational training, and microfinance support for small businesses. ♦ Prioritise hiring local labour for project activities, providing training to build their capacity and enhance employability. ♦ Facilitate access to new markets for local products by improving infrastructure and providing market linkages. ♦ Invest in comprehensive community support and development initiatives, including CSR programmes that strengthen social cohesion and support education and healthcare needs. ♦ Continuously monitor the	10,000,000.00	Number of affected landowners applying for employment in the SAPZ project - Number of vocational training provided - New market opportunities - Number of CSR requested by the communities - Number of grievances recorded	- Percentage of affected landowners employed by the SAPZ project - Percentage of people who completed training successfully - Number of new markets access facilitated - Number of CSR implemented - Zero reported grievances	E&S Safeguard Unit	FMEnv; ANSMA; ANSME; ANSIPPA; SPIU	Captured in Personnel Remuneration (Table 7.24) and in GRM Budget (Table 7.20)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		effectiveness of livelihood Programmes and adjust strategies based on community feedback and changing circumstances.						
Site Clearing and Preparation	Deforestation/ Loss of Biodiversity	♦ Limit site clearance to the absolute minimum required for construction needs ♦ Develop and implement biodiversity management and monitoring plans that include alien invasive species control, faunal handling procedures, and guidelines for ecological landscaping. ♦ Conduct habitat restoration activities, such as reforestation to compensate for unavoidable habitat loss. ♦ Establish protected areas and wildlife corridors in consultation with local communities and conservation experts. ♦ Engage local communities in biodiversity conservation efforts, providing education and incentives for sustainable practices. ♦ Regularly monitor biodiversity indicators and adapt management strategies based on	Built into Contractor's Cost	- Area extent of cleared vegetation - Biodiversity management and monitoring plans developed - Planned restoration activities	- Site clearance is limited to the minimum area needed - Extent of diversity plans implemented - Number of native trees planted	Contractor	FMEnv; ANSME; ANSIPPA; SPIU	500,000.00 during FMEnv Impact Mitigation Monitoring (IMM)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		monitoring results and scientific advancements.						
	Loss of Topsoil/Erosion/ Land Degradation /	♦ Implement erosion control measures such as silt fences, erosion control blankets, and terracing to prevent soil loss and sedimentation. ♦ Maintain natural vegetation cover where possible and restrict vegetation removal to necessary areas only, replanting promptly after disturbance.	Built into Contractor's Cost	Incidence of soil displacement or erosion in vulnerable areas	Erosion control structures installed in 100% of vulnerable areas	Contractor	FMEnv; ANSMA; ANSME; SPIU	Built into IMM cost
	Surface water contamination from sedimentation	♦ Schedule land clearance and construction activities to avoid the rainy season, minimising erosion risk.	Built into Contractor's Cost	Water turbidity	Turbidity of surface water does exceeded5 NTU	Contractor;	FMEnv, ANSME; SPIU	Built into IMM cost
	Increased flood risks	♦ Conduct comprehensive flood risk assessments to identify areas vulnerable to flooding, especially in Ugbene and Omor. Use this data to inform the design and implementation of flood prevention measures. ♦ Install drainage systems to manage stormwater. Use silt fences, retention basins, and sediment traps to minimise soil erosion and manage runoff. ♦ Plant vegetation and create green spaces that can absorb excess water, reducing surface runoff.	Built into Contractor's Cost	Flood risk assessment plan Number of drainage systems	Flood risk assessment completed Efficiency of drainage systems	Contractor	FMEnv, ANSME	Built into IMM cost

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
	Air Quality Deterioration	♦ Regularly spray water on cleared areas and dust-prone surfaces to suppress dust and minimise airborne particulates. ♦ Clear vegetation in phases rather than all at once, reducing the area exposed to dust generation at any one time. ♦ Schedule clearing activities during periods of low wind to reduce particulate spread. ♦ Make nose masks available to all workers on the site. ♦ Use environmentally safe dust suppressants, such as calcium chloride, to stabilize dust-prone areas.	Built into Contractor's Cost	Ambient air quality parameters CH_4, CO, CO_2, H_2S, Ozone, NO_2, SO_2, VOCs, $PM_{2.5}$ and PM_{10})	Ambient air quality parameters are with FMEnv/ NESREA standards	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost + 45,000.00 per sample during ECM
	Cultural Heritage Loss or Disturbance	♦ Ensure that design project activities avoid known archaeological and cultural heritage sites. ♦ Conduct comprehensive archaeological and cultural heritage assessments before the commencement of any pre-construction/construction activities ♦ Implement monitoring and contingency plans to address any unexpected discoveries of archaeological or cultural	Built into Contractor Cost and Social Management Plan	Presence of cultural heritage sites - Reported incidences of damage or disturbance to cultural heritage sites	Number of identified and documented cultural heritage sites - Zero of reported incidences, damage or disturbance to cultural heritage sites.	E&S Safeguard Unit/ Contractor	FMEnv; ANSME; ANSIPPA; SPIU	Built into IMM and Social Management costs

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		heritage materials during construction. ♦ Engage with local communities and cultural heritage experts to ensure that cultural heritage is respected and preserved.						
	Influx of migrant	♦ Prioritise hiring of locals with the uppermost consideration for competence and qualification to reduce the impact of population influx.	Built into Contractor Cost and Social Management Plan	Number of workers employed	High percentage of locals employed by the project	Contractor	FMEnv; ANSME; ANSIPPA; SPIU	Built into IMM cost
	Waste Generation	♦ Develop and implement a waste management plan before site preparation begins. ♦ Ensure proper storage and containment of hazardous materials such as fuels and oils used in machinery. ♦ Implement segregation practices on-site to separate recyclable materials from general waste. ♦ Sell usable materials like crops and wood. ♦ Train personnel on waste management protocols, emphasising the safe handling and disposal of hazardous materials. ♦ Ensure waste is handled and disposed of by qualified and accredited waste contractors.	Built into Contractor's Cost	Types and Volume of waste generated	- Percentage of waste recycled, sold or reused - Percentage of waste disposed of by accredited waste contractors	E&S Safeguard Unit/ Contractor	FMEnv; ANSME; ASWAMA; SPIU	Built into IMM cost

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
Use of generators and heavy machinery and equipment	Air Quality Deterioration / GHG Emissions	♦ Connect to the national grid as soon as possible to reduce reliance on diesel or petrol-powered generators. ♦ Opt for equipment and machinery with lower emissions, such as electric or hybrid-powered machinery. ♦ Maintain all construction equipment and machinery per the manufacturer's instructions to minimise emissions. ♦ Implement dust control measures such as water spraying, dust suppressants, and covering of stockpiles to reduce airborne particulate matter. ♦ Require contractors to use high-quality diesel fuel to reduce emissions. ♦ Regularly monitor air quality in and around the project site and implement corrective actions if pollutant levels exceed acceptable limits. ♦ Mandate the use of nose masks and earmuffs by site workers. ♦ Switch to alternative fuels like compressed natural gas (CNG) for generators	Built into Contractor's Cost	Gaseous pollutants (CH_4, CO, CO_2, H_2S, Ozone, NO_2, SO_2, VOCs, $PM_{2.5}$ and PM_{10})	Ambient air quality parameters are with FMEnv/ NESREA standards	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost + 45,000.00 per sample during ECM

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		and construction equipment where possible.						
	Elevated noise levels	♦ Install noise barriers, mufflers, and silencers on equipment, and restrict noisy activities to daytime hours to minimise disturbances to local communities and wildlife. ♦ Regularly maintain equipment and machinery to reduce noise emissions. ♦ Regularly monitor noise levels and adjust operations as necessary to comply with noise regulations.	Built into Contractor's Cost + 1,500,000.00 (Noise Management)	Ambient noise levels	Ambient noise levels are with FMEnv/ NESREA standards for industrial zones	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost + 25,000.00 per sample during ECM
	Waste Generation	♦ Develop and implement a waste management plan before site preparation begins. ♦ Conduct a thorough assessment of materials and consumables, including oils and filters, to minimise excess and avoid unnecessary waste. ♦ Segregate and safely dispose of hazardous waste, such as batteries, hydraulic fluids, fuel residues, and used oils, in	Built into Contractor's Cost	Types and Volume of waste generated	- Percentage of waste recycled, sold or reused - Percentage of waste disposed of by accredited waste contractors	E&S Safeguard Unit/ Contractor	FMENv; ASWAMA; ANSME; SPIU	Partly built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		designated containers at licensed facilities. ♦ Ensure proper storage and containment of fuels and oils used in machinery to prevent spills and contamination. ♦ Ensure that all waste is managed and disposed of by qualified and accredited waste contractors.						
	Health and safety risks	♦ Ensure regular maintenance of machinery to prevent mechanical failures. ♦ Use noise protection PPE (earplugs) and reduce exposure to noisy equipment. ♦ Train operators in safe machinery operation practices. ♦ Ensure compliance with all relevant occupational health and safety regulations.	Built into Contractor's Cost + 4,500,000.00 (Occupational Health and Safety Plan)	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)
Hiring of migrant workers	Increased risk of sexually transmitted diseases	♦ Prioritise local hiring where possible to reduce the number of temporary workers moving into project areas ♦ Implement health education programs to educate migrant workers and local communities on STDs and prevention	Built into Contractor Cost and Social Management Plan	Number of new STD cases	Zero incidence of new cases	E&S Safeguard Unit/ Contractor	ANSMA, ANSME, ANSIPPA; SPIU	Built into IMM cost Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		methods ♦ Ensure easy access to healthcare services, including STD testing and treatment for migrant workers ♦ When possible, conduct regular health screenings and STD testing for migrant workers						
	Threat to community culture, safety and security	♦ Activate the Grievance Redress Mechanism (GRM) and ensure that community members are informed about its processes and how to access it. ♦ Prioritise local hiring where possible. ♦ Establish and maintain open, two-way communication channels with local communities to ensure continuous engagement and feedback ♦ Provide cultural sensitivity training for both migrant workers and local communities to foster mutual understanding of customs, traditions, and cultural norms. ♦ Facilitate community integration programmes that promote positive interactions and mutual	Built into Contractor's Cost and Social Management Plan	- Number of grievances/ complaints filed	- 100% of grievances settled within the agreed timeframe	OHS Manager / E&S Safeguard Unit/ Contractor	ANSMA, ANSME, ANSIPPA; SPIU	Built into IMM cost, personnel remuneration (Table 7.24) and GRM Budget (Table 7.20)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		respect between migrant workers and local residents. ♦ Enhance security by improving lighting, promoting community policing, and installing surveillance in areas with high concentrations of migrant workers ♦ Establish accessible conflict resolution mechanisms to promptly address any disputes or tensions between migrant workers and local residents.						
	Pressure on local infrastructure	♦ Prioritise local hiring where possible. ♦ Provide food, water and campsites to reduce pressure on local resources ♦ work with local authorities to extend the operating hours of local infra, such as health clinics and community centres, to accommodate increased demand. ♦ Run awareness campaigns to educate both locals and migrant workers on the responsible use of local amenities.	Built into Contractor's Cost and Social Management Plan	- Increased demand for local services - Number of grievances/ complaints filed	- No significant reduction in the quality of services provided - 100% of grievances settled within the agreed timeframe	E&S Safeguard Unit/ Contractor	ANSMA; ANSME; ANSIPPA; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)
Increased transport activities	Traffic Congestion	♦ Develop and implement traffic management plans, including designated routes, schedules to avoid	Built into Contractor's Cost	- Number of vehicles on affected roads during	- Traffic volume does not increase by more than	OHS Manager / E&S Safeguard	FMEnv; ANSMA, ANSME, ANSIPPA; SPIU	Built into IMM cost and personnel

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		peak traffic times, and measures to enhance road safety. ♦ Provide commuters with real-time traffic information through mobile apps or radio/tv announcements. ♦ Conduct community awareness campaigns on traffic safety and project-related traffic changes. ♦ Continuously monitor traffic conditions and adjust plans as necessary to minimise congestion and safety risks.	+ 2,000,000.00	peak and non-peak hours - Average travel time along key routes near the project site.	20% from baseline levels during peak hours. - Average travel times on key routes remain within 15 minutes of baseline travel times during peak hours.	Unit/ Contractor		remuneration (Table 7.24)
	Air Quality Deterioration / GHG Emissions	♦ Opt for vehicles with lower emissions, such as hybrid-powered machinery. ♦ Ensure that construction vehicle engines comply with international standards for exhaust gases. ♦ Ensure the maintenance of engines as specified by the manufacturer. Adopt regular exhaust gas checks and an engine-off policy at the construction site. ♦ Use the cleanest economically available fuel. ♦ Plan and optimise transportation routes to reduce fuel consumption	Built into Contractor's Cost	Gaseous pollutants (CH_4, CO, CO_2, H_2S, Ozone, NO_2, SO_2, VOCs, $PM_{2.5}$ and PM_{10})	Ambient air quality parameters are with FMEnv/ NESREA standards	E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost + 45,000.00 per sample during ECM

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		and emissions from vehicles transporting staff, material and equipment.						
	Increased Road Accidents Risks	♦ Develop and enforce a detailed journey management policy that includes risk assessment procedures, route planning, and emergency response plans. ♦ Ensure all construction vehicles are pre-mobbed, and issue pre-mobilisation compliance certificates after conducting thorough safety checks. ♦ Ensure drivers are qualified, experienced, and trained in defensive driving techniques and accident prevention strategies, with demonstrable evidence of compliance with driving rules and regulations. ♦ Mandate the use of seat belts for drivers and all passengers in construction vehicles to enhance safety. ♦ Provide first aid training for the workforce, along with the provision of fully stocked first aid kits in all construction vehicles. ♦ Maintain comprehensive accident and near-miss logs to identify trends and implement improvements	Built into Contractor's Cost and Occupational Health and Safety Plan	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
	Preconstruction Phase							
		in safety practices. ♦ Conduct regular safety audits and inspections to ensure compliance with all safety measures and address any identified issues promptly.						

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
Mobilisation of equipment, personnel, and construction modules to the site / Increased transport activities	Increased opportunities for employment	♦ Give preference to qualified local residents during the recruitment of labour. ♦ Provide training to locals to enhance their employability. ♦ Make prompt payment to engaged labour; ♦ Ensure agreement with the community before mobilisation on modalities of promoting local entrepreneurship in the provision of housing and transport.	Built into Contractor Cost and Social Management Plan	- Number of job openings available - Number of vocational training provided	- Number of people hired - Number of workers who successfully completed the training	Contractor; E&S Safeguard Unit	FMEnv, ANSME, ANSMA; SPIU	Built into IMM Cost and personnel remuneration (Table 7.24)
	Influx of migrant workers due to increased labour demand	♦ Prioritise hiring locals with the uppermost consideration for	Built into Contractor Cost and Social	Number of applicants from outside the community	Percentage of local versus migrant workers hired	Contractor E&S Safeguard Unit	FMEnv; ANSMA, ANSME, ANSIPPA	Built into IMM Cost and personnel

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		competence and qualification to reduce the impact of population influx.	Management Plan					remuneration (Table 7.24)
	Traffic congestion from increased vehicular movements	♦ Develop and implement traffic management plans, including designated routes, schedules to avoid peak traffic times, and measures to enhance road safety. ♦ Provide commuters with real-time traffic information through mobile apps or radio/tv announcements, allowing them to plan alternative routes or adjust travel times. ♦ Work with local authorities to improve road infrastructure and signage to accommodate increased traffic. ♦ Monitor traffic conditions and adjust plans as necessary to	Built into Contractor's Cost and Occupational Health and Safety Plan	Ambient noise levels	Ambient noise levels are with FMEnv/ NESREA standards for industrial zones	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		minimise congestion and safety risks.						
	Noise pollution from the transportation of heavy machinery and equipment	♦ Install noise barriers, mufflers, and silencers on equipment, and restrict noisy activities to daytime hours to minimise disturbances to local communities and wildlife. ♦ Regularly maintain equipment and machinery to reduce noise emissions. ♦ Inform local communities of potential noise impacts and involve them in developing noise management plans. ♦ Regularly monitor noise levels and adjust operations as necessary to comply with noise regulations.	Built into Contractor's Cost and Noise Management	Ambient noise levels	Ambient noise levels are with FMEnv/ NESREA standards for industrial zones	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost + 25,000.00 per sample during ECM
	Air quality deterioration from emissions during transportation / Climate	♦ Opt for equipment and machinery with lower	Built into Contractor's Cost	Gaseous pollutants (CH_4, CO, CO_2, H_2S,	Ambient air quality parameters are with FMEnv/	E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost +

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
	Impact (GHG Emissions)	emissions, such as electric or hybrid-powered machinery. ♦ Maintain all construction equipment and machinery per the manufacturer's instructions to minimise emissions. ♦ Implement dust control measures such as water spraying, dust suppressants, and covering of stockpiles to reduce airborne particulate matter. ♦ Regularly monitor air quality in and around the project site and implement corrective actions if pollutant levels exceed acceptable limits. ♦ Ensure site workers and visitors wear nose masks and earmuffs. ♦ Connect to the national grid as soon as possible to		Ozone, NO_2, SO_2, VOCs, $PM_{2.5}$ and PM_{10})	NESREA standards			45,000.00 per sample during ECM

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		reduce reliance on diesel or petrol-powered generators.						
	Safety risks associated with the movement of heavy machinery and equipment	♦ Develop and implement comprehensive health and safety management systems, including risk assessments, safety training, and emergency response plans. ♦ Develop and enforce a detailed journey management policy. ♦ Place warning signs and signals along transport routes, especially on site to alert both workers and the public about the presence of heavy machinery. ♦ Ensure regular maintenance and inspections of heavy machinery and construction	Built into Contractor's Cost and Occupational Health and Safety Plan	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		vehicles to prevent mechanical failures that could lead to accidents. ♦ Mandate the use of appropriate PPE for all personnel involved in the movement of heavy machinery to enhance safety. ♦ Provide training sessions for operators and personnel on safe operation practices, traffic management, and emergency response procedures. ♦ Maintain comprehensive accident and near-miss logs to identify trends and implement improvements in safety practices. ♦ Conduct regular safety audits and inspections to ensure compliance with all safety						

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		measures and address any identified issues promptly. ♦ Ensure all accidents and incidents are recorded, investigated, and follow-up actions implemented. ♦ Ensure compliance with all relevant occupational health and safety regulations.						
	Increased road accident risks from Vehicular Movements	♦ Implement the mitigation measures for safety risks associated with moving heavy machinery. ♦ Ensure all construction vehicles are pre-mobbed, and issue pre-mobilisation compliance certificates after conducting thorough safety checks. ♦ Establish a regular maintenance	Built into Contractor's Cost and Occupational Health and Safety Plan	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		schedule for construction vehicles, specifying maintenance frequency and adherence to safety standards. ♦ Ensure drivers are qualified, experienced, and trained in defensive driving techniques and accident prevention strategies. ♦ Mandate the use of seat belts for drivers and all passengers in construction vehicles to enhance safety. ♦ Provide first aid training for the workforce, along with the provision of fully stocked first aid kits in all construction vehicles. ♦ Establish an emergency response plan that						

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		outlines procedures for various types of accidents, ensuring all workers are familiar with the plan.						
Use of generators and heavy machinery and equipment	Deterioration of Air Quality / Climate Impact (GHG Emissions)	♦ Connect to the national grid as soon as possible to reduce reliance on diesel or petrol-powered generators. ♦ Opt for equipment and machinery with lower emissions, such as electric or hybrid-powered machinery. ♦ Maintain all construction equipment and machinery per the manufacturer's instructions to minimise emissions. ♦ Implement dust control measures such as water spraying, dust	Built into Contractor's Cost	Ambient air quality parameters CH_4, CO, CO_2, H_2S, Ozone, NO_2, SO_2, VOCs, $PM_{2.5}$ and PM_{10})	Ambient air quality parameters are with FMEnv/ NESREA standards	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost + 45,000.00 per sample during ECM

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		suppressants, and covering of stockpiles to reduce airborne particulate matter. ♦ Require contractors to use high-quality diesel fuel to reduce emissions. ♦ Regularly monitor air quality in and around the project site and implement corrective actions if pollutant levels exceed acceptable limits. ♦ Mandate the use of nose masks and earmuffs by site workers. ♦ Switch to alternative fuels like compressed natural gas (CNG) for generators and construction equipment where possible.						
	Elevated noise levels	♦ Install noise barriers, mufflers, and silencers on equipment, and restrict noisy activities to daytime hours to	Built into Contractor's Cost and Noise Management	Ambient noise levels	Ambient noise levels are with FMEnv/ NESREA standards for industrial zones	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost + 25,000.00 per sample during ECM

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		minimise disturbances to local communities and wildlife. ♦ Regularly maintain equipment and machinery to reduce noise emissions. ♦ Regularly monitor noise levels and adjust operations as necessary to comply with noise regulations.						
	Waste Generation	♦ Develop and implement a waste management plan before site preparation begins. ♦ Conduct a thorough assessment of materials and consumables, including oils and filters, to minimise excess and avoid unnecessary waste. ♦ Segregate and safely dispose of hazardous waste, such as batteries,	Built into Contractor's Cost	Types and Volume of waste generated	- Percentage of waste recycled, sold or reused - Percentage of waste disposed of by accredited waste contractors	E&S Safeguard Unit/ Contractor	FMEnv; ASWAMA; ANSME; SPIU	Partly built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		hydraulic fluids, fuel residues, and used oils, in designated containers at licensed facilities. ♦ Ensure proper storage and containment of fuels and oils used in machinery to prevent spills and contamination. ♦ Ensure that all waste is managed and disposed of by qualified and accredited waste contractors.						
	Health and safety risks, including musculoskeletal injuries, noise-induced hearing loss, and accidents from machinery	♦ Ensure regular maintenance of machinery to prevent mechanical failures. ♦ Use noise protection PPE (earplugs) and reduce exposure to noisy equipment. ♦ Train operators in safe machinery operation practices. ♦ Ensure compliance with all relevant	Built into Contractor's Cost and Occupational Health and Safety Plan	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		occupational health and safety regulations.						
Hiring of migrant workers	Increased risk of sexually transmitted diseases	♦ Prioritise local hiring where possible to reduce the number of temporary workers moving into project areas ♦ Implement health education programs to educate migrant workers and local communities on STDs and prevention methods ♦ Ensure easy access to healthcare services, including STD testing and treatment for migrant workers ♦ When possible, conduct regular health screenings and STD testing for migrant workers	Built into Contractor Cost and Social Management Plan	Number of new STD cases	Zero incidence of new cases	E&S Safeguard Unit/ Contractor	ANSMA, ANSME, ANSIPPA; SPIU	Built into IMM cost Built into IMM cost and personnel remuneration (Table 7.24)
	Threat to community culture, safety and security	♦ Activate the Grievance Redress Mechanism (GRM) and	Built into Contractor's Cost and Social	- Number of grievances/ complaints filed	- 100% of grievances settled within the agreed timeframe	OHS Manager / E&S Safeguard	ANSMA, ANSME, ANSIPPA; SPIU	Built into IMM cost, personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		ensure that community members are informed about its processes and how to access it. ♦ Prioritise local hiring where possible. ♦ Establish and maintain open, two-way communication channels with local communities to ensure continuous engagement and feedback ♦ Provide cultural sensitivity training for both migrant workers and local communities to foster mutual understanding of customs, traditions, and cultural norms. ♦ Facilitate community integration programmes that promote positive interactions and mutual respect between migrant	Management Plan			Unit/ Contractor		and GRM Budget (Table 7.20)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		workers and local residents. ♦ Enhance security by improving lighting, promoting community policing, and installing surveillance in areas with high concentrations of migrant workers ♦ Establish accessible conflict resolution mechanisms to promptly address any disputes or tensions between migrant workers and local residents.						
	Increase pressure on local infrastructure/amenities and services including health facilities, water resources, etc.	♦ Prioritise local hiring where possible. ♦ Provide food, water and campsites to reduce pressure on local resources ♦ work with local authorities to extend the operating hours of local infra, such as health clinics and community centres, to	Built into Contractor Cost and Social Management Plan	- Increased demand for local services - Number of grievances/ complaints filed	- No significant reduction in the quality of services provided - 100% of grievances settled within the agreed timeframe	E&S Safeguard Unit/ Contractor	FMEnv; ANSMA; ANSME; ANSIPPA; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		accommodate increased demand. ♦ Run awareness campaigns to educate both locals and migrant workers on the responsible use of local amenities.						
Increased transport activities due to construction activities (material and workforce transportation)	Traffic Congestion / Mental health stress for commuters due to delays	♦ Develop and implement traffic management plans, including designated routes, schedules to avoid peak traffic times, and measures to enhance road safety. ♦ Provide commuters with real-time traffic information through mobile apps or radio/tv announcements. ♦ Conduct community awareness campaigns on traffic safety and project-related traffic changes. ♦ Continuously monitor traffic conditions and adjust plans as	Built into Contractor's Cost + 2,000,000.00	- Number of vehicles on affected roads during peak and non-peak hours - Average travel time along key routes near the project site.	- Traffic volume does not increase by more than 20% from baseline levels during peak hours. - Average travel times on key routes remain within 15 minutes of baseline travel times during peak hours.	OHS Manager / E&S Safeguard Unit/ Contractor	FMEnv; ANSMA, ANSME, ANSIPPA; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		necessary to minimise congestion and safety risks.						
	Climate Impact (GHG Emissions) / Deterioration of Air Quality	♦ Opt for vehicles with lower emissions, such as hybrid-powered machinery. ♦ Ensure that construction vehicle engines comply with international standards for exhaust gases. ♦ Ensure the maintenance of engines as specified by the manufacturer. ♦ Adopt regular exhaust gas checks and an engine-off policy at the construction site. ♦ Use the cleanest economically available fuel. ♦ Plan and optimise transportation routes to reduce fuel consumption and emissions from vehicles transporting staff,	Built into Contractor's Cost	Ambient air quality parameters CH_4, CO, CO_2, H_2S, Ozone, NO_2, SO_2, VOCs, $PM_{2.5}$ and PM_{10})	Ambient air quality parameters are with FMEnv/ NESREA standards	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost + 45,000.00 per sample during ECM

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		material and equipment.						
	Increased Road Accidents Risks	♦ Develop and enforce a detailed journey management policy that includes risk assessment procedures, route planning, and emergency response plans. ♦ Ensure all construction vehicles are pre-mobbed, and issue pre-mobilisation compliance certificates after conducting thorough safety checks. ♦ Ensure drivers are qualified, experienced, and trained in defensive driving techniques and accident prevention strategies, with demonstrable evidence of compliance with driving rules and regulations. ♦ Mandate the use of	Built into Contractor's Cost and Occupational Health and Safety Plan	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		seat belts for drivers and all passengers in construction vehicles to enhance safety. ♦ Provide first aid training for the workforce, along with the provision of fully stocked first aid kits in all construction vehicles. ♦ Maintain comprehensive accident and near-miss logs to identify trends and implement improvements in safety practices. ♦ Conduct regular safety audits and inspections to ensure compliance with all safety measures and address any identified issues promptly.						
Nighttime lighting	Changes in the behaviour of Fauna Species	♦ Use wildlife-friendly lighting, such as LED lights, with lower colour temperatures to minimise	Built into Contractor's Cost and Biodiversity Management	Illuminance levels (lux) in areas known to be habitats for sensitive or	- Illuminance levels in sensitive wildlife habitats remain below 5 lux, in line with	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		disruption to nocturnal animals ♦ Install directional lighting to focus light downward and prevent spillover into natural areas ♦ Limit nighttime lighting hours, especially during wildlife breeding or migration seasons ♦ Establish buffer zones with natural vegetation to reduce wildlife exposure to artificial light ♦ Monitor wildlife behaviour regularly and provide advice to the contractor based on findings		nocturnal species.	general wildlife protection standards.			
	Changes to visual aesthetics	♦ Incorporate dimmable lighting to adjust brightness levels based on need, maintaining safety while preserving aesthetic value ♦ Design lighting to blend with landscape features,	Built into Contractor's Cost and Social Management Plan	- Number of complaints or concerns regarding changes in visual aesthetics. - Noticeable degradation of scenic views or dark skies.	Minimal complaints filed - No noticeable degradation of scenic views or dark skies.	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		minimising visual disruption and aligning with community preferences						
Use and application of materials such as cement, paint, and solvents in construction	Deterioration of Air Quality	♦ Use low-VOC paints and solvents to reduce harmful emissions. ♦ Implement dust control measures like water sprays and dust suppressants during construction. ♦ Ensure proper ventilation when using materials that release fumes. ♦ Interdict the burning of construction waste	Built into Contractor's Cost	Ambient air quality parameters CH_4, CO, CO_2, H_2S, Ozone, NO_2, SO_2, VOCs, $PM_{2.5}$ and PM_{10})	Ambient air quality parameters are with FMEnv/ NESREA standards	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Partly built into IMM cost + 45,000.00 per sample during ECM
	Soil Contamination	♦ Store paints and solvents in designated areas to prevent leaks and spills. ♦ Use spill containment measures for hazardous materials to protect the soil. ♦ Regularly inspect and maintain storage containers	Built into Contractor's Cost	Laboratory analysis of soil physiochemistry, heavy metals, THC, TPH and micro-organisms	Soil analysis not significantly different from baseline levels	Contractor; E&S Safeguard Unit	FMEnv, ANSME; SPIU	Partly built into IMM cost + 150,000.00 per sample during ECM

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		to prevent deterioration. ♦ prevent unauthorised personnel from inadvertently causing spills or contamination ♦ Store paints and solvents on impervious surfaces in covered areas, equipped with spill trays to contain any accidental spills and prevent soil contamination.						
	Water Quality Impairment	♦ Implement mitigation measures for soil contamination. ♦ Prohibit disposal of paint, solvents, and other chemicals in drains or water bodies.	Built into Contractor's Cost	Laboratory analysis of water physiochemistry, heavy metals, THC, TPH and micro-organisms	Water analysis parameters are with FMEnv/NESREA limits for surface or groundwater	Contractor; E&S Safeguard Unit	FMEnv, ANSME; SPIU	Partly built into IMM cost + 150,000.00 per sample during ECM
	Health Hazards	♦ Use trained and experienced personnel to minimise risks and ensure safe handling of materials. ♦ Establish safety protocols for	Built into Contractor's Cost and Occupational Health and Safety Plan	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		working with cement and chemicals to minimise exposure to dust and chemicals. ♦ Conduct regular health and safety training for workers. ♦ Mandate compulsory use of PPE for the workforce ♦ Limit and control access to paint and other chemical storage areas to prevent unauthorised personnel from inadvertently causing spills or contamination. ♦ Establish an emergency response plan that outlines procedures for various types of accidents, ensuring all workers are familiar with the plan. ♦ Ensure compliance with all relevant						

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		occupational health and safety regulations.						
	Hazardous waste generation from painting and cement operations such as leftover paints, solvents, and cement slurry.	♦ Establish a waste management policy for the safe disposal of hazardous waste, aligning with FMEnv standards and using approved disposal sites. ♦ Implement a waste reduction strategy by ordering only the necessary amount of materials. ♦ Train workers on proper disposal methods for hazardous waste to ensure compliance with regulations. ♦ Ensure hazardous waste is handled and disposed of by qualified and accredited waste contractors.	Built into Contractor's Cost	Volume of waste generated	- Percentage of waste recycled, sold or reused - Percentage of waste disposed of by accredited waste contractors	E&S Safeguard Unit/ Contractor	FMEnv; ASWAMA; ANSME; SPIU	Partly built into IMM cost and personnel remuneration (Table 7.24)
Offloading and loading of products and materials	Risk of injuries from improper handling, falls, or equipment malfunction during offloading and loading	♦ Provide training on safe material handling and lifting techniques. ♦ Mandate the use of	Built into Contractor's Cost and Occupational	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		appropriate PPE (gloves, helmets, boots). ♦ Use mechanical aids (e.g., forklifts, hand trucks) to reduce the need for manual lifting. ♦ Encourage team lifting for heavy or awkward loads, ensuring proper coordination between workers. ♦ Implement safe loading/unloading protocols, including designated loading zones. ♦ Rotate tasks to prevent repetitive strain on specific muscle groups. ♦ Regularly inspect equipment used for loading/unloading to ensure they are in good working condition. ♦ Schedule regular breaks to prevent fatigue and muscle strain during prolonged periods of	Health and Safety Plan					

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		loading/offloading.						
Working at height	Risk of falls leading to serious injuries or fatalities	♦ Ensure proper use of fall protection systems, such as safety harnesses and guardrails ♦ Provide training for working at heights ♦ Conduct regular inspections of scaffolding and other height-related equipment ♦ Establish criteria for use of 100 per cent fall protection (typically when working over 2 metres above the working surface. ♦ Ensure proper maintenance of hoisting equipment and properly train hoist operators. ♦ Use Safety belts that are not less than 16 millimetres (mm) (5/8 inch) of two-in-one nylon or material of equivalent strength. ♦ Ensure workers use a second (backup) safety strap when	Built into Contractor's Cost and Occupational Health and Safety Plan	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Construction Phase								
		operating power tools at height,						
Electrical works	Risk of electrocution, fire hazards, and injuries due to faulty electrical connections	♦ Employ only qualified and certified electricians for all electrical works. ♦ Provide electrical safety training. ♦ Implement lockout/tagout procedures. ♦ Ensure electrical systems are regularly inspected and maintained. ♦ Put up signs to warn the public and workers about energised areas, and where possible, install barriers, such as locks and fencing, to prevent unauthorised access to potentially dangerous equipment and areas. ♦ Provide and enforce the use of appropriate PPE for all workers.		Number of accidents/ near-misses		Contractor	FMEnv, ANSME	

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
Operation of the SAPZ processing facilities/ equipment	Elevated Noise Levels	♦ Install noise barriers, mufflers, and silencers on equipment, and restrict noisy activities to daytime hours to minimise disturbances to local communities and wildlife. ♦ Where technically feasible, ensure machinery and equipment are sound-proof ♦ Ensure regular maintenance of machinery and equipment to reduce noise emissions. ♦ Provide PPE for facility workers and visitors to the facility. ♦ Regularly monitor noise levels and adjust operations as necessary to comply with noise regulations.	Built into Facility Owner's Cost and Noise Management	Ambient noise levels	Ambient noise levels are with FMEnv/ NESREA standards for industrial zones	Contractor; E&S Safeguard Unit	NESREA; ANSME; SPIU	Partly Built into personnel remuneration (Table 7.24) + 25,000.00 per sample during ECM
	Deterioration of Air Quality / Climate	♦ Use of low-emission processing	Built into facility owner's Cost	Gaseous pollutants (CH_4, CO, CO_2, H_2S,	Ambient air quality parameters	Facility Owner; E&S	NESREA; ANSME; SPIU	Partly Built into personnel

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
	Impact (GHG Emissions)	equipment. ♦ Implement dust suppression techniques, such as water spraying or using dust suppressants. ♦ Ensure Stack height is at 30 m ♦ Regularly monitor air quality and take corrective actions if pollutant levels exceed acceptable limits.		Ozone, NO_2, SO_2, VOCs, $PM_{2.5}$ and PM_{10})	are with FMEnv/ NESREA standards	Safeguard Unit		remuneration (Table 7.24) + 45,000.00 per sample during ECM
	Increased Demand for Water Resources	♦ Promote water conservation by recycling and reusing water where feasible. ♦ Implement efficient water-use technologies and equipment, such as smart metering to encourage responsible use of water resources. ♦ Ensure that water storage systems, pipes, and distribution systems are	Built into the Contractor's Cost and social management plan	- Increased demand for water resources - Number of grievances/ complaints filed	- No significant reduction in the quality and volume of water supply - 100% of grievances settled within the agreed timeframe	E&S Safeguard Unit/ Contractor	NESREA; ANSMA; ANSME; ANSIPPA; SPIU	Built into personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		regularly inspected and maintained to prevent leaks and promote water efficiency and conservation. ♦ Regularly monitor water usage to avoid overconsumption.						
	Soil and Water Contamination	♦ Ensure proper storage and containment of chemicals, oils, and other hazardous materials. ♦ Regularly inspect equipment for leaks to prevent contamination. ♦ Ensure proper collection and transfer of wastewater to the treatment plant, following guidelines to prevent leakage and ensure compliance with environmental standards.	Built into Contractor's Cost	Laboratory analysis of soil and physiochemistry, heavy metals, THC, TPH and micro-organisms	- Soil analysis not significantly different from baseline levels - Water analysis parameters are with FMEnv/NESREA limits for surface or groundwater	Contractor; E&S Safeguard Unit	FMEnv, ANSME; SPIU	Partly built into IMM cost + 150,000.00 per sample during ECM

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
	Waste Generation	♦ Implement the SAPZ waste management plan as it relates to their activities within the SAPZ AIH/ATC. ♦ Segregate, recycle, and dispose of waste responsibly. ♦ Implement processes for converting reusable waste, such as cassava peels, into high-quality animal feed to promote resource efficiency and minimise waste. ♦ Compost non-reusable organic waste and other biodegradable materials to create nutrient-rich soil amendments. ♦ Monitor waste generation and adjust procedures as necessary to minimise waste.	Built into Owner's Cost	Types and Volume of waste generated	- Percentage of waste recycled, sold or reused - Percentage of waste disposed of by accredited waste contractors	E&S Safeguard Unit/ Contractor	NESREA; ASWAMA; ANSME; SPIU	Built into personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		♦ Ensure waste is disposed of by qualified and accredited waste contractors. ♦ Ensure proper collection and transfer of wastewater to the treatment plant, following guidelines to prevent leakage and ensure compliance with environmental standards.						
	Unpleasant Odours from agro-produce processing, waste composting, wastewater treatment, and livestock sheds	**Odours from Agro-produce Processing:** ♦ Confine processing activities to enclosed, well-ventilated areas with efficient exhaust systems. ♦ Use natural or synthetic odour-neutralising agents or air fresheners specifically designed for food processing environments. ♦ Regularly clean	Built into Contractor's Cost	Number of complaints from nearby communities or workers	No noticeable unpleasant odour perceived - Zero/minimal number of complaints received	Facility Owner; OHS Manager	NESREA, ANSME; SPIU	Built into personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		and sanitise equipment and facilities to prevent odour-causing residue build-up. ♦ Maintain appropriate temperature and humidity levels to control microbial activity and reduce odour production. ♦ Monitor odour levels and engage local communities about potential impacts. **Odours from Waste Composting:** ♦ Ensure proper aeration of compost piles to promote aerobic decomposition and reduce anaerobic processes that produce foul odours. ♦ Cover compost piles to prevent odours from escaping.						

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		♦ Add wood chips or charcoal to the compost pile to absorb odours. ♦ nsure composite sites are situated away from residential areas and sensitive locations. **Odours from Wastewater Treatment:** ♦ Implement effective biological treatment processes, such as activated sludge or trickling filters, to break down organic matter and reduce odours. ♦ Use chemicals to neutralise or mask odours. ♦ Install odour control systems, such as scrubbers or biofilters, to capture and treat odorous gases. ♦ Ensure regular maintenance of						

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		wastewater treatment equipment to prevent malfunctions and odour issues. **Odours from Livestock Sheds:** ♦ Provide adequate ventilation to remove moisture, ammonia, and other odorous gases. ♦ Use appropriate bedding materials and manage litter properly to reduce odour production. ♦ Add sawdust or lime to the bedding to absorb odours. ♦ Clean and disinfect livestock sheds regularly to prevent odour-causing residue build-up.						
	Health and Safety Risks	♦ Conduct risk assessments and develop and implement an emergency	Built into Facility Owner's Cost and Occupational	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	NESREA; ANSME; SPIU	Built into personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		response plan to address accidents, spills, and other emergencies. ♦ Ensure only qualified and trained personnel operate facility equipment ♦ Provide regular training to employees on health and safety procedures, including emergency response, first aid, and the proper use of personal protective equipment (PPE). ♦ Provide and mandate workers to use appropriate PPE. ♦ Install ventilation systems to disperse heat and maintain safe working temperatures. ♦ Use energy-efficient equipment to	Health and Safety Plan					

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		reduce excessive heat production. ♦ Maintain equipment and machinery in good working condition to prevent accidents and injuries. ♦ Monitor temperatures to ensure compliance with health and safety standards. ♦ Ensure proper machine guarding and safety protocols for operating processing equipment. ♦ Maintain high standards of hygiene and sanitation in the facility to prevent the spread of diseases. ♦ Provide adequate ventilation in all work areas to ensure good air quality and reduce exposure to harmful fumes						

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		and gases. ♦ Conduct regular inspections of the facility to identify and address potential hazards before they lead to accidents or injuries. ♦ Ensure all accidents and incidents are recorded, investigated, and follow-up actions implemented. Ensure compliance with all relevant occupational health and safety regulations.						
Hiring of labour during the operational phase	Increased opportunities for employment	♦ Give preference to qualified local residents during the recruitment of labour. ♦ Provide training to locals to enhance their employability. ♦ Make prompt payment to engaged labour; ♦ Ensure agreement with the community before	Built into Facility Owner's Cost and Social Management Plan	- Number of job openings available - Number of vocational training provided	- Number of people hired - Number of workers who successfully completed the training	E&S Safeguard Unit/ Facility Owner	NESREA, ANSME, ANSMA, ANSIPPA	Built into personnel remunerations (Table 3.22)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		mobilisation on modalities of promoting local entrepreneurship in the provision of housing and transport.						
Hiring of migrant workers	Increased risk of sexually transmitted diseases	♦ Prioritise local hiring where possible to reduce the number of temporary workers moving into project areas ♦ Implement health education programs to educate migrant workers and local communities on STDs and prevention methods ♦ Ensure easy access to healthcare services, including STD testing and treatment for migrant workers ♦ When possible, conduct regular health screenings and STD testing	Built into Facility Owner's Cost and Social Management Plan	Number of new STD cases	Zero incidence of new cases	E&S Safeguard Unit/ Contractor	ANSMA, ANSME, ANSIPPA; SPIU	Built into personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		for migrant workers						
	Threat to community culture, safety and security	♦ Activate the Grievance Redress Mechanism (GRM) and ensure that community members are informed about its processes and how to access it. ♦ Prioritise local hiring where possible. ♦ Establish and maintain open, two-way communication channels with local communities to ensure continuous engagement and feedback ♦ Provide cultural sensitivity training for both migrant workers and local communities to foster mutual	Built into Contractor's Cost and Social Management Plan	- Number of grievances/ complaints filed	- 100% of grievances settled within the agreed timeframe	OHS Manager / E&S Safeguard Unit/ Contractor	ANSMA, ANSME, ANSIPPA; SPIU	Built into IMM cost, personnel remuneration (Table 7.24) and GRM Budget (Table 7.20)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		understanding of customs, traditions, and cultural norms. ♦ Facilitate community integration programmes that promote positive interactions and mutual respect between migrant workers and local residents. ♦ Enhance security by improving lighting, promoting community policing, and installing surveillance in areas with high concentrations of migrant workers ♦ Establish accessible conflict resolution mechanisms to promptly address any disputes or tensions between migrant workers and local residents.						

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
	Increase pressure on local infrastructure/amenities and services including health facilities, water resources, etc.	♦ Prioritise local hiring where possible. ♦ Provide food, water and campsites to reduce pressure on local resources ♦ work with local authorities to extend the operating hours of local infra, such as health clinics and community centres, to accommodate increased demand. ♦ Run awareness campaigns to educate both locals and migrant workers on the responsible use of local amenities.	Built into Contractor's Cost and personnel remuneration	- Increased demand for local services - Number of grievances/ complaints filed	- No significant reduction in the quality of services provided - 100% of grievances settled within the agreed timeframe	E&S Safeguard Unit/ Contractor	NESREA; ANSMA; ANSME; ANSIPPA; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)
Increased transport activities due to operational activities (material and produce	Climate Impact (GHG Emissions) / Deterioration of Air Quality	♦ Opt for vehicles with lower emissions, such as hybrid-powered machinery. ♦ Ensure that	Built into Contractor's Cost	Ambient air quality parameters CH_4, CO, CO_2, H_2S, Ozone, NO_2, SO_2, VOCs, $PM_{2.5}$ and PM_{10})	Ambient air quality parameters are with FMEnv/ NESREA standards	Contractor; E&S Safeguard Unit	NESREA; ANSME; SPIU	Partly built into personnel remuneration +

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
transportation)		operational vehicle engines comply with international standards for exhaust gases. ♦ Ensure the maintenance of engines as specified by the manufacturer. ♦ Adopt regular exhaust gas checks and an engine-off policy at the construction site. ♦ Plan and optimise transportation routes to reduce fuel consumption and emissions from vehicles transporting staff, material and equipment.						45,000.00 per sample during ECM
	Increased Road Accidents Risks	♦ Develop and enforce a detailed journey management policy that includes risk assessment procedures, route planning, and	Built into Facility Owner's Cost and Occupational Health and Safety Plan	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	NESREA; ANSME; SPIU	Built into personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		emergency response plans. ♦ Ensure all construction vehicles are pre-mobbed, and issue pre-mobilisation compliance certificates after conducting thorough safety checks. ♦ Ensure drivers are qualified, experienced, and trained in defensive driving techniques and accident prevention strategies, with demonstrable evidence of compliance with driving rules and regulations. ♦ Mandate the use of seat belts for drivers and all passengers in construction vehicles to enhance safety. ♦ Provide first aid training for the						

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		workforce, along with the provision of fully stocked first aid kits in all construction vehicles. ♦ Maintain comprehensive accident and near-miss logs to identify trends and implement improvements in safety practices. ♦ Conduct regular safety audits and inspections to ensure compliance with all safety measures and address any identified issues promptly.						
Nighttime lighting	Changes in the behaviour of Fauna Species	♦ Use wildlife-friendly lighting, such as LED lights, with lower colour temperatures to minimise disruption to nocturnal animals ♦ Install directional lighting to focus light downward	Built into Contractor's Cost and Biodiversity Management	Illuminance levels (lux) in areas known to be habitats for sensitive or nocturnal species.	- Illuminance levels in sensitive wildlife habitats remain below 5 lux, in line with general wildlife protection standards.	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Built into personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		and prevent spillover into natural areas ♦ Limit nighttime lighting hours, especially during wildlife breeding or migration seasons ♦ Establish buffer zones with natural vegetation to reduce wildlife exposure to artificial light ♦ Monitor wildlife behaviour regularly and provide advice to the contractor based on findings						
	Changes to visual aesthetics	♦ Incorporate dimmable lighting to adjust brightness levels based on need, maintaining safety while preserving aesthetic value ♦ Design lighting to blend with landscape features, minimising visual	Built into Contractor's Cost and Social Management Plan	- Number of complaints or concerns regarding changes in visual aesthetics. - Noticeable degradation of scenic views or dark skies.	Minimal complaints filed - No noticeable degradation of scenic views or dark skies.	Contractor; E&S Safeguard Unit	FMEnv; ANSME; SPIU	Built into IMM cost and personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		disruption and aligning with community preferences						
Offloading and loading of products and materials	Risk of injuries from improper handling, falls, or equipment malfunction during offloading and loading	♦ Provide training on safe material handling and lifting techniques. ♦ Mandate the use of appropriate PPE (gloves, helmets, boots). ♦ Use mechanical aids (e.g., forklifts, hand trucks) to reduce the need for manual lifting. ♦ Encourage team lifting for heavy or awkward loads, ensuring proper coordination between workers. ♦ Implement safe loading/unloading protocols, including designated loading zones. ♦ Rotate tasks to prevent repetitive strain on specific muscle groups. ♦ Regularly inspect	Built into Facility Owner's Cost and Occupational Health and Safety Plan	Number of accidents/ near-misses	Zero incidence of accidents or near-misses	Contractor; OHS Manager	NESREA; ANSME; SPIU	Built into personnel remuneration (Table 7.24)

Project Activities	Associated and Potential Impacts	Mitigation Measures	Cost of Mitigation (NGN)	Parameters to be Measured	Performance Indicator	Action Party for Mitigation	Institutional Responsibility (Monitoring)	Cost of Monitoring (NGN)
Operational / Maintenance Phase								
		equipment used for loading/unloading to ensure they are in good working condition. ♦ Schedule regular breaks to prevent fatigue and muscle strain during prolonged periods of loading/offloading.						

7.9 Environmental and Social Management and Monitoring Plan (ESMMP) and Reporting

The Environmental and Social Management and Monitoring Plan (ESMMP) is a detailed framework within the ESMP that outlines specific actions, responsibilities, and procedures for monitoring and managing environmental and social impacts during a project's lifecycle. It ensures the effective implementation and tracking of mitigation measures to maintain compliance with environmental and social standards. The ESMMP includes clearly defined roles and responsibilities for all stakeholders, ensuring that mitigation strategies are executed effectively. ESMMP implementation can be both internal and external mechanisms to ensure continuous oversight and accountability.

7.9.1 Internal Monitoring

This aspect of the monitoring plan involves regular and systematic checks by the State Programme Implementation Unit (SPIU), contractors, and other relevant stakeholders to assess the effectiveness of the ESMMP's implementation. Internal monitoring activities focus on compliance with environmental, social, and safety standards, ensuring that observed deviations or non-compliance issues are promptly identified, reported and addressed. This approach follows best practices outlined by the International Finance Corporation (IFC) (2015), which emphasises the importance of continuous internal oversight to improve environmental and social performance throughout the project lifecycle.

7.9.2 External Monitoring

External monitoring is carried out by independent organisations, such as ANSME, FMEnv, NESREA, and other relevant regulatory agencies. This independent oversight ensures an impartial evaluation of the project's environmental and social performance. External monitoring activities include periodic site inspections, review of internal monitoring reports, and verification of compliance with national and international standards. The AfDB ISS emphasises the importance of external monitoring in ensuring that all environmental and social safeguards are strictly adhered to during project implementation. Additionally, the involvement of external stakeholders, including NGOs and local communities, will be encouraged to provide additional layers of transparency and accountability.

Documentation and Reporting: All monitoring results are systematically documented, including detailed records of preventive and corrective actions implemented. This documentation serves as a reference for continuous improvement, helping to refine the ESMMP over time. Regular reporting will be provided when requested by relevant stakeholders, including the AfDB and local authorities, to demonstrate compliance and maintain transparency throughout the project.

Table 7.22 outlines the proposed monitoring programme for the implementation of the AN SAPZ II ESMP.

Table 7.22: Monitoring Programme for Anambra SAPZ ESMP

Monitoring Aspect	Action/Parameters to Monitor	Responsibility	When	Deliverables	Indicative Unit Budget (NGN)
Preconstruction Phase					
Environmental	Review approved ESMP and mitigation plans.	E&S Safeguard Unit, SPIU – ANSMA, ANSME	Before the start of site reparation activities	Review report; compliance checklists	Included in Personnel Remunerations (Table 7.24)
	Ensure waste management plans are developed and verify strategies comply with federal and state regulations.	E&S Safeguard Unit, SPIU – ANSMA, ANSME	Before the start of site reparation activities	Approved waste management plans	
	Confirm that waste management plans are communicated to all stakeholders involved in the project.	E&S Safeguard Unit, SPIU, ANSMA, ANSME, ASWAMA	Before the start of site reparation activities	Communication records, stakeholder acknowledgement records	
	Ensure mitigation measures are being applied effectively on-site	E&S Safeguard Unit ANSMA	Weekly	Compliance Monitoring reports, compliance records corrective action plans	
	Conduct regular site inspections to ensure waste segregation, storage, and disposal practices are being followed.	E&S Safeguard Unit ASWAMA	Monthly	Site inspection reports, waste management adherence documentation	
	Conduct air quality measurements	OHS Manager, E&S Safeguard Unit	Quarterly	Reports of noise level measurements	45,000.00*
	Conduct ambient noise level measurements	OHS Manager, E&S Safeguard Unit	Quarterly	Reports of air quality measurements	20,000.00*
Social	Verify the RAP Is developed and implemented as planned	E&S Safeguard Unit ANSIPPA, ANSMA, ANSWASW, NGOs, CSOs, CBO, CLO	Throughout the preconstruction phase	Engagement records, feedback summary reports	
	Verify fair compensation mechanisms are in place and that compensation is provided promptly and transparently.	CLO, E&S Safeguard Unit, NGOs, CSOs, CBO	Throughout the preconstruction phase	Compensation records, transparency reports	

Monitoring Aspect	Action/Parameters to Monitor	Responsibility	When	Deliverables	Indicative Unit Budget (NGN)
	Monitor the establishment and effectiveness of grievance redress mechanisms.	CLO, E&S Safeguard Unit, NGOs, CSOs, CBO	Throughout the preconstruction phase	GRM reports Resolved grievance reports	Included in Personnel Remunerations (Table 7.24)
	Assess the effectiveness of community support programs and ensure alignment with identified needs.	E&S Safeguard Unit – ANSMARD, CLO	Ongoing	Evaluation reports (with community feedback summaries, impact assessments and action plans)	
OHS	Verify OHS management is implemented on-site	OHS Manager, E&S Safeguard Unit	Throughout the preconstruction phase	OHS Monitoring Reports (with incidence records, training records, compliance records and corrective action plans)	
Construction Phase					
Environmental	Conduct air quality measurements	OHS Manager, E&S Safeguard Unit	Quarterly	Compliance Monitoring Reports	45,000.00*
	Conduct ambient noise level measurements	OHS Manager, E&S Safeguard Unit	Quarterly	Compliance Monitoring Reports	20,000.00*
	Site inspections to ensure implementation of mitigation measures.	E&S Safeguard Unit, ASWAMA, ANSMA	Weekly	Compliance Monitoring Reports	
	Verify that contractors are implementing waste management plans as specified in the contract.	E&S Safeguard Unit, ASWAMA	Monthly	Contractor compliance reports, waste management records	
	Verify proper disposal of hazardous waste and that records are kept for tracking.	E&S Safeguard Unit – ASWAMA	Monthly	Hazardous waste disposal records, tracking documentation	
	Impact Mitigation Monitoring exercise to verify mitigation application	FMEnv, ANSME, ANSMA, E&S Safeguard Unit	Once during the Construction Phase	IMM report	
Social	Monitor and support livelihood restoration programs and community support initiatives.	E&S Safeguard Unit, SPIU, CLO, NGOs, CBOs, CSOs, ANSMA	On-going	Progress reports on livelihood programs and community initiatives	Included in Personnel

Monitoring Aspect	Action/Parameters to Monitor	Responsibility	When	Deliverables	Indicative Unit Budget (NGN)
					Remunerations (Table 7.24)
OHS	Ongoing health and safety monitoring, including compliance with safety protocols.	OHS Manager	Weekly	Safety inspection reports, incident logs	Included in Personnel Remunerations (Table 7.24)
Operational/Maintenance Phase					
Environmental	Conduct ambient noise level measurements	E&S Safeguard Unit ANSMA	Quarterly	Reports of noise level measurements	45,000.00*
	Conduct air quality measurements	E&S Safeguard Unit ANSMA	Quarterly	Reports of air quality measurements	20,000.00*
	Conduct periodic monitoring of groundwater quality	E&S Safeguard Unit	Biannually	Environmental Compliance Reports	150,000.00*
	Conduct periodic monitoring of surface water quality	E&S Safeguard Unit	Biannually	Environmental Compliance Reports	150,000.00*
	Conduct periodic monitoring of soil health	E&S Safeguard Unit	Biannually	Environmental Compliance Reports	150,000.00*
	Conduct mandatory environmental audits every three years as per federal regulations.	External Consultant, E&S Safeguard Unit, NESREA	Every 3 Years	Environmental audit reports	To be Determined
	Monitor waste generation, segregation, and disposal records to identify trends and areas for improvement.	E&S Safeguard Unit. ASWAMA	Quarterly	Waste management reports, segregation and disposal records	Included in Personnel Remunerations (Table 7.24)
	Verify proper disposal of hazardous waste and that records are kept for tracking.	E&S Safeguard Unit – ASWAMA	Monthly	Hazardous waste disposal records, tracking documentation	
	Ensure that waste management practices are updated based on operational feedback and regulatory changes.	E&S Safeguard Unit – SPIU, ASWAMA NESREA, FMEnv	As needed	Updated waste management plans, and documentation of changes made	
Social	Ongoing monitoring of community dynamics, social	E&S Safeguard Unit – SPIU, ANSIPPA, ANSMA	Ongoing	Monitoring reports, feedback and adjustment plans	Included in Personnel

Monitoring Aspect	Action/Parameters to Monitor	Responsibility	When	Deliverables	Indicative Unit Budget (NGN)
	cohesion, and project impacts on livelihoods.	ANSME, CLO, NGOs, CBOs, CSOs			Remunerations (Table 7.24)
OHS	Continuous monitoring of OHS management, including regular safety audits and health impact assessments.	OHS Manager	Ongoing	Safety audit reports, health impact assessment reports	Included in Personnel Remunerations (Table 7.24)

*: Unit Cost. See Table 7.23 for the estimated cost per annum

Source: Anambra SAPZ ESIA (2024)

7.8.3 Estimated Cost of Environmental Monitoring Programme

The estimated costs of conducting environmental sampling analysis during the monitoring programme are presented in Table 7.23, while Table 7.24 presents the remuneration of staff responsible for conducting the monitoring programmes. The cost is separate from the costs of mitigation strategies, presented in Section 7.6 of the report.

Table 7.23: Cost of Environmental Monitoring Program per Annum

S/N	Environmental Aspect	Number of Times Per Year	Number of Samples Per Annum	Total Cost (NGN)	Environmental Sample Monitoring
1	Air Quality	4	32	45,000.00	5,760,000.00
2	Noise Quality	4	32	20,000.00	2,560,000.00
3	Soil (topsoil and subsoil)	2	64	150,000.00	19,200,000.00
4	Surface Water	2	18	150,000.00	5,400,000.00
5	Ground Water	2	15	150,000.00	4,500,000.00
6	Biodiversity	1	1	15,000,000.00	15,000,000.00
	Total				**52,420,000.00**

Note: Number of samples per facility location: Ogboji – 12; Ogbunka – 6; Omor – 6; Ugbene – 6; Control – 2; Total = 32. Soil samples will be taken at two depths, hence total samples equal 64.

*: Lump sum per site for air quality and noise monitoring

Source: Anambra SAPZ ESIA (2024)

Table 7.24: Estimated Annual Staff Remuneration

S/N	Project Unit	Amount (NGN)
1	OHS Manager and Staff	7,500,000.00
2	E&S Safeguard Unit	20,000,000.00
3	GRM Officers, CLO and Support Staff	12,500,000.00
	Total	**40,000,000.00**

Source: Anambra SAPZ ESIA (2024)

7.10 ESMP Disclosures

Following the review and approval of the ESMP by the FMEnv/AfDB, it will be disclosed at the National and local levels by ANSIPPA/ANSMA/SPIU in line with the applicable Nigerian EIA laws and regulations. Minimum disclosure requirements and budget are shown in Table 7.25.

Table 7.25: Disclosure Procedure to comply with Nigerian regulations

Action	Remarks	Cost (Naira)
Disclosure on 2 national newspapers	ANSIPPA/ANSMA/SPIU will disclose the ESIA/ESMP as required by the Nigeria EIA Act for public notice and review procedures. This entails advertising in two newspapers: one national and one local (state) newspaper.	500,000
Disclosure at the ANSME	ANSIPPA/ANSMA/SPIU will disclose the ESMP as required by the Nigeria EIA public notice and review procedures.	--
Disclosure at ANSMA	The project proponent will display the ESMP as required by the Nigeria EIA public notice and review procedures.	--
Disclosure at project LGA offices	The purpose will be to inform stakeholders about the project activities, anticipated environmental and social impacts, and proposed environmental and social mitigation measures.	--
Total		**500,000.00**

Source: Anambra SAPZ ESIA (2024)

7.11 Indicative Budget Estimation for ESMP Implementation

Table 7.26 presents a summary of the total indicative ESMP implementation cost grouped by major cost categories, totalling NGN192,170,000.00 (one hundred and ninety-two million, one hundred and seventy thousand naira) only. The table provides an overview of key cost components related to the ESMP's implementation, categorised into Mitigation Strategies, Environmental Sampling Monitoring, Staff Remuneration, Capacity and Competency, ESMP Disclosure and Grievance Redress Mechanism. Mitigation costs that will be incurred by the contractor are integrated into their contract as part of the overall project implementation budget. This structured approach ensures that resources are efficiently allocated to effectively address environmental and social impacts throughout the project's duration

Table 7.26: Summary of Estimated Total Budget for ESMP Implementation (Excluding Land Acquisition/Resettlement Mitigations)

S/N	Cost Components	Estimate (NGN)
1	Mitigation strategies	67,000,000.00
2	Environmental Sampling Monitoring	52,420,000.00
3	Staff Remuneration	40,000,000.00
4	Capacity and Competency	8,750,000.00
5	ESMP Disclosure	500,000.00
6	Grievance Redress Mechanism	23,500,000.00
	Total	**192,170,000.00**

Source: Anambra SAPZ ESIA (2024)

7.12 Implementation Schedule

Table 7.27 shows the tentative implementation schedule for the ESMP implementation and monitoring.

Table 7.27: Proposed Implementation Schedule of the Anambra SAPZ II

S/N	Activity	Responsibility	Preconstruction	Construction	Operation†
	Months		3*	12-18*	After 18 months*
1	Clearance of ESIA	SPIU			
2	Inclusion of E&S Requirements in Bid Documents	SPIU			
3	Inclusion of ESMP in Contract Documents	SPIU			
4	Review and Approval of Contractor's ESMP	SPIU			
5	Finalisation of Engineering Designs	SPIU			
6	Implementation of Environmental and Social Mitigation Measures	SPIU, CLO, GO, Contractors, E&S Safeguard Unit, OHS Manager, Affected MDAs			
7	Supervising ESMP Implementation	SPIU, CLO, E&S Safeguard Unit, OHS Manager, Affected MDAs			
8	Monitoring and Reporting on ESMP Implementation	SPIU, CLO, E&S Safeguard Unit, OHS Manager, Affected MDAs, Interested Stakeholders			
9	Environmental and Social Auditing*	SPIU, CLO, GO, E&S			

* Actual start date may differ among the project sites in Ogboji, Ogbunka, Omor and Ugbene

† The Schedule does not include the decommissioning stage. A decommissioning plan will be developed at the end of the project life.

Source: Anambra SAPZ ESIA (2024)

CHAPTER 8 STAKEHOLDERS CONSULTATION

8.1 Introduction

Prior to the execution of this ESIA, relevant stakeholders, especially potentially affected communities, were identified through a stakeholder mapping analysis, so that adequate engagement and consultation can be carried out during the ESIA process and beyond. This stakeholder mapping analysis then informed the development and implementation of a Stakeholder Engagement Plan (SEP) that includes a detailed description of the plan for stakeholder engagement through the ESIA process.

For this ESIA, the fundamental principle of consultations is meaningful engagement with the various identified groups (i.e., free, prior and informed), to inform the stakeholders and to ultimately achieve Broad Community Support (BCS) for the SAPZ. In addition, the Stakeholder engagement through the ESIA process captured broad perspectives including those of women, minority groups as well as vulnerable individuals or groups ensuring that the requirements for meaningful engagement and consultation are adequately fulfilled. These consultations served as a two-way process between the project and its host/affected communities and other stakeholders to adequately inform them about the project (including its benefits and adverse impacts) and to obtain their input, concerns and fears which were then mainstreamed into this ESIA.

8.2 Stakeholder Analysis and Identification

The stakeholder analysis focused on the identification of stakeholders, roles and influence they wield in decision-making and implementation of the ESIA and development of the SAPZ in general. This is apt for determining the capacities, concerns and influence on policy formulation and implementation. For example, this ESIA acknowledges that an agency, organisation or group can have the dominant influence over the formulation of a policy but at the same time have less practical impact than a large number of groups who have no knowledge of the regulations and information about the project, but nevertheless, control day to day events or actions that affects the project. By plotting the relative influence and impacts of different stakeholders on a graph, valuable insights can be gained in terms of the actions that need to be taken to make policies more effective.

Table 8.1: Stakeholder Categorisation and Analysis Influence and Interest

Project Phase	Project Activities	Target Groups	Influence /Interest	Engagement Method
Pre-construction	▪ Disclosure of project information ▪ Identification of proposed project location and area of influence ▪ ESIA scoping and study. ▪ ESIA disclosure ▪ Stakeholder Consultations to discuss impacts and mitigation/ GRM channels	• Federal Ministry of Environment FMEnv. • Anambra State Ministry of Agriculture (ANSMA) • Anambra State Ministry of Environment (ANSME) • Anambra State Waste Management Authority (ASWAMA) • Affected/Benefitting communities. • PAPs • Affected LGAs • ANSME • NGOs, CBOs • Project communities including Market women/ community Women	High	▪ Invitation through village heads, youth leaders and heads of association. ▪ Distribution of background information document (BID) to the locals interpreted in the local language. ▪ Invitation through LGAs ▪ Disclosure of ESIA at LGAs, ANSME, project SPIU, National & Local Dailies. Consultations with different stakeholder groups (separate consultations for women and Girls)
Construction	▪ construction – Civil Works ▪ ESIA/RAP Implementation ▪ ESIA Monitoring ▪ RAP Audit ▪ Stakeholder Consultations to assess the effectiveness of ESIA implementation/ effectiveness of GRM	• Affected LGAs • Affected/Benefitting communities. • PAPs • Affected LGAs • PSME • NGOs, CBOs • Police. • Traditional Rulers/Community leaders • Farmers groups, • CBOs, NGOs, CSOs • Market/ Community Women • Vulnerable persons	High	▪ Invitation through the village heads, youth leaders and heads of MDAs. ▪ Information via village messenger ▪ Distribution of fliers to the locals printed in the local language. ▪ Arrangement of monitoring responsibilities to stakeholders. ▪ Follow up calls by SSO/ESO Consultations with different stakeholder groups (separate consultations for women and Girls)

Project Phase	Project Activities	Target Groups	Influence /Interest	Engagement Method
Operation	▪ Demobilisation ▪ Audit/ Post construction evaluation ▪ Facility Maintenance	▪ Farmers/Market men and women in project communities ▪ Traditional rulers, and village heads. ▪ Affected LGAs ▪ ANSME	High	▪ Community based interview, questionnaire surveys by SPIU ▪ Invitation through village heads, youth leader & heads of MDAs ▪ Information via village messenger ▪ Arrangement of monitoring responsibilities to stakeholder. ▪ Follow up calls by SSO/ESO

8.2 Summary of Consultations, Concerns Raised and Responses to Address Concerns

The summary of consultation with various stakeholders is presented in Table 8.1 while the attendance at these meetings is attached as Appendix 4.

8.2.1 Inception Meeting

The inception meeting was held on Tuesday 9 July 2024 in the conference room of the Anambra State Investment Promotion and Protection Agency (ANSIPPA). In attendance were the ESIA consultants, the Anambra SAPZ State Programme Implementation Unit (SPIU), 2 representatives of the Anambra State Ministry of Environment (ANSME), Anambra State Ministry of Agriculture (ANSMA), ANSIPPA, National Environmental Standards Regulatory Enforcement Agency (NESREA, and the Federal Ministry of Environment (FMEnv) in attendance. The focus of the inception meeting was to provide an update on the ESIA activities as well as to provide preliminary on the project. It was confirmed at the meeting that the scoping workshop will be held the next at the ICC, with host communities in attendance. ICC was the preferred venue as it is easily accessible to project-affected communities. Following the close of the meeting at about noon, the ESIA team proceeded with the FMEnv team to site investigation and data gathering. Plate 8.1 shows photographs taken during the meeting, while attendance is presented in Appendix 4.1.

Plate 8.1: Participant at the Inception Meeting at ANSIPPA

8.2.2 Scoping Work Workshop with ANSIPPA, FMEnv, Community Representatives

The Scoping Workshop was held at the International Conference Centre, Awka on the 10th of July 2024. The details of the Workshop are presented in Table 8.2. The attendance sheet is presented in Appendix 4.2.

Table 8.2: Summary of the Scoping Workshop

Date	**10/07/2024**
Time	4 pm
Venue	International Conference Centre Awka
Attendance	**ANSIPPA** Management Staff, FMEnv, ANSMA, ANSME, ESIA Team, Representatives of project-affected LGAs/Communities
Language of Communication	English and Igbo
Overview	The meeting started with an opening prayer and then a welcome address by the project coordinator of ANSIPPA Mr. Congo, who welcomed all stakeholders in the meeting. A welcome brief from the Honourable Minister of Environment representative Mrs. Laura Ezeala. speaks about the essence of ESIA and its impact in protecting project communities and safeguarding the resources within the environment. She talks about the importance of the ESIA questionnaire and the need to ensure that field officers involved in the project ask more questions in these project communities to identify and collect data which in the long run will bring a positive impact on the project and the society at large. Reference was made to the rice mill built in a community and the ongoing negative impact being experienced and reported by the community residents because an environmental and social impact assessment was allegedly not conducted and if ever it was, probably was not detailed enough to capture the present challenges. She explained the importance of community engagement which is designed to; • ensure the safety of the project in the stipulated community • know the educational status of the individual segments in the proposed community. • collaborate with the local health centres and clinics on the data collection in terms of prevalent ailments in the community. • Collect income data for use in evaluating the employability capacity of the individuals in the community. • ascertain the level of community residents' awareness as that would enable stakeholders to harness the opportunities within the project communities.

Response and Concerns from the representatives of project-affected LGAs/communities	1. Samuel Ike from Ndikelionwu-Asked about the questionnaire and if it is possible to administer the questionnaire at the community level. 2. Emmanuel Mba from Aguluezechukwu advised that the project proponent should inform the communities properly by coming to the community to interact with their leaders to ensure a smooth stakeholder engagement process 3. Mr Emmanuel stressed that providing land for government was not the issue, the need for involving critical community stakeholders from project initiation, planning and construction stages should not be neglected as that would give the community further assurances. 4. Mr Ken Okoye from Nanka – explained that the Anambra State community leadership structure differs because of the community governance structure. It is important to identify the structure because the leadership is basically on a community level. The four structures are Igwe, PG (president general), Woman leaders and Youth leaders. He also stresses the issues of insecurity challenges in the project communities. 5. Mr. Muorah from Umuomaku - asked how long it would take for the project to commence and be completed, and who is constructing the project. He also assured the Consultant that the PG of Orumba would be on the ground to welcome them on arrival so that the stakeholder engagement would be a huge success. 6. Mr. Clement Offor PG Ufuma - Given the importance of ESIAs which enables project issues to be identified early enough and nipped in the bud, he wanted to be assured that all necessary regulatory prescriptions and guidelines for conducting ESIA of this nature will be followed while also stating the need for proper community engagement for security reasons as well. He said that the employment of local labour is important because it gives the community a sense of involvement and empowerment. He also suggested that relevant documents should be signed and documented by each community for future reference. 7. Mr Nworah John from Omor - talked about meeting the 4 structures of the community and advised on the need to commence work immediately. 8. Casimir Nwafor from Oko - suggested that the PGs and TCs should always be duly carried along and informed by the team on each planned visit to the community as this would enable them to plan and put things in place to ensure the provision of adequate security

Response from ESIA Consultant and ANSIPPA Representative	The ESIA consultation team lead explained that the next engagement activities would include focus group meetings and questionnaire administrations at the community level where more community-based residents would be engaged and their perspectives sought. While the issue about security was expressed, the project team were assured that the relevant community leaders would be engaged to ensure successful community socioeconomics engagements. As regards the question raised by Mr. MBA. The consultant explained that the team will reach out to all project host communities and schedule timely consultations with them. She further stated that a process will be put in place to continue meaningful engagement with the project owners. The Consultant expressed appreciation for the above assurances and advice from Mr Ken Okoye from Nanka while affirming that the information is one of the benefits of this meeting. This assurance according to him showed the youth's readiness to support the government in its effort to create opportunities aimed at alleviating poverty and unemployment in the affected communities. Mr Ajekwu who represented ANSIPPA informed the stakeholders that the company that will construct the project is Melinda Industrial Company in India. According to him, the company has given a 20-year timeline for the successful completion of the project.
ESIA lead Consultants Response	He expressed his gratitude for the questions and concerns raised and assured the community representative that the project would be conducted in line with applicable regulations. The Consultant in his response, stated that he resonated with the need for effective communication. According to him, it is important to leverage the community leaders' structure will guarantee adequate security. He also suggested the need to ensure that the employment of low-level workers is considered in the project

Plate 8.2: Scoping Workshop Photos at the ICC (10 July 2024)

8.2.3 Consultation Meetings with Ugbene, Omor and Aguluezechukwu Communities

Table 8.3 provides detailed summaries of community consultation meeting proceedings in Ugbene (Awka North LGA), Omor (Ayamelum LGA) and Aguleezechukwu (Aguata LGA). The ESIA team paid a courtesy visit to the Igwe of Ugbene, Igwe Samson Chimakwa, who facilitated the community participation in the meeting. The Igwe of Omor, Igwe Dr Oranu Chris Chidume, although absent from the community, granted permission for the ESIA team to meet with the community. At Aguluezechukwu, the meeting was presided over by Prince Amaechi Okafor, representative of the president general of Aguluezechukwu Improvement Union (AIU), Nze John Ezenwaka (Ohamadike). Plates 8.3 (Ugbene), 8.4 (Omor) and 8.5 (Aguluezechukwu) show collages of photographs taken during the consultation meetings while the attendance sheets are shown in Appendices 4.3 – 4.5.

Table 8.3: Summary of Consultations in Ugbene, Omor and Aguluezechukwu

<table>
<tr><th>Consultation community</th><th>Igwe (Ugbene Community)</th><th>Ugbene community</th><th>Omor Community</th><th>Aguluezechukwu Community</th></tr>
<tr><td>Date/Time</td><td>29/07/2024/1:00 am</td><td>30/07/2024/5:00 pm</td><td>29/07/2024/2:00 pm</td><td>30/07/2024/10:00 am</td></tr>
<tr><td>Intervention</td><td colspan="4">Construction Agro-Industrial Hub and Agricultural Transformation Centres</td></tr>
<tr><td>Attendance</td><td colspan="4">Village heads/elders, youths, traders, farmers, women, members of the ANSIPPA and the Consultant team.</td></tr>
<tr><td></td><td colspan="4">Consultation with Community Leaders, Elders and Youths

The meeting on the socio-economic aspects of the project, which are crucial in this regard, was introduced by the Community Liaison Officer (CLO), Eucharia Onyemaobi. She took the opportunity to emphasise to the community representatives the importance of community engagement, an essential part of the Environmental and Social Impact Assessment (ESIA).

Dr Ukamaka Anagboso , the ESIA team lead, provided an overview of the Anambra State SAPZ Project and the proposed interventions in the communities. She explained that conducting the ESIA is vital before the commencement of any interventions, as it helps identify potential environmental and social sensitivities and suggests possible mitigation measures to avoid, reduce, minimise, or offset these impacts. The preparation of the ESIA reflects a commitment to realising the project in the area. The project aims to improve the lives of the people, particularly in rural areas, by enhancing access to farming techniques, farm infrastructure, and market infrastructure. Therefore, it is crucial for the communities to cooperate with the project and to share their perspectives, suggestions, and concerns to facilitate the smooth implementation of the project.</td></tr>
</table>

Concerns/comments/questions by stakeholders	The Igwe of Ugbene in his response, expressed appreciation to the team for the opportunity provided to not only educate but guide the community members present on the pros and cons of the proposed project and the need for effective community participation and ownership. He also explained that if not that it was the farming season, more people would have been in attendance. a farming period, the community members would have been more in attendance. The Igwe said he would facilitate getting his people together for the group discussion the next day.	♦ Ozo Herbert Ibeh asked where the ATC will be installed, and if the road will be built. ♦ Kingsley Onyi – appreciates the project and asked about the employment rate. He pleaded that the government should provide employment opportunities for the youths and women. ♦ Mr Dickson Nze appreciated the ESIA team for coming and prayed for more strength to continue this project, he also said that the Ugbene Community will give support to the team during field exercises ♦ Levi Ebuka wanted to know if the electricity and other amenities provided will be restricted to the project or be extended to the community. ♦ Ozo Herbert Ibeh asked if there is additional amenities	♦ Chief Joseph Morah asked about reviving the recycling plant in the community. ♦ Chief Emmanuel Martins expressed his concern over the construction and post construction air quality. ♦ Mr Okonkwo Joseph asked if the Honourable Commissioner and the State Ministry of Agriculture were aware of the visit.	♦ Rev Ezenwa Miracle thanked the team for coming. He explained that Aguluezechukwu's vision is in agricultural development. He further asked the exact location of the proposed project in the community and the commencement date. He asked if there is a slot/allocation for the community in investment package. ♦ Mr Ejike Okoli appreciated the Anambra State government for the initiative and further informed the team that Aguluezechukwu has enough land and would be willing to provide the 450 hectares of land needed for the project

		different from the one proposed for the project community. He wanted to know if the government would maintain the land for cultivation. ♦ PG Pastor Amuzie Nnalue said that the community lacks both garri- and oil-processing machines. He also mentioned that telecommunication services were poor. ♦ Many members of the community expressed concern about the poor quality of telecommunication service in the area. ♦ A member of the community wanted to know if some of the proposed infrastructure like electricity could be extended to the town. ♦ In general, people were overwhelmingly in support of the project.		

Response by the Consultants	The ESIA team lead thanked Igwe and his chiefs for receiving the team and the time to be part of the meeting.	Dr Anagboso answered that the necessary facilities will be provided likeelectricity, road, and water supply, amongst others. She informed the community that the youth and women of this community would benefit more from the project. She mentioned that the project is for everybody in the community that the government will provide opportunities for those around to partake in it and that there will be a training centre for capacity building.	About the recycling plant in the community, Dr Anagboso answered that the request would be relayed to the state government via ANSIPPA request. With regards to the community air quality, Dr Anagboso explained that the baseline air quality was generally good but sulphur dioxide was a little higher than normal at one monitored location during the air quality assessment of the project area. She further stated that the assessment is an ongoing process which will be reviewed during monitoring programmes. She further explained that the ESMP for the project includes mitigation measures to ensure thr management of potential air quality impacts. Furthermore, she stated that the state commissioner for agriculture was fully aware of the ongoing ESIA process. .	The ESIA team lead stated that the Ogboji community is the project's primary beneficiary and a total of 450 hectares of land has been proposed for the development. Dr Anagboso further stated that Aguluezechukwu is also a beneficiary of the project since 450 ha of land required for the project is also part of their land.

Remarks from the project communities	The meeting was scheduled for the next day, 30th July 2024, to enable more community members' availability and participation.	♦ Community PG thanked the ESIA team and promised the team that all necessary support would be given to the team throughout their fieldwork. community happily accepted the project and thanked the government of Anambra State for the choice of sitting the project on their land.	♦ Mr Jideofor Aniekwe emphasised the importance of the project, stating that Omor is known for agriculture and that this project will help to not only sustain but enable them to also learn how to preserve their produce thereby making agriculture more profitable ♦ Chief Godwin Nonyelum informed the team that the community happily accepted the project and welcomed the choice of siting the project on their land. ♦ He therefore suggested that the ESIA team should endeavour to give them enough notice for the next visit to enable them to organise more farmers and other community stakeholders. With this, the entire community will be aware of the proposed project and also	♦ The Aguluezechukwu community expressed their interest in the proposed project and concluded that; ♦ The proposed project by the Federal government, State government and African Development Bank is welcomed by Aguluezechukwu. ♦ The said 450 hectares of land needed, Aguluezechukwu is capable of providing the land and the project site should be well defined between Ogboji and Aguluezechukwu.

<table>
<tr><td></td><td></td><td></td><td>suggest better ways to sustain the project</td><td></td></tr>
<tr><td></td><td colspan="4">Consultations with Women Group
The consultants explained the AIH/ATC Projects and the various components of the project to the women. He also explained the type of interventions the project is executing in the community and the role of the women as part of the stakeholders. The consultants reiterated on the need of the women to monitor the movement of their daughters due to the influx of foreign workers as a result of the project to avoid any form of sexual harassment, sexual abuse and Gender base Violence. The project does not want anybody to be left worse than he/she was before the project interventions in any aspect.</td></tr>
<tr><td>Concerns, Complaints/suggestions</td><td>♦ The women were so excited about the explanation by the consultant and promised to abide by all that was said.
♦ However, the women asked if the project would support women financially</td><td>♦ Nnadozie Janet asked if the government can support them with loans to improve on their agricultural produce.
♦ A lady lamented about the lack of teachers in the local school and wanted to know if something could be done about it.</td><td>♦ The women were delighted with the intervention as it will ease the hardships faced during farming season and boost their agricultural produce processing
♦</td><td>♦ They welcomed the consultants and appreciated the Project for selecting their roads as part of the benefiting roads.
♦ They pleaded with the project to support them with some money to boost their agro processing activities in the community</td></tr>
<tr><td>Response by the Consultants</td><td colspan="4">Dr Anagboso the ESIA team lead answered all their questions and told the community women that all they requested for is already in the proposed project package and that women are at the centre as a major beneficiary of the proposed project</td></tr>
</table>

Plate 8.3: Collage of Community Engagement Photos in Ugbene, Awka North LGA



Plate 8.4: Collage of Community Engagement Photos in Omor, Ayamelum LGA

Plate 8.5: Collage of Community Engagement Photos in Aguluezechukwu, Aguata LGA

8.2.4 Consultation Meetings with Ogbunka and Ogboji Communities

Table 8.4 provides detailed summaries of community consultation meeting proceedings in Ogbunka and Ogboji in Orumba South LGA. Ogbuefi Felix Ike, Chairman of Isiokpu Village led the meeting in Ogbunka, while Mrs Ifeyinwa Mary Okafor (Women Leader) and Mr Solomon Osuji (Chairman of Amangwu Town Union) led the meetings with the community women and men, respectively at Ogboji. At all the locations, the people expressed enthusiastic support for the project. Plates 8.6 (Ogbunka) and 8.7 (Ogboji) show collages of photographs taken during the consultation meetings while the attendance sheets are shown in Appendix 4.6 – 4.7.

Table 8.4: Summary of Consultations in Ogbunka and Ogboji

Consultation community	Ogbunka	Ogboji	Ogboji
Date/Time	**13 July 2024/11.00 am**	**30 July 2024/1:00 pm**	**31 July 2024/4:00 pm**
Intervention	**Construction Agro-Industrial Hub and Agricultural Transformation Centres**		
Language	**Igbo**	**Igbo**	**Igbo**
Venue	**Isiokpu Community Town Hall**	**Central School, Ogboji**	**Igba Ogboji (Village Square)**
Attendance	Isiokpu-Ogbunka community members, ESIA consulting team, community groups (including men, women, youth, Vigilante group and farmers groups	Ogboji community women group, farming group, ESIA Consulting team	Ogboji community members, ESIA Consulting team, community groups
Introduction	The consultant representative and the Community Liaison Officer, Ms Eucharia Onyemobi, in her opening remark, thanked the members of the community who attended the meeting and also the village who made the land available for the project development. In her words, the project is all about establishing agro-processing and storage facilities in the community. The facility will equally come with other college industries. She highlighted some importance of the project including but not limited to a boost in economic activities, an increase in agricultural produce, food security and employment opportunities for community residents, amongst others. She also urged the community to take ownership of the project since it will be domiciled within the locality. After the welcome remark, Mr. Cyril Anaekwe, a team member from the Consultant pleaded with the community members to exercise some patience with the project as the commencement date has not yet been determined by the government since the project has not yet been greenlighted to start. He also mentioned that a complex project requires careful planning and consultation among all stakeholders to ensure its success.		
Perception of the Project	♦ Ogbuefi Felix Ike, Chairman of Isiokpu Village of Ogbunka Community in his welcome address appreciated the team	♦ The women leader, Mrs Okafor Mary Ifeyinwa, welcomed the opportunity and the importance of community engagement in a	♦ Mr Solomon thanked the ESIA team for the meeting, stating the project is a good one for agricultural development in

Consultation community	Ogbunka	Ogboji	Ogboji
	and thanked the Anambra State Government (ANSG) for choosing to site an Agricultural Transformation Centre in their Community. According to him, the village has accepted that the project would be sited in their community. ♦ Mrs Virgina Okafor, the women leader, equally expressed her happiness about the project. In all, the members spoke in favour of the project.	thorough socio-economic assessment. She highlighted the State government's commitment to conducting this assessment in partnership with community residents, particularly farmers, women, and youth, to address potential concerns and misconceptions. ♦ When asked as a group their perception of the project, the women expressed support for their initiative.	Ogboji. ♦ Asked as a group their perspective about the initiative, the participants stated they welcomed and approved of it.
How concerns questions and requests were addressed.	♦ The ESIA team requested the names of neighbouring communities to the proposed project site. This information is crucial because those communities can potentially benefit from its development. ♦ Given the request, the chairman Ogbuefi Felix Ike mentioned the names of the communities to include: Agbariagba Umunze, Umuacha Ezinanato, Umunochi Agbala Ufuma and Akwuoba Village, while villages in Ogbunka include Isiokpu, Awuka, Agbala, Umunobe and	♦ Okafor suggested that the State government should prioritise providing access roads to the community and constructing an oil mill to address the challenges faced by local farmers. She also offered to take the ESIA team to visit the only oil palm processing facility in the community. ♦ Mrs Nnadozie Janet inquired about the availability of loans to support improved farming practices and mitigate food insecurity. ♦ In her response to the above, Dr Anagboso thanked Mrs Okafor	♦ On project location, he wanted clarifications on whether it is on the same land allocated for the proposed Pharmaceutical Manufacturing Park or another land. ♦ Chukwuma Nwankwo wanted clarification on the exact location of the SAPZ in Ogboji. He also wanted to know whether the government has acquired the land already or if the Ogboji would donate land to them. ♦ In her remarks, the ESIA lead, Dr Anagboso, stated that the Pharmaceutical Park is now part

Consultation community	Ogbunka	Ogboji	Ogboji
	Akwuoba	for her remarks and suggestions and affirmed that problems like inadequate processing facilities are exactly one of the issues the project is addressing. On providing access roads, she reiterated that the Anambra State Government has factored those, including other ancillary facilities in the project design based on the master plan. She also clarified that while the project itself does not include providing loans, it will contribute to improving the overall economic well-being of the community and create opportunities for local businesses and farmers.	of the proposed AMIC and that additional land is required to accommodate the expanded AMIC programme, including SAP. She also reiterated the ANSG's commitment to community development and carrying the people along during decision-making.
CLOSING REMARK	The chairman thanked the team for the fruitful interaction and prayed that God would help the government to complete their intended project on the community. He equally extended his appreciation to the Commissioner for Agriculture for his effort and also for making sure that the gathering was held. At this juncture, kola was presented and prayer was said. The meeting ended by 4:10 pm.	The women leader thanked the ESIA team for coming to Ogboji, She said the women are ready and support the initiative wholeheartedly. The closing prayer was said and the meeting ended at about 2:30 pm	The Village Chairman thanked the ESIA team for the consultation and the opportunity provided for communities to share their view. He also extended appreciation to the ANSG.

Plate 8.6: Collage of Community Engagement Photos in Aguluezechukwu, Aguata LGA


GPS Map
Camera Lite
Agulezechuku-Ajalli Rd, Ogboji 423114, Anambra,


GPS Map
Camera Lite

Plate 8.7: Collage of Community Engagement Photos in Ogboji, Orumba South LGA

CHAPTER 9 CONCLUSION

The Environmental and Social Impact Assessment (ESIA) for the proposed Special Agro-Industrial Project Zone (SAPZ II) Programme in Anambra State, South-East Nigeria, was conducted in compliance with the relevant regulatory laws in Nigeria. The ESIA identified, evaluated, and predicted the impacts of the proposed project activities on the various biophysical and socio-economic components of the project environment. It also proposed mitigation measures for adverse impacts and enhancement measures for beneficial impacts.

A comprehensive literature review and field measurements were employed to carefully establish and assess the status and sensitivity of the various ecological and socio-economic components at the project locations. If implemented correctly, the accompanying Environmental Management Plan (EMP) provides a framework to achieve acceptable residual impacts from the project.

This project offers several benefits, as Chapter Two of this report details. Broadly, it aims to improve agricultural productivity in Nigeria, contributing to food security, economic diversification, and poverty reduction among rural farmers.

Furthermore, the Anambra State Government is committed to sustainable development, ensuring that environmentally friendly technologies are integrated into the project design to minimise the environmental footprint and associated impacts. The state is also dedicated to enhancing the quality of life for Anambrians, particularly those in rural communities where the project will be implemented.

Given the foregoing, Grim & Green Consult Limited recommends that this report be approved and that the Anambra State Investment Promotion and Protection Agency (ANSIPPA) be issued an Environmental Impact Statement by the Federal Ministry of Environment (FMEnv).

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APPENDIXES

APPENDIX 1: COMPARATIVE SITE ANALYSIS OF MAMU FOREST VERSUS OGBOJI

<table>
<tr><th rowspan="3">S. No</th><th rowspan="3">Critical Success Factor (CSF)</th><th rowspan="3">CSF weight (%)</th><th rowspan="3">Parameters to evaluate the CSF</th><th rowspan="3">Weightage (%)</th><th colspan="4">Anambra State Region</th></tr>
<tr><th colspan="2">Site 1 at Ogboji</th><th colspan="2">Site 2 at Mamu Forest Reserve</th></tr>
<tr><th>Status</th><th>Score</th><th>Status</th><th>Score</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Land status</td><td rowspan="2">15%</td><td>Land area</td><td>5%</td><td>4000 hectares of Land are Allocated for AMIC Development.

Based on the land profile, contours, slope & wind directions, existing rivers & streams including 100m buffer on either side, etc., effective planning area of AMIC will be 3150 Ha with discrete parcels.</td><td>4%</td><td>5000 Hectares of land is allocated for the development of the AMIC. But it should also be noted that the Amansea – Ndiukwuenu – Awa – Ufuma Road cuts through the site. This creates two discrete parcels</td><td>4%</td></tr>
<tr><td>Challenges in the acquisition (if any)</td><td>10%</td><td>Land acquisition is underway, with completion achieved solely for the proposed pharmaceutical district within the designated site area.</td><td>7%</td><td>The Land acquisition is underway for the designated area.</td><td>5%</td></tr>
<tr><td>2</td><td>Connectivity</td><td>25%</td><td>Resource availability</td><td>12%</td><td>Abundant agricultural commodities & mineral resources are found within the state. The State has the following Solid Minerals: Kaolin, Bentonite, Lignite, Iron Stone, Sandstone, Petroleum and Natural Gas, Pyrite and Glass Sandstone, Petroleum and</td><td>10%</td><td>Abundant agricultural commodities & mineral resources are found within the state. The State has the following Solid Minerals: Kaolin, Bentonite, Lignite, Iron Stone, Sandstone, Petroleum and Natural Gas, Pyrite and Glass Sandstone, Petroleum</td><td>10%</td></tr>
</table>

S. No	Critical Success Factor (CSF)	CSF weight (%)	Parameters to evaluate the CSF	Weightage (%)	Anambra State Region			
					Site 1 at Ogboji		Site 2 at Mamu Forest Reserve	
					Status	Score	Status	Score
					Natural Gas, Pyrite and Glass Sand. The following crops are also found across the state: Cassava, Rice, Sesame Seeds, Maize, Yam, Elle Yam, Oil Palm, Vegetable & Fruits, Piggery and Fishery		and Natural Gas, Pyrite and Glass Sand. The following crops are also found across the state: Cassava, Rice, Sesame Seeds, Maize, Yam, Elle Yam, Oil Palm, Vegetable & Fruits, Piggery and Fishery	
			Nearest railhead and its distance from the identified site	2%	The Proposed site is situated within a range of 3-5 km from the Proposed Ekwulobia Railway Station. Furthermore, according to the preliminary railway masterplan submitted, a siding is designated to connect to the Proposed AMIC. (Refer to CPCS Preliminary Alignment Report Option 3 - Phases I and II)	2%	The Proposed site is situated within a range of 15 - 20 km from the Proposed Awka Railway Station. (Refer to CPCS Preliminary Alignment Report Option 3 - Phases I and II)	1%
			Distance from nearest National expressway/highway	6%	The nearest expressway/highway is the Awka – Okigwe Road which is located at a distance of 2.9 km from the site.	6%	The nearest expressway/highway is the Enugu - Onitsha Expressway which is located at a distance of 8.5 km north of the proposed AMIC.	4%
			Nearest airport/seaport and its distance from the site	2%	The nearest airport is the Chinua Achebe International Cargo Passenger Airport which is located at a distance of 48.8 km from the site. An airstrip shall be proposed in the state near the industrial clusters of Nnewi and	1%	The nearest airport is the Chinua Achebe International Cargo Passenger Airport which is located at a distance of 48.8 km from the site. An airstrip shall be proposed in the state near the industrial clusters of	1%

S. No	Critical Success Factor (CSF)	CSF weight (%)	Parameters to evaluate the CSF	Weightage (%)	Anambra State Region			
					Site 1 at Ogboji		Site 2 at Mamu Forest Reserve	
					Status	Score	Status	Score
					AMIC based upon the the availability of the site and feasibility		Nnewi and AMIC based upon the availability of the site and feasibility	
			Nearest urban settlement and its distance from the site	3%	3 km to Ekwulobia Town	3%	10 km to Amansea Town	2%
3	Physical features	10%	Size & shape	4%	Adequate size and irregular in shape.	4%	Adequate size and irregular in shape.	4%
			Topography	6%	Sloping from West to East, which is characterized by a steep slope, Sloping from South to North and is characterized by a fairly gentle slope, Sloping from East to North with a fairly gentle slope. The North region of the site is observed to be relatively flat. Also, the site sits in between two ridgelines that run parallel to the northern and southern boundary of the site. The contour variation is from +60m to +280m	2%	A fairly Gentle Slope is observed in both the parcels. The Eastern Land Parcel is observed to be sloping from East to West towards the Amansea – Ndiukwuenu – Awa – Ufuma Road. The Western Land Parcel is Observed to be Relatively Flat. The Contour Variation is from +50m to +150m	4%
4	Infrastructure availability	20%	Industrial power & network	10%	LT lines are seen along the approach road. One of the potential power sources identified for AMIC project is the establishment of a 150 MVA 330/132 KV substation in Onitsha. This substation	5%	LT lines are seen along the approach road. The power source for the AMIC development is yet to be identified by the Government.	5%

S. No	Critical Success Factor (CSF)	CSF weight (%)	Parameters to evaluate the CSF	Weightage (%)	Anambra State Region			
					Site 1 at Ogboji		Site 2 at Mamu Forest Reserve	
					Status	Score	Status	Score
					would include a double-circuit 132 KV line extending from Onitsha to the AMIC near Ogboji. Additionally, 2x60 MVA 132/33 KV substations will be installed to meet the power needs of the AMIC. These installations are planned to be implemented as part of the first phase of the Light-up Anambra Project.			
			Water for industrial use	5%	Groundwater can be tapped using Boreholes and can be relied on the Surface Water resources in the vicinity. Hydrological test shall be carried out for the surface water and Yield reports have to studied for the boreholes	5%	Groundwater can be tapped using Boreholes.	3%
			Sewerage disposal & stormwater disposal point	5%	Sewerage will be treated and recycled. A drain facility needs to be planned to facilitate stormwater disposal	3%	Sewerage will be treated and recycled. A drain facility needs to be planned to facilitate stormwater disposal	3%
5	Environment and social considerations	15%	Environmental considerations	8%	Mamu Reserve Forest is located at a distance of 27.5 km from the Proposed AMIC. Also Ahommiri river, Otalu River, Ubo River, Ezegu River Kpoko stream runs in the delineated area. Ugboji rice farm, Otalu sand	4%	The Proposed AMIC itself located in a Reserve Forest. The Government has initiated plans to change the land use title name from Reserve Forest for Urbanization (New Awka 2.0).	0%

S. No	Critical Success Factor (CSF)	CSF weight (%)	Parameters to evaluate the CSF	Weightage (%)	Anambra State Region			
					Site 1 at Ogboji		Site 2 at Mamu Forest Reserve	
					Status	Score	Status	Score
					mining area and Oderembionwu Lake is also seen within the delinated area.		This violates the World Bank's Environmental and Social Standard 6 for Biodiversity Conservation and Sustainable Management of Living Natural Resources, as it fails to meet the objective of protecting and conserving biodiversity and habitats	
			Development regulations and restrictions	4%	Development can be planned in compliance with the regulations	3%	Development cannot be planned in compliance with the regulations as the site itself falls within the reserve forest area	0%
			Surrounding areas and neighbourhood influence	3%	The Proposed AMIC is surrounded by towns almost on all sides. Ajalli Town is located at the east, Ekwulobia and Aguata Towns is seen to west, Oko Town is seen to the North of the site and the Approach Road, Private Lands and Few Settlement are Observed on the south of the site.	1%	It was observed that some of the portion of the designated area is located in Enugu State. Also the Northern Periphery of the site is also seen bordering with the Enugu State. Also the Entire site is thickly vegated with dense forest. Towns of Ndiobani, Mamu and Od are observed south of the site	1%
6	Business considerations	15%	Presence of competing facilities	5%	The Lions Business Park (FTZ) in Enugu State is located at a distance of 85.5 km, the AHL Energy Free Zone in Delta State is Located at a distance of 143	3%	The Lions Business Park (FTZ) in Enugu State is located at a distance of 58 km, the AHL Energy Free Zone in Delta State is Located at a distance of 148	3%

S. No	Critical Success Factor (CSF)	CSF weight (%)	Parameters to evaluate the CSF	Weightage (%)	Anambra State Region			
					Site 1 at Ogboji		Site 2 at Mamu Forest Reserve	
					Status	Score	Status	Score
					km, the Bundu Free Zone Located in Rivers State, GC Export Industrial Park in the Kogi State, Delta Special Economic Zone (Zone Under Construction), Premier Industrial FTZ in Rivers State (Zone Under Construction). Nnewi Automobile Companies are located at a distance of 28 - 30 km from the Proposed AMIC. Other Industries like Finoplast, Plastic Industries are seen in Awka which is at a distance of 45 - 50 km from the site		km, the Bundu Free Zone Located in Rivers State, GC Export Industrial Park in the Kogi State, Delta Special Economic Zone (Zone Under Construction), Premier Industrial FTZ in Rivers State (Zone Under Construction). Nnewi Automobile Companies are located at a distance of 52 -55 km from the Proposed AMIC. Other Industries like Finoplast and plastic Industries are seen in Awka which is at a distance of 15 - 20 km from the site.	
			Presence of complementing facilities	5%	Ljime Stone Quary is located at a Distance of 45 km in Enugu State. ATCs are proposed in Ogbunka-Ufuma, Omor and Ebenebe. Also, proximity to Oil Refineries. The Cattle markets and slaughterhouses are located in Awka	3%	Ljime Stone Quary is located at a Distance of 33 km in Enugu State, ATCs are proposed in Ogbunka-Ufuma, Omor and Ebenebe. The nearest slaughterhouses and Cattle Market is Located in Awka.	2%
			Supporting business environment	5%	Available in the near vicinity	4%	Available in the near vicinity	4%
Total		100%	Total	100%	Site 1 at Ogboji	70%	Site 2 at Mamu Forest Reserve	56%

Inference: According to the data presented in the table, it can be concluded that ***Site 1 in Ogboji*** is the preferred location for the development of the AMIC. Due to certain limitations at the Ogboji site, proposing an airstrip within the site is not feasible due to site constraints. A detailed report on airstrip considerations has been annexed in the Annexure.

Source: ANSG (2024)

APPENDIX 2: CONFIRMATION OF LABORATORY ANALYSIS OF SAMPLES

RC: 1631540
MOZUK SCIENTIFIC & ANALYTICS LABORATORIES LTD
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MSAL/ABJ/69/75/24

21st August, 2024

The Chief Executive Officer,
Grim & Green Consult Limited
Suite F12, Milipat Plaza, Abuja

LABORATORY RESULTS OF GROUNDWATER, SURFACE WATER, SEDIMENT, SOIL, AND HYDROBIOLOGICAL SAMPLES FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR SPECIAL AGRO-INDUSTRIAL PROCESSING ZONE IN ANAMBRA STATE

Sample Received: Eight (8) Groundwater, Twelve (12) Surface Water, Four (4) Sediment, Fifty Six (56) Soil, Eight (8) Plankton and Four (4) Benthos Samples

Date Received in the Laboratory: 16/07/2024 and Analysis commenced 17/07/2024

Packaging: Samples were collected into airtight containers and materials with their site identification numbers and labels

Sample Location: Omor (OM) at Ayamelum LGA, Ogboji (OGB) at Orumba LGA, Ogbuke (OGK) at Orumba South LGA and Ugbene (UG) at Awka North LGA in Anambra State

Laboratory No: MSAL/89/23/38/Lab/NG/GW1-3/SW1-9/SED1-9/SS1-40

Test Procedure: Standard Methods for the Examination of Water and Wastewater; American Public Health Association (APHA) 24th Edition and American Society for Testing and Materials(ASTM) Standard for Soil Testing

Regulatory Limit Quoted: Federal Ministry of Environment National Guidelines and Standards for Water Quality in Nigeria 2009

I hereby certify that we have analyzed the above-described samples in the condition we received them, following due diligence and best laboratory practices. Kindly find the laboratory analysis results for the groundwater, surface water, sediment, soil, plankton and benthos samples presented on pages 2 to 25, followed by the relevant observations.

THE INSTITUTE OF PUBLIC ANALYSTS OF NIGERIA (IPAN)
IPAN REGISTERED CERTIFICATE
INSTITUTE OF PUBLIC ANALYSTS OF NIGERIA
P/L No.: 008236

Mrs. Farida O. Bello
Public Analyst

Safebrooks

APPENDIX 3: SOCIO-ECONOMIC AND HEALTH ASSESSMENT QUESTIONNAIRE

Dear Respondent,

We would like your kind assistance in answering the following questions as correctly as possible about a proposed construction of agricultural facilities in your community. Please note that your participation is strictly voluntary. You may choose to terminate your participation at any point or refuse to participate at all. We assure you that any information you supply shall be treated with strict confidence under the Nigeria Data Protection Regulation (NDPR) 2019.

Thank you for your understanding and support.

Name of Settlement/Community: ……………………………

L.G.A/State: ……………………………………………………

Interviewer: …………………………………………………..

Date: …………………………………………………………..

Please tick as an appropriate response where applicable

DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

QUESTIONS	RESPONSE		Write the number here
1. Sex	1) Male	2) Female	
2. Actual Age	……………………………………………		
3. Education	1) No formal education 2) Primary 3) Secondary	5) OND/NCE 6) HND/B.Sc 7) Postgraduate certificate	
4. Religion	1) None 2) Christianity 3) Islam	4) Traditional 5) Others (Pls specify)	
5a. Marital Status	1) Never married 2) Married	3) Separated/Divorced 4) Widowed	
5b. If married, what is the marriage type?	1) Monogamy (only one spouse) 2) Polygyny (one manwith two or more wives)	3) Polyandry (One woman with two or more husbands)	
6. Ethnic Group	1) Igbo 2) Igala 3) Hausa	4) Bini 5) Yoruba 4) Others (pls specify)	
7. What is the nature of the apartment wherein you stay?	1) A single room 2) Room and parlour	3) Flat 4) Duplex 5) Others (pls specify)	

8. How many peopleincluding you stay in your household?	....

9. Why are you in this community?

Purpose in the community	Please Tick
Living in the community	
Working in the community	
Living and working in the community	
Other (specify)	

10. For how long have you been living in the community?

..

11. Residency Status

Status of Resident	Please tick the option that applies to you
Landlord	
Tenant	
Living in family house without rent payment	
Other (specify)	

12. Income Source

INCOME SOURCE		₦
Agriculture	Crop farming	
	Livestock sales	
	Crop, vegetable, fruit sales	
	Animal products' sales	
	Other (specify)	
Employment (non-farm)	Civil service	
	Private sector	
	Self-employment: petty trading (hairdresser, seamstress, carpenter etc), sale of handicrafts	
Other income sources	Pensions	
	Housing and land rent	
	Other income sources (specify)	
ESTIMATED TOTAL MONTHLY INCOME		

13A. Buildings/structures (more than one option/material is possible)

Building Type	Frequency	Number
Which of the followings describe the type of building wherein you live?	1) Mud wall un-plastered with thatch roof 2) Mud wall un-plastered & zinc roof 3) Mud wall plastered with cement & zinc roof 4) Cement block wall un-plastered & zinc roof 5) Cement block wall plastered & zinc roof	

13B. Toilet facilities:

Kindly indicate the toilet type in your house	Please tick
No toilet	
Pit latrine	
Water Closet toilet	

14. Expenditure

Indicate the effect of the following expenditure items on your family income over the past year (Multipleoptions are allowed)

Item	Very strong effect	Strong effect	Minor effect	No effect
Food				
Education				
Health				
Transport				
Hire of labour				
Other (specify)				

15. Which ailments have persons in your household suffered from in the past 1 year? (Multiple optionsare allowed)

Illness	Please Tick
Malaria	
Cough / lung problems	
Diarrhea	
Skin infection	
Sexually transmitted disease	
Eye disease	
Tooth ache	
Cholera	
Fever	
Birth complications (women)	
Other (specify) …………………………………………	

16. Where do you normally seek help when a member of your household is sick?

Facility	Please Tick
Government hospital	
Private health facility	
Traditional healer	
Chemist/pharmacy	
Self-medication (orthodox or herbs)	
Others (Specify)	

17.* Where does your household get water from? *(more than one answer may be given)

Source	Drinking/Cooking,	Washing, / Others
Borehole		
Well		

Rain collected at Homestead		
River /spring		
Water sold by other people		
Other (specify)		

18. Source of fuel or energy for cooking

Source	Please
Electricity	
Gas	
Charcoal	
Wood	
Other (specify)	

19. Are you in favour of the project? Yes: _________________ No:_________________

20. In your own words, tell us how you are in favour or against the project.

21. Are you or anyone in your immediate family live with disability? Yes__________ No___________

22. If yes, what is the nature of the disability?

23. How do you think the Agricultural Transformation Center (ATC) could better accommodate individuals with disabilities?

24. What specific services or resources would be beneficial for individuals with disabilities in the community?

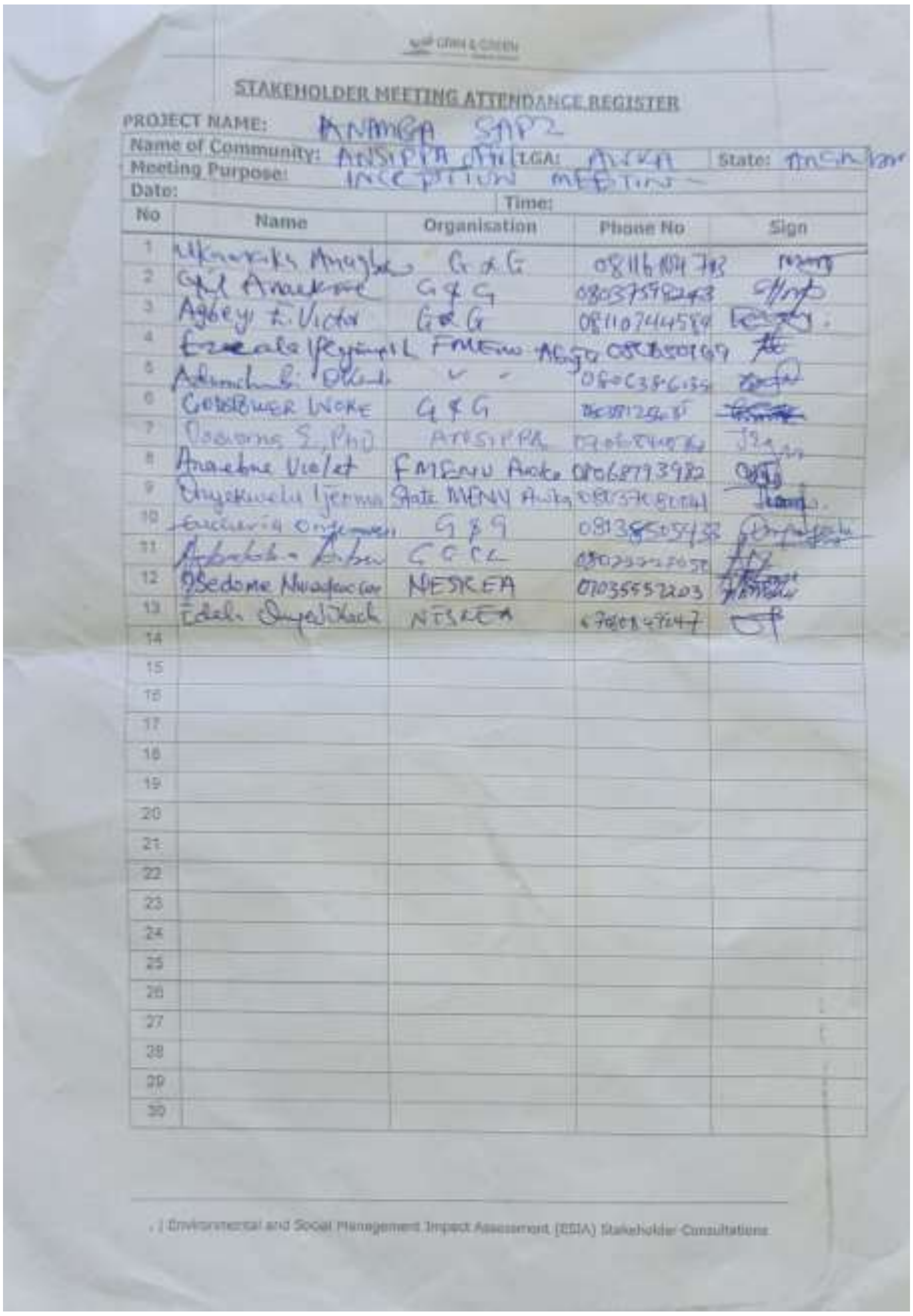
25. Are there any barriers you or your family face in accessing agricultural resources or support?

26. What strategies have been effective in helping individuals with disabilities participate in community activities?

27. How can we ensure that the Agricultural Transformation Center promotes inclusivity for all community members?

APPENDIX 4: ATTENDANCE SHEETS

4.1 Inception Meeting Attendance Sheet



GRIN & GREEN

STAKEHOLDER MEETING ATTENDANCE REGISTER

PROJECT NAME: ANAMBRA SAPZ
Name of Community: ANSIPPA [illegible] LGA: AWKA State: Anambra
Meeting Purpose: INCEPTION MEETING
Date:
Time:

No	Name	Organisation	Phone No	Sign
1	Ukwuoma [illegible] Anagba	G & G	08116104783	[illegible]
2	[illegible] Anaekwe	G & G	08037598243	[illegible]
3	Agbey E. Victor	G & G	08110744589	[illegible]
4	Ezeala Ifeyinwa L	FMEnv Abuja	08[illegible]50149	[illegible]
5	[illegible]	✓ "	080[illegible]38[illegible]6135	[illegible]
6	Goodbwer Woke	G & G	[illegible]	[illegible]
7	Osabomo S. PhD	ANSIPPA	[illegible]	[illegible]
8	Anaebue Violet	FMEnv Awka	07068773982	[illegible]
9	Onyekwelu Ijeoma	State MENV Awka	0803[illegible]	[illegible]
10	Eucharia Onyemen	G & G	08138505438	[illegible]
11	[illegible]	G C C L	0802[illegible]058	[illegible]
12	Obedome Nwadinobi	NESREA	07035552203	[illegible]
13	Edeh Onyedikachi	NESREA	[illegible]4 9247	[illegible]
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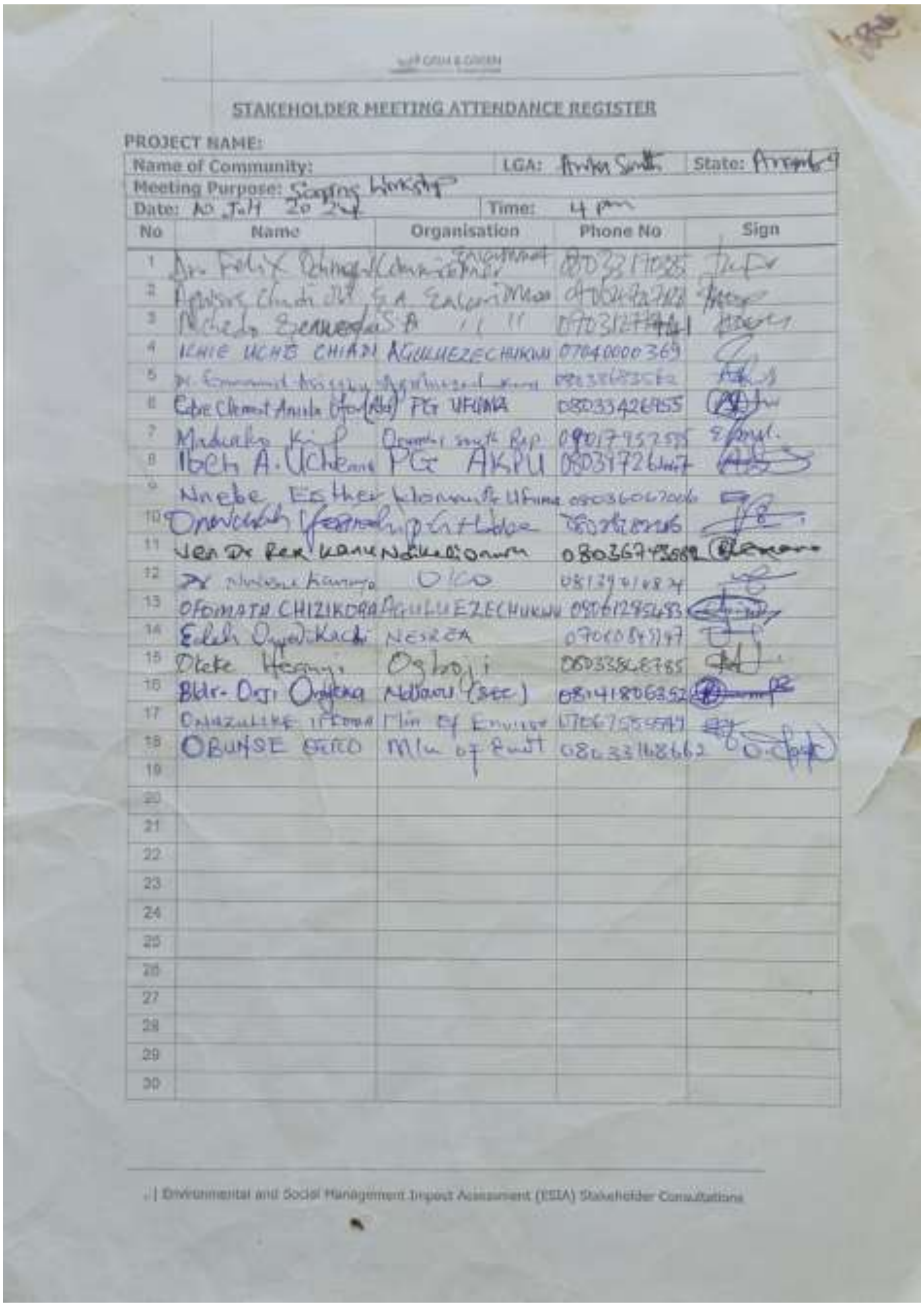
| Environmental and Social Management Impact Assessment (ESIA) Stakeholder Consultations

4.2 Scoping Workshop Attendance Sheet



STAKEHOLDER MEETING ATTENDANCE REGISTER

PROJECT NAME:

Name of Community:	LGA: Anaocha South	State: Anambra
Meeting Purpose: Scoping Workshop		
Date: 10 July 2024	Time: 4 pm	

No	Name	Organisation	Phone No	Sign
1	Dr. Felix Ochinga Kamarizenga	Enyemma...	08033171035	
2	[illegible] Chudi	S.A. Enlogn Mgt	[illegible]	
3	Nkechi Ezenwafa	S.A. " "	0703127[illegible]	
4	IKHIE UCHE CHIADI	AGULUEZECHUKWU	07040000369	
5	Dr. Emmanuel [illegible]	[illegible]	[illegible]	
6	Ebe Clement Anula Ufor (Abu)	PG UFUMA	08033426955	
7	Madueke Kil	Onamiri south Rep	09017757555	
8	Ibeh A. Ucheana	PG AKPU	0803172[illegible]	
9	Nnebe Esther	Woman Pr Ufuma	08036067006	
10	Onwuchekwa [illegible]	[illegible]	[illegible]	
11	Ven Dr Rex Kanu	Ndikelionwu	08036749588	
12	Dr [illegible]	OICO	08129414874	
13	OFOMATA CHIZIKORA	AGULUEZECHUKWU	08061295483	
14	Edeh Oyedikachi	NESREA	07010843147	
15	Oteke Henry	Ogboji	08033868785	
16	Bldr. Orji Onyeka	Ndiowu (Sec)	08141806352	
17	ONUZULIKE IFEOMA	Min of Environ	07067555547	
18	OBUNSE OTITO	Min of Envt	08033148662	
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| Environmental and Social Management Impact Assessment (ESIA) Stakeholder Consultations

CIMA & GREEN

STAKEHOLDER MEETING ATTENDANCE REGISTER

PROJECT NAME:

Name of Community:	LGA: Anka South	State: Anambra
Meeting Purpose: Scoping Workshop		
Date: 10 July 2024	Time: 4 pm	

No	Name	Organisation	Phone No	Sign
1	NKEIRU MOKWE [illegible]	MIN OF LANDS	08037252919	
2	Omejuch Nipai		08063014360	
3	Uchenna Ogbonna	Ndikelionwu	08064582655	
4	Samuel Ike	Ndikelionwu	07037735248	
5	Hon Fabian Nwoko	Ndikelionwu	08107783004	
6	Comrade Ken Okoli	PG Ihitenansa [illegible]	08122988897	
7	Comrade Nnebe Chuck	ASATU Youth Lead	07038275[illegible]	
8	Mazi Chikwendu [illegible]	PG Ndiukwuenu [illegible]	08033[illegible]539	
9	Capt Casmir Nwafor [illegible]	DG Okpo TC Ihitenansa [illegible]	08036760955	
10	Moruah Safr [illegible]	PG OMOR	08037833[illegible]	Rep
11	Hon Alphonsus Ofumelu	TC Chairman Ayamelum	08022880462	
12	Onwuka Michael	Rep TC Chairman Ayamelum	08035524646	
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| Environmental and Social Management Impact Assessment (ESIA) Stakeholder Consultations

Appendix 4.3 Consultation Attendance Sheet at Ugbene (1 of 3)

30 May 2024

	NAME	VILLAGE	PHONE NUMBER	SIGNATURE
1	Nnalue Amoue Isaac		08109210727	
2	Okoye Ugochukwu	Ifiteora		
3	Okonkwo Longinus	Umuan[illegible]	0864504397	
	Ohandi Okeke	Ifiteora	08141399187	
4	Linus Mbaonu	Umualor	09070592984	
5		Ifiteora	09018227523	
6	Martha Okafor			
7	Hillary Ozuah	Umuagunwoke	081219747827	
8	Francis Okafor	Ifiteora		
9	Maureen Anyaka	Umualor		
10	Nnadume Nweke	Umuagunwoke	09070092917	
11	Ezekiel Nwankwo	Ifiteora	09074841758	
12	Jerimaih Egbuka	Ifiteora	09022751240	
13	Francisca Anialo	Ifiteora	09122169619	
14	Theresa Okoye	Umuemem	08033998560	
15	Wilfred Anyaegbunam	Umuemem		
16	Uzochukwu Mgbemfulu	Umuagunwoke	08135101144	
17	Anthony Chukwuma	Umuagunwoke		
18	Dickson Nze	Ifiteora		
19	Christopher Nweke	Ifiteora		
20	Fidelis Ozuah	Umuagunwoke	07050588266	
21	Christian Mgbemfulu	Umuagunwoke	08763056983	
22	Kingsley Onyi	Umualor	08109014355	

Consultation Attendance Sheet at Ugbene Continues (2 of 3)

Ugben Town 30 July 2024

SN	Name	Village	Phone	Sign
23	Joseph Nmadi	Ifiteora		
24	Levi Egbuka	Ifiteora	09090529071	
25	Ifeoma Aniekezie	Umualor	07019082587	
26	Ikechukwu Nwachukwu	Umualor	08080844372	
27	Hellen Ibe	Ifiteora	07082662302	
28	Glory Nathaniel	Ifiteora		
29	Leticia Ikeyina	Ifiteora		
30	Justina Umenyelu	Umuemem		
31	Edina Obodo	Emagu		
32	Theresa Agbata	Emagu		
33	Agatha Okoye	Umualor	09079731769	
34	Comfort Chukwuma	Umualor	08126103044	
35	Nwaokwulu Chinwendu	Ebonyi State		
36	Ngozika Chinwuba	Aguluezi		
37	franca Obodo	Emagu		
38	Amaechi E Agbatue	Ifiteora	08165219007	
39	Sunday Agbatue Lambert	Ifiteora	08027333023	
40	OKAFOR Pascal Onduka	Ifiteora	09076577841	
41	Blessing Chima	Umualor		
42	Agnes Okoye	Umuemem		
43	Jecinta Anieke	Umualor		
44	Stella Onyi	Umualor		
45	Bridget Agbatue	Ifiteora		
46	Mary Ozuah	Ummaguonwoke		
47	Simeon Ainyelu	Umuanukwam		
48	Samson Okoye	Ifiteora	08089703781	

Consultation Attendance Sheet at Ugbene Continues (3 of 3)

Ugbene Town 3rd July 2024

	Names	Village	Phone No
47	Ijeoma Omoro	Emagu	
48	Pelience Agbatue	Ifiteora	
49	Eastha Nnechi	Umuemen	
50	Josephine Amadubuko	Emagu	
51	Mary Ann Ekweazu	Umuemen	
52	Eucharia Ikeyima	Ifiteora	
53	Damian Chimaka	Umualor	
54	Eucharia Agbatue	Ifiteora	
55	Felicia Nwafor	Ifiteora	
56	Cathrine Ndife	Emagu	
57	Anastecia Okoye	Umuemem	
58	Hellen Aniemeke	Umualor	
59	Lovelyn Ikeyima	Ifiteora	
60	Jeorgina Okafor	Umualor	
61	Okechukwu Offor	Umualor	
62	Ifeanyi Okafor	Umualor	
63	Michael Chima	Umualor	
64	Jonas Onyigbo	Umualor	
65	Anthonia Anyaka	Umualor	
66	Zippark Uchenny	Umueme	
67	Benjamine Egbuke	Ifiteora	
68	Chiemelie Egbuke	Ifiteora	
65	Ogbonnaya Egbuke	Ifiteora	
66	Obinna Agbatue	Ifiteora	
67	Patience Okoye	✓	
68	Clara Okeke	✓	
69	Blessing Izuchukwu	✓	
70	Pauline Okonie	Umualor	
71	William Nwabueze	Ifiteora	
72	Mbanugo Okeke		

Appendix 4.4 **Public Consultation Attendance Sheet at Omor (1/3)**

	Name (Youth Leader [illegible])	Village	Date	Phone	Sign
1	Comr. Nweke Chinedu [illegible]	Igbakwu	29/07/24	07038275680	
2	Chief Joseph Moneh	Isiokwe	29/7/24	08166560333	
3	Comr. Clement Onwuachu	Isiokwe Omor	29/07/24	07046627884	
4	Mezeh John C	Isiokwe	29/7/24	08037 8668	
5	Nwoke Anekwe	Isi-okwe	29/7	—	
6	Nwosu Nwankwo	"	"	"	
7	Okonkwo Nnamdi	"	"	"	
8	Nwadikolu Okonkwo	"	"	"	
9	Nwaneke Onyeagolu	Isi-okwe	29/7	"	
10	Nwadiogbu Chinwendu	Isi-okwe	29/7	"	
11	Agbata Bernard	"	29/07	"	
12	Uchegbu Ikwunne	Isi-okwe	29/7	~~08[illegible]~~	
13	Chiamogwu Onubuenyi	Isi-okwe	29/7	—	
14	Dingelu Chinwendu	"	"	—	
15	Osinachi Christopher	"	"	07069137547	
16	Obiorah Anumudu	"	"	07032434653	
17	Nwonyelu Godwin	"	"		
18	Anekwe Dennis	"	"	08107025804	
19	Ugwuanyi Ikemefune	"	29/7	08146115343	
20	Okonkwo Okoye	"	29/7		
21	Okoye Israel	Isi-okwe	29/7		
22	Okafor Anekwe	"	"	08108415055	
23	Nnebife Ikechukwu	Isi-okwe	29/7	09064783438	
24	Nwankwo John Paul	Isi-okwe	29/7	08140259280	
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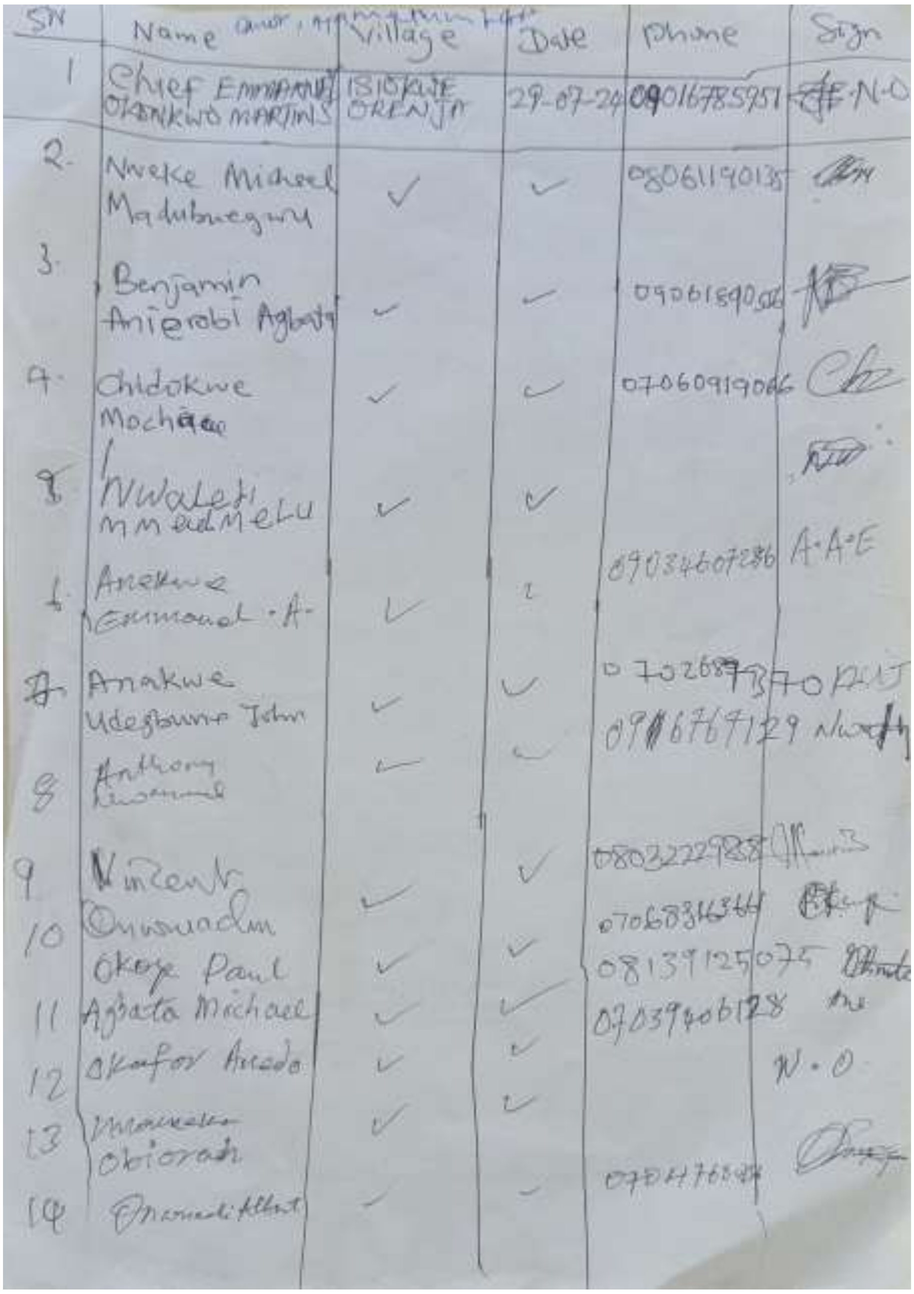
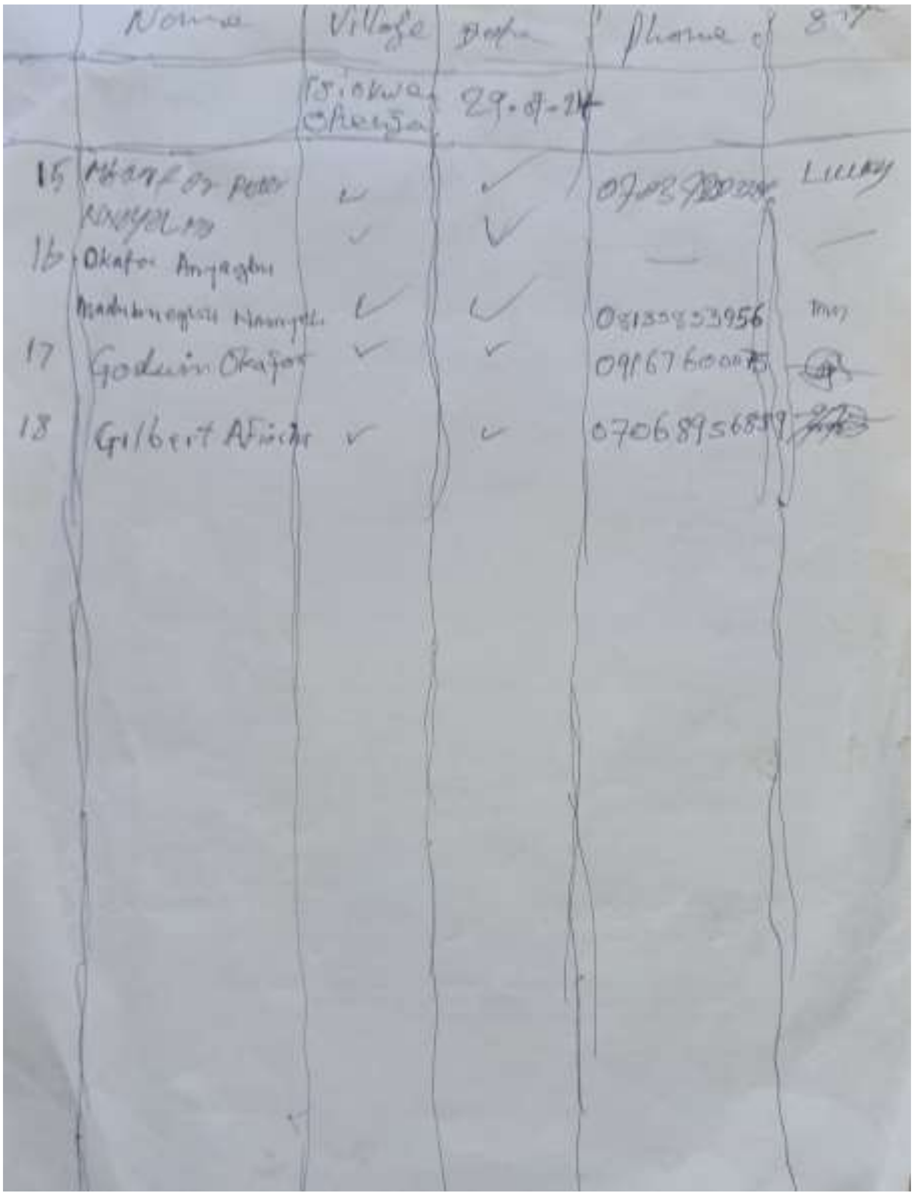
Consultation Attendance Sheet at Omor Continues (2 of 3)



SN	Name	Village	Date	Phone	Sign
1	Chief Emmanuel Okonkwo Martins	Isiokwe Orenja	29-07-24	09016785951	N.O
2.	Nweke Michael Madubuegwu	✓	✓	08061190135	
3.	Benjamin Anierobi Agbata	✓	✓	09061890[illegible]	
4.	Chidokwe Mochaa	✓	✓	07060919066	
5	Nwaleti Mmeedmelu	✓	✓		
6.	Anekwe Emmanuel .A.	✓	✓	09034607286	A.A.E
7.	Anakwe Udegbunam John	✓	✓	07026897370	
8	Anthony [illegible]	✓	✓	0916767129	
9	Vincent Onwuadum	✓	✓	08032229888	
10	Okoye Paul	✓	✓	07068316344 / 08139125075	
11	Agbata Michael	✓	✓	07039406128	
12	Okafor Amedo	✓	✓		W.O
13	[illegible] Obiorah	✓	✓		
14	Onwuneli Albert	✓	✓	0704476[illegible]	

Consultation Attendance Sheet at Omor Continues (3 of 3)



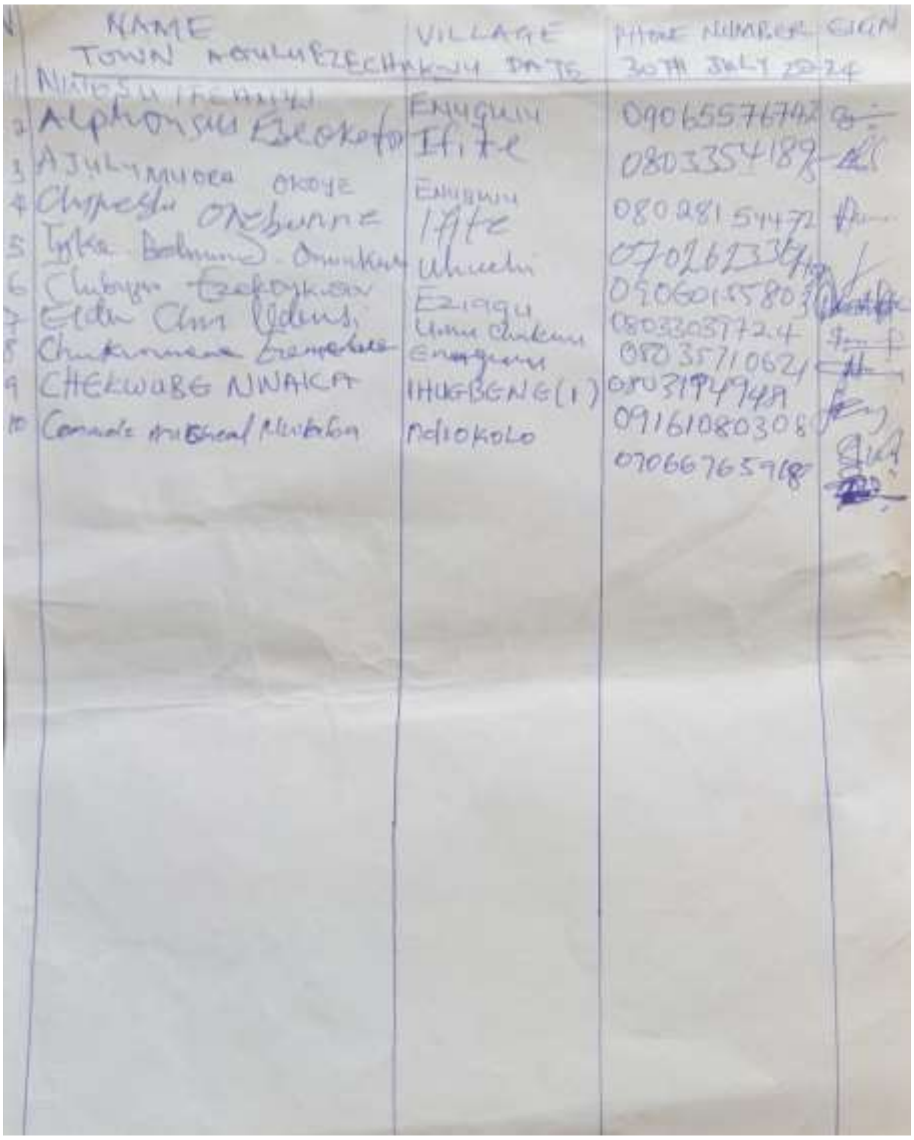
	Name	Village	Date	Phone	Sign
		Isiokwa Okeyia	29-8-24		
15	[illegible] Peter Nnaegbuna	✓	✓	0708[illegible]	[illegible]
		✓	✓	—	—
16	Okafor Anyaegbu				
	[illegible] Nwaegbu	✓	✓	08135853956	[illegible]
17	Godwin Okafor	✓	✓	09167600075	[illegible]
18	Gilbert Afiache	✓	✓	07068956859	[illegible]

Appendix 4.5 Public Consultation Attendance Sheet at Aguluezechukwu (1of2)

TOWN AGULUEZECHUKWU 30TH JULY 2024

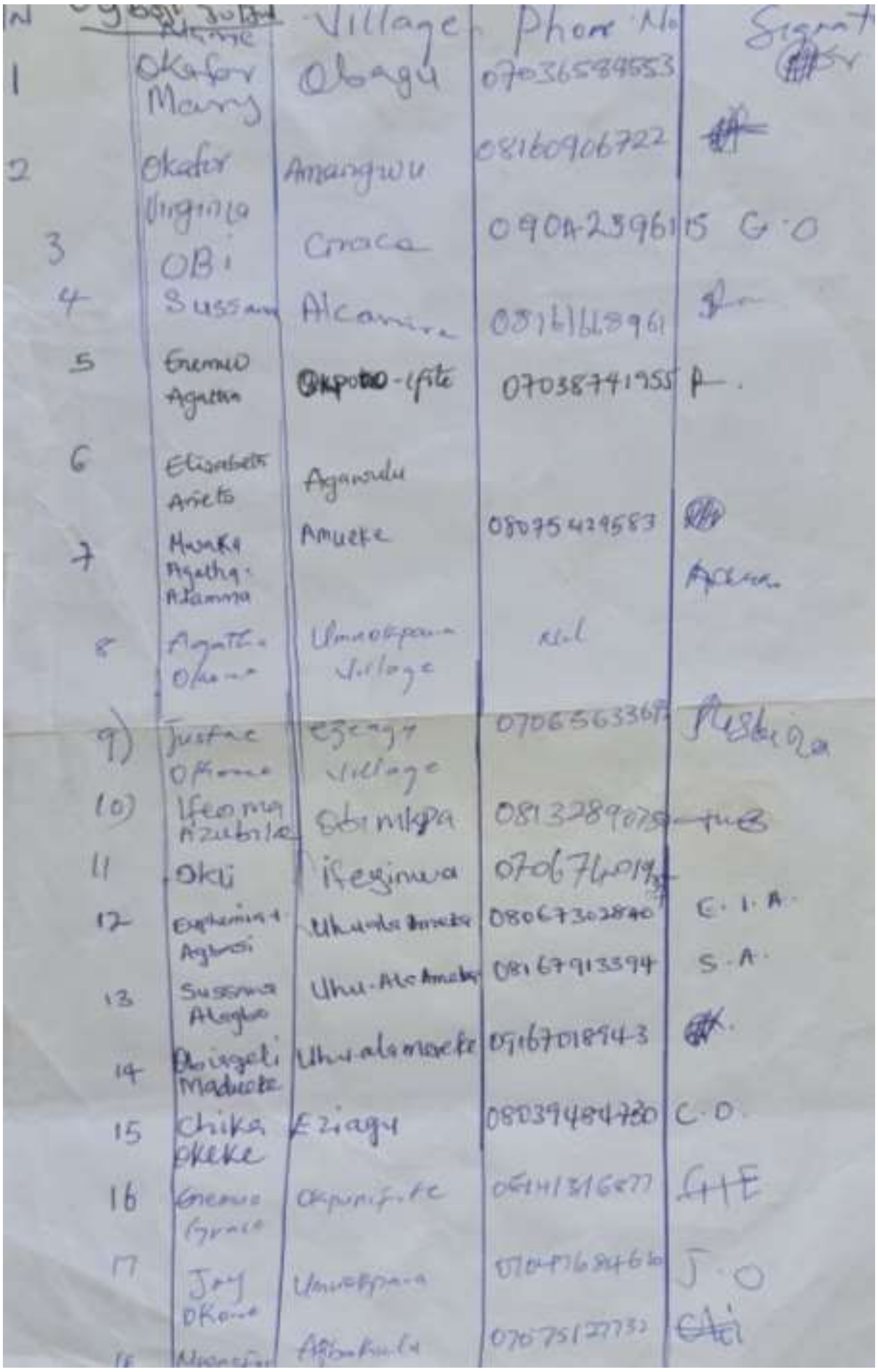
N	NAME	VILLAGE	PHONE NUMBER	SIGN
1	BENJAMIN [illegible] IFEOMA	ENUGU VILLAGE	08062733860	
2	CHIKELUE EZENWANNE	Ifite village	09068[illegible]784	
3	Onyemachukwu Tochukwu	Ozala village	08062587190	
4	Amaje Ezeilo	Ezeagu village	08132830602	
5	CHIADI Ekpereka. C	OZALA village	081885[illegible]	
6	Nnadozie Chigozie[illegible]	OZALLA village	0814[illegible]	
7	[illegible] Izuchukwu J	Enugu village	08140024815	
8	Christopher Okafor	Ifite Village	09071996338	
9	Ezenwa E-Okolie	Ozala	080 60358429	
10	FRANK Ezimmegwu	Umuokpala kabah	08038554890	
11	Ezeifedobi Donatus	Ezeiagu	08163733236	
12	Nwokedi Ifeanyi	Ukwuelu	08038677995	
13	Kenechukwu Obi	Ozalla village	08037121478	
14	Ahato Theresa	Ifite village	08139250794	
15	Ilechukwu John	Ifite Village	07064388934	
16	Ejiofor Stella	Ifite Village	09046473471	
17	Obita Okoronkwo	Ifite village	07061835970	
18	Onyeka Sebastine	Enugu village	0706501604	
19	Osita Ogochukwu	Ifite village	08138181908	
20	Ugochukwu Nnamne	Ifite Village	08162292411	
21	Uchenna Ezeomon	Ifite Village	07067225118	
22	Ofoma Gabriel. C.	Ezeagu Village	NIL	
23	Francis Ezekiel	Ezeagu Village	08145417066	
24	NDA Benson -N Ogoyekwu	Umuemodoh	08121534719	
25	Nwadobulike Benjamin	Ezeagu village	07063632579	

Consultation Attendance Sheet at Aguluezechukwu Continues (2of 2)


TOWN AGULUEZECHUKWU DATE 30TH JULY 2024

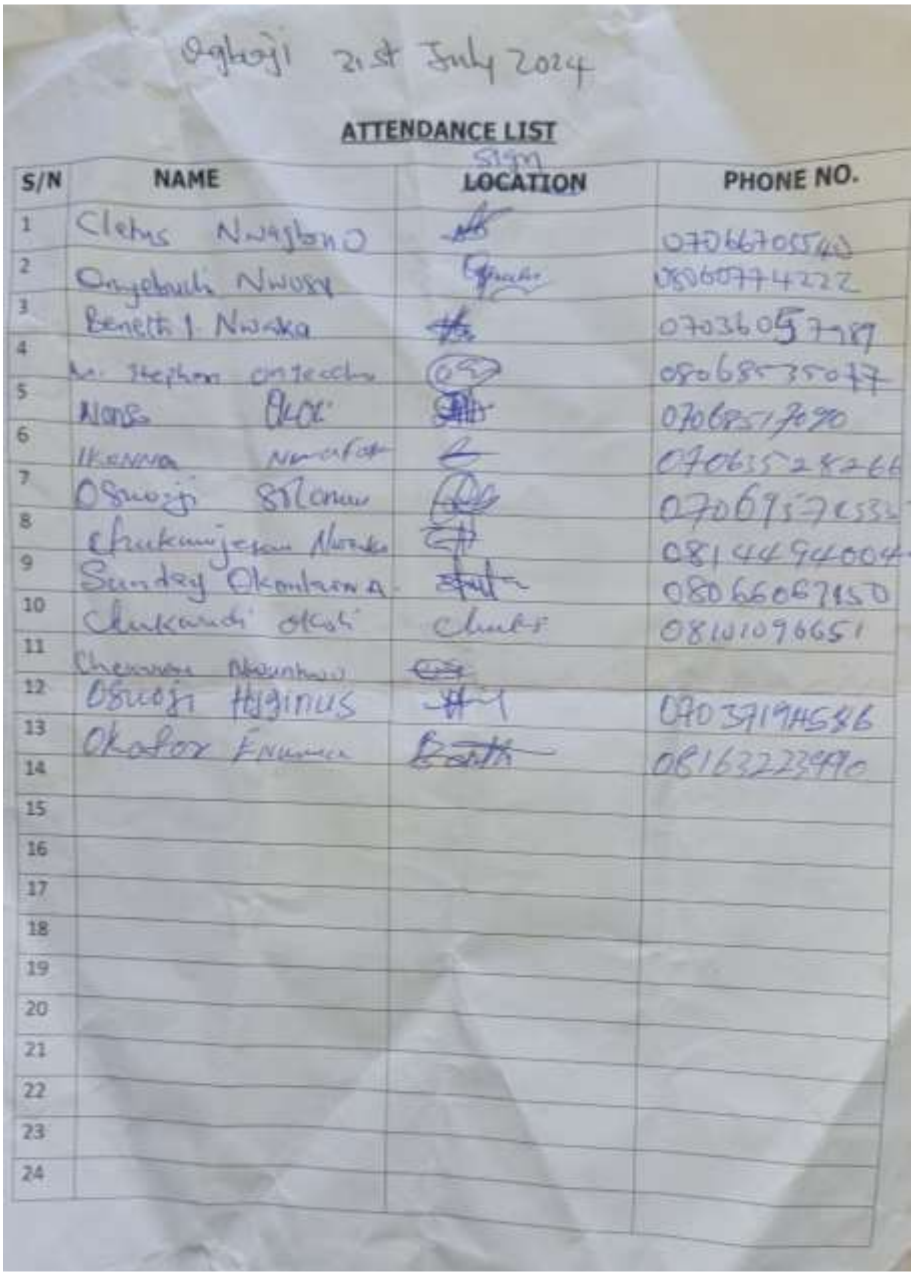
N	NAME	VILLAGE	PHONE NUMBER	SIGN
1	[illegible]			
2	Alphonsus Ekekefo	Enugwu Ifite	09065576742	[signature]
3	AJULUMUOBA OKOYE		08033541898	[signature]
4	Chigozie Okwunne	Enugwu Ifite	08028154472	[signature]
5	Ifeka Edmund Onwukwe	Umuezu	0702623349	[signature]
6	Chibuzor Ezekokwu	Eziagu	09060155803	[signature]
7	Elder Chris Udeh	Umu Chukwu	08033037724	[signature]
8	Chukwuemeka Ezenwelu	Enugwu	08035710621	[signature]
9	CHEKWUBE NWAKA	IHUGBENE (I)	0803194948	[signature]
10	Comrade [illegible]	Ndiokolo	09161080308	[signature]
			07066765918	[signature]

Appendix 4.6 Public Consultation Attendance Sheet at Ogboji (1of2)



SN	Name	Village	Phone No	Signature
1	Okafor Mary	Obagu	07036589553	
2	Okafor Virginia	Amangwu	08160906722	
3	OBI	Grace	09042396115	G.O
4	Sussan	Alcamira	08161168961	
5	Enemuo Agatha	Okpoto-ifite	07038741955	A.
6	Elizabeth Aneto	Aganudu		
7	Nwankwo Agatha Adamma	Amueke	08075429583	Agatha
8	Agatha Okoro	Umuokpara village	nil	
9)	Justina Ofomma	Ezeagu village	07065633697	Ngozi
10)	Ifeoma Azubike	Obinikpa	08132890759	
11	Okli	Ifeginwa	0706760194	
12	Euphemia Agbasi	Uhuala Ameke	08067302840	E.I.A.
13	Sussana Alagbo	Uhu-Ala Ameke	08167913394	S.A.
14	Abigail Maduake	Uhu-ala-meke	09167018943	
15	Chika Okeke	Eziagu	08039484780	C.O.
16	Enemuo Grace	Okpunifite	08141316877	G.E
17	Joy Okonkwo	Umuokpara	07047684616	J.O
18	[illegible]	Afobukwu	07075127731	

Consultation Attendance Sheet at Ogboji Continues (2 of 2)



Ogboji 21st July 2024

ATTENDANCE LIST

S/N	NAME	Sign LOCATION	PHONE NO.
1	Cletus Nwagbo		07066705540
2	Onyebuchi Nwosu		08060774222
3	Beneth I. Nwaka		07036057787
4	Mr. Stephen Onyeachu		08068535077
5	Nonso Okoye		07068517090
6	Ikenna Nwafor		070635282644
7	Osuoji Stanley		0706957053[illegible]
8	Chukwujekwu Nwaka		08144944004
9	Sunday Okonkwo A.		08066067150
10	Chukwudi Okoli	Chuks	08101096651
11	Chinonso Nwankwo		
12	Osuoji Hyginus		07037194586
13	Okafor Emma		08163223990
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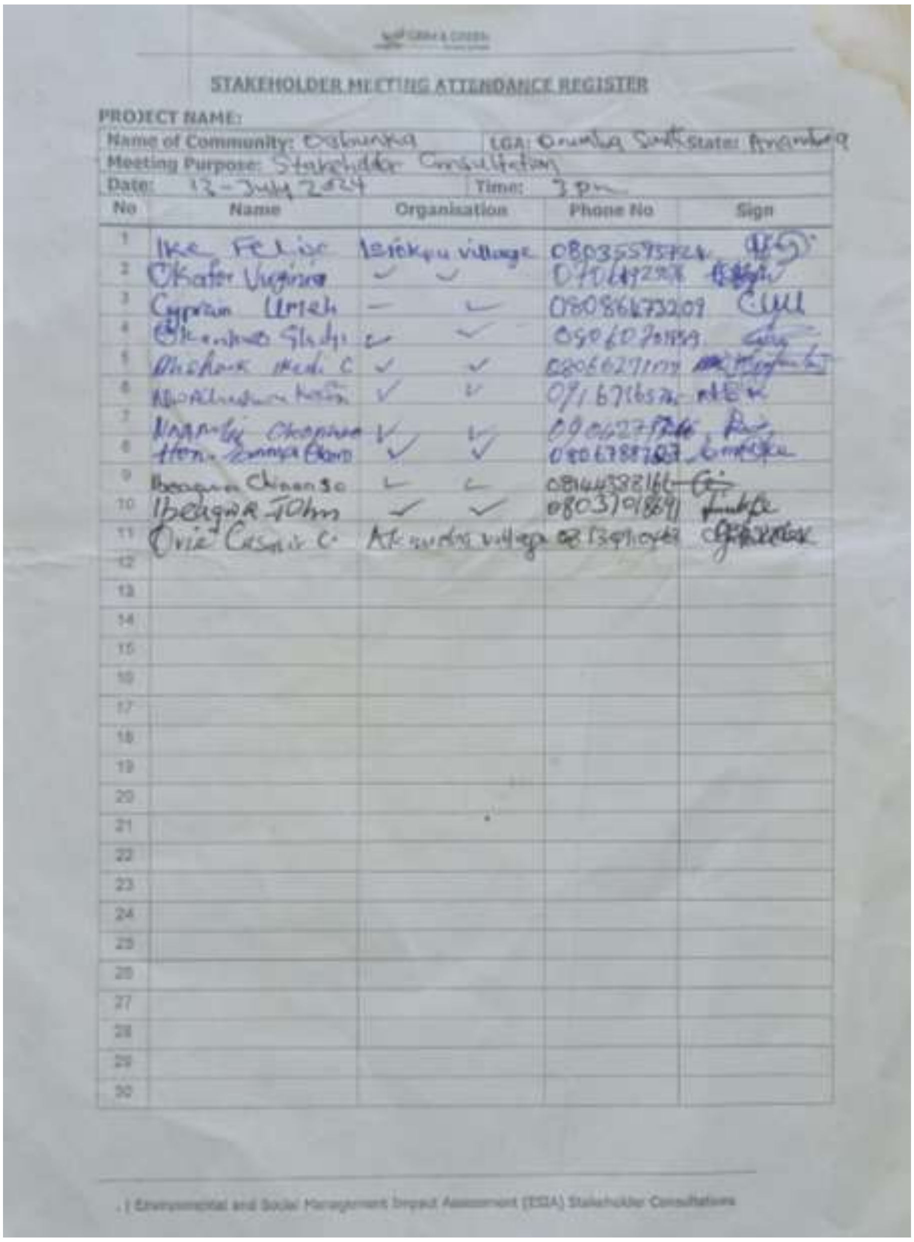
Appendix 4.7 Consultation Attendance Sheet at Ogbunka



STAKEHOLDER MEETING ATTENDANCE REGISTER

PROJECT NAME:

Name of Community: Ogbunka	LGA: Orumba South	State: Anambra
Meeting Purpose: Stakeholder Consultation		
Date: 13-July 2024	Time: 3pm	

No	Name	Organisation	Phone No	Sign
1	Ike Felix	Isiokpu village	08035575724	[illegible]
2	Okafor Virginia	✓ ✓	0710492928	[illegible]
3	Cyprian Urieh	— ✓	08086673209	[illegible]
4	Okonkwo Gladys	✓ ✓	09060701959	[illegible]
5	[illegible] C	✓ ✓	08066271079	[illegible]
6	[illegible]	✓ ✓	0716716574	[illegible]
7	[illegible]	✓ ✓	0906627[illegible]	[illegible]
8	Hon. [illegible]	✓ ✓	08067887[illegible]	[illegible]
9	[illegible] Chinenso	✓ ✓	08144338166	[illegible]
10	Ibegwa John	✓ ✓	08031918691	[illegible]
11	Ovie Caesar C.	[illegible] village	0813[illegible]	[illegible]
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Environmental and Social Management Impact Assessment (ESIA) Stakeholder Consultations