EIA

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

OF PROPOSED

CONSTRUCTION OF A LIFE CAMP AND INFRASTRUCTURE AT POLO-CICO FARMS AND ESTATE AT EBOCHA, OGBA/NDONI/EGBEMA LGA RIVERS STATE

DRAFT REPORT

September, 2020

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Report No:rfl.eia.lci – 1231

Date of Report: September 2020

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Version	Status			
01	Draft Report			September 2020

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List of Abbreviation /Acronyms

Abbreviation/ Acronyms	Meaning
%	Percentage
<	Less than
ACI	American Concrete Institute
A.S.T.M	American society for testing and material
AISC	American Institute of Steel Construction
ALARP	As low As Reasonably Possible
APHA	American Public Health Association
AQ	Air and Noise
ARV	Anti-retroviral drugs
BAT	Best Available Technology
BOD	Biochemical Oxygen Demand
C	Carbon
Ca	Calcium
CDC	Community Development Committee
CEC	Cation Exchange Capacity
cfu/g	Colony forming unit per gram
cfu/ml	Colony forming unit per millilitre
Cl^-	Chloride
Cm	Centimetre
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Cu	Copper
Db	Decibel
E	East, Easting
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency in USA
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FMEnv	Federal Ministry of Environment
FRSC	Federal Road Safety Corps
GC	Gas Chromatograph
GPS	Global Positioning System
H_2SO_4	Tetraoxosulpate (VI) acid
Ha	Hectare
HAZOP	Hazard and Operability
HEMP	Hazards and effects Management Process

HNO_3	Trioxonitrate (V) acid
HP	High Pressure
HSE	Health, Safety and Environment
HUB	Hydrocarbon Utilizing Bacteria
HUF	Hydrocarbon Utilizing Fungi
IFC	International Finance Corporation
JBN	Julius Berger Nigeria PLC
Km	Kilometres
LGA	Local Government Area
M	Metres
Max	Maximum
mg/kg	milligram per kilogram
mg/l	milligram per litre
Min.	Minimum
Ml	Millilitre
Mm	Millimetre
ms^{-1}	metres per second
N	North
N	Northings
NE	North East
NGOs	Non-Governmental Organizations
NMT	Non-Motorised Transport
NOx	Nitrogen Oxides North West
^{O}C	Degree Celsius
PAC	Project Affected Community
PAH	Poly Aromatic Hydrocarbon
PC	Personal Computer
pH	Hydrogen ion Concentration
Ppm	Parts Per Million
Ppt	Parts Per Thousand
PTDF	Petroleum Technology Development Fund
PU	Per Unit
QC/QA	Quality Control /Quality Assurance
QHSE	Quality, Health Safety and Environment
RE	Resident Engineer
RMEnv	Rivers State Ministry of Environment
RMW	Rivers State Ministry of Works
ROW	Right of Way
RS	Rivers State
S	South
SE	South East
SPM	Suspended Particulate Matter

Spp.	Species
SSW	South South West
STDs	Sexually Transmitted Diseases
STIs	Sexually Transmitted Infections
SW	South West
TDS	Total Dissolved Solid
TFC	Total Fungal Count
THB	Total Heterotrophic Bacterial Count
THC	Total Hydrocarbon Content
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
VIO	Vehicle Inspection Office
VOC	Volatile Organic Carbon
W	West
WHO	World Health Organization

Units

% - Percentage
^{0}C - Degree centigrade
Kg - Kilogram
mol/eq - Molar equivalent
mg - miliigram
mgkg^{-1} - Milligram per kilogram
mgl^{-1} - Milligram per litres
l - Litre
µg - Microgram
µs/cm - Micro Siemens per centimetre
NTU - Nephelometric Turbidity Unit

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Acknowledgment

Polo-Cico, Julius Berger PLC and Resourcefield Limited acknowledge the input and concern of the Federal Ministry of the Environment, the other stakeholders, the affected communities and the NGO.

EXECUTIVE SUMMARY

E.S 1 Introduction

Polo-Cico Farming and Estate Ltd., wants to realize an agricultural business in Ebocha, in Ogba/Ndoni/Egbema LGA, Rivers State. Two adjacent plots of land with a total of approximately 183 hectares are available for this purpose. Both plots will be provided with a ring road and border-fence. The bigger plot of 122 ha is reserved for upstream agricultural purposes which are outside the scope of this EIA; while the 61 ha will accommodate the proposed Life Camp, the subject of this EIA.

The proposed Ebocha Farms project is essential to exploit the features of the location and which has a prosperity feature of mechanized agriculture in a strategic manner for socioeconomic empowerment of the people and for a sustainable economic development.
This type of project must undergo an environmental and social impact assessment as required by the EIA Act No. 86 of 1992

Polo-Cico Farming and Estate Ltd., the proponent, intends to undertake this environmental impact Assessment (EIA), to predict the impacts of this proposed agricultural business on the environment and propose mitigation measures that will be incorporated into the project environmental management plan and detailed engineering design

E.S 1.1 Project Location

The proposed Ebocha Farm Camp is located in Ebocha, Ogba/Ndoni/Egbema LGA, Rivers State. The proposed project location is defined by latitude 5°25'39.41"N, longitude 6°41'17.30"E along the Ebocha - Omuku Road, to meet a tributary of Orashi River bank on latitude 5°26'51.98"N, longitude 6°40'15.35"E.

E.S 1.2 Policy, Legal and Institutional Framework

Section 20 of the constitution of Nigeria (1999), makes it an objective of the Nigerian State to improve and protect the air, land, water, forest and wildlife of Nigeria. And Section 12 establishes, though impliedly, that international treaties (including environmental treaties) ratified by the National Assembly should be implemented as law in Nigeria. Furthermore, Sections 33 and 34 which guarantee fundamental human rights to life and human dignity, respectively, have also been argued to be linked to the need for a healthy and safe environment to give these rights effect.

National Environmental Policy

The policy specify guidelines for achieving sustainable development in fourteen vital sectors of the nation's economy, namely: Human Population; Land Use and Soil Conservation; Water Resources Management; Forestry, Wildlife and Protected Natural Areas; Marine and Coastal Area Resources; Sanitation and Waste Management; Toxic and Hazardous Substances; Mining and Mineral Resources;

Agricultural Chemicals; Energy Production; Air Pollution; Noise in the Working Environment; Settlements; Recreational Spaces, Green Belts, Monuments, and Cultural Property.
It also contains Nigeria's commitment to ensure that the country's natural and built environment is safeguarded for the use of present and future generations. This commitment demands that efficient resource management and minimization of environmental impacts be the core requirements of all development activities.

National Land Policy

The legal basis for land acquisition and resettlement in Nigeria is the Land Use Act of 1978, modified in 1990. According to the act, all land in Nigeria is vested in the Governor of each State, to be held in trust for the use and common benefit of all people.

The administration of urban land is directly under the control and management of the Governor; whereas non – urban land is under the control and management of the Local Government Area. The Governor had the right to grant statutory rights of occupancy to land. Local Government has the right to grant customary rights of occupancy.

The Land Act gives government the right to acquire land by revoking statutory and customary rights to land for the overriding public interest. In doing so, the act specifies that the state or local government should pay compensation to the current holder or occupier with equal value. The act also requires the state or local government to provide alternative land for affected people who will lose farmlands and alternative residential plots for people who will lose their house.

The Environmental Impact Assessment (EIA) Act Cap E12 LFN, 2004

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

This project is a major development, which is expected to have some impacts on the environment. Hence, full compliance with the EIA Act is required. The EIA guidelines (procedural and sectoral) issued by the FMEnv drives from this Act and the project proponents shall conduct their activities in conformance with these guidelines.

Land Use Act of 1978

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

The Act vest every parcel of Land, in every State of the Federation, in the Executive Governor of the State. He holds such parcels of land in trust for the people and government of the State.
All land irrespective of the category belongs to the State while individuals only enjoy a right of occupancy as contained in the Certificate of Occupancy up to the limit of 99 years. The administration of the urban land is vested in the Governor, while rural land is vested in the Local Government Councils.

The Local Government Councils may grant customary rights of Occupancy for residential and other purposes, up to a limit of 500 hectares for agricultural purposes and 5,000 for grazing except with the consent of the Governor. The State is required to establish an administrative system for the revocation of the rights of occupancy, and payment of compensation for the affected parties. The holder or occupier of such revoked land is to be entitled to the value of the unexhausted development as at the date of revocation.

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

Administered by the Ministry of Environment, the National Environment Standards and Regulations Enforcement Agency (NESREA) Act of 2007, repealed the Federal Environmental Protection Agency (FEPA) Act. It is the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources. This project will comply with NESREA regulations, including conducting ESIA, environmental audit every three years after commissioning, obtain permit before disposing hazardous wastes, etc.

E.S 1.3 Other National Laws

Other National Laws Relevant to the project include the following;

- The Nigerian Urban and Regional Planning Act CAP N138, LFN 2004; contain requirements for development planning
- Harmful Waste (Special Criminal Provisions) ACT CAP H1, LFN 2004; prohibits dumping of harmful wastes within Nigeria.
- Civil Aviation (Repeal and Re-Enactment) Act 2006
- Nigerian Airspace Management Agency (Establishment etc) Act CAP N90 LFN 2004
- The Endangered Species Act, CAP E9, LFN 2004; protects endangered species.
- The Factories Act, 1987 (Factory Act cap 126, LFN, 1990); contain labour requirements, including occupational health, and similar matters.
- Labour Act - CAP. L1 L.F.N. 2004; specify requirements relevant to labour issues, including wages, recruitment, discipline, employee welfare, employment of women and child labour.

- Wages Board and Industrial Council Act, 1974; established the National Wages Board and Area Minimum Wages Committee for States and for Joint Industrial Councils for particular industries, which determines minimum wages.
- Workers' Compensation Act, 1987; provisions for the payment of compensation to workmen for injuries suffered in the course of their employment and compulsory insurance covers employees of all categories
- National Environmental Regulations established by NESREA based on Section 34 of the NESREA Act, 2007. Those relevant to this project include Effluent Limitations, management of Solid and Hazardous Waste and Pollution Abatement in Industries Generating Wastes.
- FRSC Act CAP 141 LFN 2007
- National Inland Waterways Authority Act CAP N47 LFN 2004

E.S 1.4 Rivers State Laws

Rivers State Ministry of Environment and Mineral Resources: The Rivers State Ministry of Environment (RMEnv) has the overall responsibility (directly or indirectly through various agencies) of environmental protection within the state. With respect to the proposed project the Rivers Environmental Protection and Waste Management Agency Law no. 8 of 2000 (an agency under the supervision of RMEnv) states that:

- No person shall cause any waste generated in the process of manufacturing of business operation to be discharged without treating or purifying it in accordance with the standards approved by the Agency;
- No person shall discharge or cause to be discharged untreated human waste into any public drain, watercourse, gorge storm water, drainage or into any land or water;
- No person shall discharge any form of oil, grease or spent oil produced in the course of any manufacturing operation or other type of business into any public drain, watercourse, water gorge or road verge, any such waste which is to be discharged by the person generating it shall have been certified as having complied with set-down and approved standards by the agency;
- No person shall discharge into the air inadequately filtered and purified industrial gaseous waste containing substances injurious to life and property, such as sulphur dioxide, oxides of nitrogen, hydrogen fluoride, sulphide, carbon monoxide, ammonia, chlorine, smoke and metallic dust, particulate and other injurious gases;
- No person shall dump or burn or cause or allow to be buried or dumped in any land or water any toxic, hazardous substance or harmful waste;
- No person shall establish petrol stations, gas plants or other petroleum related activities without adherence to approved environmental standards; and
- No person shall engage in any form of petroleum exploration or production activities which cause pollution of the environment through spillage.

E.S 1.5 The EIA Process in Nigeria

The Federal Ministry of Environment (FMEnv) developed procedural guideline as well as sectoral guideline for conducting EIA in Nigeria in accordance with the EIA Act. The following steps sequentially summarises the entire process.

- Project Initiation
- Prepare/submit Project proposal
- Screening
- Scoping process
- Site Verification/TOR approval
- Conducting the study and submit reports to the Ministry
- Review process, including public display and public hearing
- Approval of the project or otherwise
- Project commencement
- Impact mitigation monitoring
- EIA certification

E.S 1.6 EIA Terms of Reference

In line with the Nigeria's EIA procedural guidelines (FEPA, 1995), the Terms of Reference (ToR) for the EIA of the proposed project approved by the FMEnv's had the following objectives:

- Define the relevant framework of legal and administrative requirements for EIA of the proposed project;
- Outline the general scope of the EIA study including the overall data requirements on the proposed project and affected environment; and.
- Define the procedures and protocols for identification and assessment of associated and potential impacts and for selecting appropriate prevention, reduction, and control as well as enhancement measures for such impacts; and eventually developing an effective Environmental Management Plan (EMP) for the project.

E.S 2 Project Justification

The proposed Ebocha Farms project is timely and essential to exploit the features of the location and which has a prosperity feature of mechanized agriculture in a strategic manner for socioeconomic empowerment of the people and for a sustainable economic development. The exploitation of these features would provide employment and skill acquisition opportunities for Nigerians through direct and indirect involvement of contractors, consultants, suppliers and other professionals especially during the construction and operations phases of the project.

When completed, it will also add to the infrastructural development, economic, social and health advancement of the host communities, Local, State and Federal Governments at large. it will add value in terms of improved and / additional infrastructural and social amenities, influx of businesses and people, etc. at all levels. During the construction phase about 400 people on an average will be employed. The manpower requirement of the proposed Ebocha farms during operation and maintenance period is estimated to be over 500 people when fully completed.

E.S 2.1 Analysis of Project Alternatives

Three options were considered - the do-nothing option which simply means that the proponent does nothing to commence the construction of the infrastructure/structures designed for or associated with the project. The obvious outcome of this alternative/option would be a negative effect on the housing, tourism and agricultural prospect of Nigeria.

The second option was to delay the execution of the proposed project while the third option was to execute the proposed project now to bring its benefits to bear on the economy positively. The first two options were therefore rejected in favour of the third. The chosen option was subsequently subjected to various project alternatives, principally based on sites selections, source of Power supply and Layout.

E.S 2.2 Envisaged Sustainability

The sustainability of the project has been considered on three premises – technical, economic and environmental and social. Technically, Polo-Cico farms is employing proven architectural conceptual designs who have proven construction management records for the project execution. On the economic premise, Polo-Cico farms and some development partners that have expressed interest on completing of the project since it shall be income generating because of the expected global patronage. In addition, the proposed project will create jobs during construction and operation to people in the area. Environmental and social sustainability stem from the complete acceptance of the project by host communities, the careful identification and mitigation of project negative impacts.

E.S 3 Project Description

The proposed project is an agricultural business in Ebocha, in Ogba / Egbema / Ndoni LGA, Rivers State. Two adjacent plots of land with a total of approximately 183 hectares are available for this purpose. Both plots will be provided with a ring road and border-fence. The bigger plot of 122 ha is reserved for upstream agricultural purposes which are outside the scope of this EIA; while the 61 ha will accommodate the proposed Life Camp, the subject of this EIA. The Life Camp will have the following components;

- Entrance Gate
- Gate house
- Lake

- Lakeside cottage
- Swimming pool area
- Club House/Canteen
- Wire mesh fence area
- Sewage tank
- Water reservoir
- Generator House
- Staff accommodation
- 7nos 1bedroom flats, dining,
- 2-bedroom flat 2nos; 2nos bedroom en-suite,
- Lawn tennis court
- Helipad landing

E.S 3.1 Helipad Construction

The heliport, a designated helicopter landing area, will be constructed at the northeastern end of the proposed Life Camp facility. The proposed helipad will be constructed out of concrete and marked with a circle and/or a letter "**H**", so as to be visible from the air. The summary of the major features of the proposed construction are:

- -Working in a heavily trafficked area including interfacing with the Public.
- -Risk Management.
- -Temporary hoarding.
- -Earthmoving/Clearing of the site and excavation of trenches for electrical ducts and storm sewers. Tie-in to existing storm sewer-road crossing.
- -Concrete works which will include the construction of the helipad.
- Installation of lighting and associated cabling.
- -Installation of switchgear.

E.S 3.2 Proposed Facility Operations and Maintenance

The facility manager will provide the ongoing operation, maintenance and lifecycle management of the proposed Life Camp facility including the following services; General Management Services, Sustainability services, help desk service, Utilities Management Services, Roads and ground maintenance services and Parking Management Services. The successful management consultant will be responsible for the provision, maintenance and repair, and as appropriate, replacing and upgrading of all physical plant, mechanical systems, electrical systems, building structure, fixed equipment, building finishes and fixed furnishings required to maintain the facilities in a condition fit for the intended uses.

E.S 3.3 Proposed Facility Operations and Maintenance

Communication: The proposed helipad will use the standard emergency Room Network frequency for reports.

Safety: Do not approach a running helicopter unless instructed to do so by the crew. Always approach from the front in full view of the pilot and only when the pilot says it is safe to do so. Secure all loose items in the vicinity of the landing area.

Fire Extinguishers: For safety purposes the proposed facility and helipad will be equipped with fire extinguishers of the appropriate types. A fire hose cabinet or the appropriate extinguisher will be provided at each access gate/door and each fueling location. At the refueling station, a foam system will be installed.

E.S 3.4 Energy Consumption

The project yard shall 4 Nos, 1275kVa generators which supply electrical energy for its operations. Three of the generators are operational for 24hrs while one is on standby. The generators consume about 800 litres of diesel (Automotive Gas oil – (AGO) per day (i.e. 400 litres per generator per day).

E.S 3.5 Personnel Requirement and Transport

Approximately 400 personnel in the Life Camp and the fabrication yard. There are specialised sub-contractors that will be engaged by the main contractors when the needs arise. These will be sourced from JBN staff and host communities. Personnel carriers pick up workers at designated points within the town and in the outskirts, to work before 7am and return them at close of work

E.S 3.6 Waste Management

The waste management plan for the proposed project has been informed by the understanding of the possible waste characteristics.
The construction waste to be considered includes: -

Soil: excavated soil which will be reused as backfilling materials for the Life Camp foundations.
Oil: oil & grease from malfunctioning vehicles and equipment at site
Office waste and domestic solid waste (refuse): this is generated at the construction site.
Demolition waste – concrete, soil, sand, metals

From the above, the Engineering, Procurement and Construction (EPC) Contractor will design its waste management plan under two categories:
Solid Waste
Emissions

The over-burden will be separated into top soil and sub-soil which shall be dumped in separate locations for reuse during phased construction-pit reclamation. Generated scrap metals, paper, glasses and plastics will be sorted and sold out for recycling or reuse.

There will be at-source segregation of solid wastes. The Rivers Waste Management Agency will be contracted to collect and dispose of the waste that will be generated after the EPC Contractor has recovered those it can reuse. The waste shall be tracked and dumped in any of the existing approved dumpsites in the area. On completion of construction works, the EPC Contractor shall demobilize from site and shall clear the site of all debris, including the remains of abandoned temporary structures erected in the vicinity of the Life Camp site by food and other vendors, to serve the workers at the site. These will be collected and disposed of also by the EPC Contractor's waste disposal subcontractor.

E.S 3.7 Project Schedule

The proposed project execution schedule, indicates construction commencement in Q1 2021 and commissioning scheduled for Q1, 2023

E.S 4 The Existing Environment

Environmental impact assessment procedure for the proposed Ebocha Farm and Life Camp project involves the use of adequately planned and well-structured analysis to establish the existing environmental conditions of the proposed project location. This environmental status will provide the basis for identification of potential impacts of the project activities on the ecological system and the resource use of the area.
A one-season (wet) fieldwork was embarked upon for the biophysical, social and health studies. Responses by the natives are not limited to any particular season. The field data gathering exercise was performed between 24th and 26th August, 2020. The collected samples were analysed in certified laboratories in the Akwa Ibom State Ministry of Environment/Science and Technology laboratory in Uyo.

E.S 4.1 Meteorology

The study area is situated within the tropical wet climatic belt. In general, two seasons are characteristic of the climate in the region, namely the dry and wet seasons. In wet season, the annual distribution starts with the initial rains in March, which ceases in late November. Temperature data shows that the months of July-September recorded lower temperatures (28-29 ^{o}C) due to rainy periods while the months December to March recorded higher temperatures (32-34^{o}C) due to intense solar radiation prevalent in the dry season. Due to the moist nature of the atmospheric environment in the study area, relative humidity is always high throughout the year with peaks during the wet season. The prevailing wind direction was the easterly and south-westerly winds. This implies that any released air emissions will be blown towards the west and north-east direction of the study environment.

E.S 4.2 Air Quality and Noise

A total of 6 samples each were monitored at and around the project site. Generally, recorded measurements in the study area indicated criteria pollutants such as NO_2, SO_2, $PM_{2.5}$ and PM_{10} were lower than the permissible limits of FMEnv. NO_2 was even below the equipment detection limit. The project environment was quite pristine. However, caution must be taken in interpreting these results because of the relatively short averaging sampling times (5 – 10 m) used in this study, compared to the averaging times of 8-24 hours used for regulatory limits. Noise level at Ebocha ranged from 58.4-74.6 [d(B)A] with the mean of 63.72±6.52. The recorded noise level was below the FMEnv permissible limit of 90 dB(A).

E.S 4.3 Geology and Geomorphology

The local geology of the study area is comprised of alluvial and fluvial sediment deposits of fine to medium sandstone, brown dense silty sand, clay and pebbles in which sand percentage increases as observed (5.45686^0 N, 6.67320^0 E) along the river bank of Orashi river. The study area has a flat topography and its elevation varies between 20m to 30m above sea level. thus, no outcrop was observed within the study area.

The soils of the study area are part of the coastal soils, originally laid down at or near sea level in Oligocene to Pleistocene times. The soils are dark to brown in colour. coarse grained, locally fine grained, poorly sorted, subangular to well rounded. Soil consistency as observed during the field exercise were between wet (slightly sticky and non-sticky) and moist (friable), while soil colour were between black, Dark red and Brown. The Flood risk assessment within the study area reveals there is risk of occurrence of potentially damaging floods with increasing rainfall intensity, the area is prone to flooding and inundation hazards.

E.S 4.4 Hydrogeology

The study area is underlain by the coastal plain sands, overlain by firm – stiff clay/sandy clay sediments belonging to the pleistocenic formation. The area essentially reflects the influence of movements of water runoff in their search for lines of flow to the sea with consequent deposition of transported sediments from Orashi river and its tributaries. The groundwater potentials of study area and its environs are enormous based on the positive indicators of high resistivity values, clean coarse sand formation materials, the thickness of the established aquiferous saturated zone and the shallow depth to locating the aquifer, which is about from 22m that can facilitate the easy harnessing and supply of safe, sustainable and portable water to the people of the area.

E.S 4.5 Water Quality

A total of 6 surfacewater samples and 4 Groundwater samples were monitored at and around the project site. The heavy metals and metalloid investigated in the groundwater samples include arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, vanadium and zinc. The recorded values were within WHO/FMEnv permissible limit.

E.S 4.6 Soil Quality

A total of 10 samples each were monitored at and around the project site. The pH of the soil ranged of 5.45-5.76. The cations are below the FMEnv limits. Ten heavy metals were analyzed including arsenic, chromium, copper, iron, lead, manganese mercury, nickel, vanadium and zinc. Arsenic, mercury and vanadium were below detection limit.

E.S 4.7 Vegetation and Wildlife

The general structure of the study area is derived savannah but dominated by the rainforest. The existing vegetation is composed of the rainforest and a derived savannah with abundance of grasses, herbs and shrubs with scattered trees. The vegetative distribution and types in the study area include; the rainforest, Freshwater forest and the Anthropogenic vegetation effect due to construction activities. However, there is a mix of habitats in the study area. A total of twenty-eight (28) species were censored yielding 470 individuals (Abundance). About 56.5% were trees, 6% shrubs, 20.6% were herbs and about 16.9% were grasses.

Fauna Diversity in the study area is very rich., a total of thirty-two (32) fauna resources were inventoried in the study. These 32 fauna species were obtained via indirect evidences. Twenty (26) mammalian fauna were recorded through indirect evidence. Ten avi fauna taxon was recorded of which six (6) species were sighted directly and 4 through indirect evidence. A breakdown of abundance for each fauna group revealed that the avifauna group recorded the highest abundance with 37 individuals, followed by the mammalian and amphibian groups with 26 and 10 individuals respectively.

E.S 4.8 Marine Ecology

The productivity of any aquatic water body depends on the amount of plankton present in the said water body. Four groups of hydrobiology parameters were evaluated. They are phytoplankton, zooplankton benthos and Fishes.

A total of 16 species of zooplankton were recorded namely: Rotifera, Cladocera, Crustaceans (Copepoda) and Euphausiacea families. the major families of phytoplankton recorded were Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae and Euglenophyceae families. A total of sixteen (16) benthic organisms were recorded in the study area. Benthic fauna encountered belong to four (4) major taxonomic groupings comprising Polychaete, Crustaceans, Bivalve Molluscs and Gastropods Molluscs. Gastropods Molluscs were the dominant benthos and they constituted 39 % of the macro-benthic organisms followed by bivalves which constituted 25 % while Polychaete and Crustaceans constituted 18 % apiece of the number of benthos. A total of twenty-six (26) countable individuals were recorded from 4 families mainly Cichlidae, Mugilidae, Sciaenidae and Ictaluridae during the fishing survey.

E.S 4.9 Socio-Economics

The EIA guideline has made it mandatory to consult communities on the possible impact of a proposed project. It is also binding to integrate community views at the project design stage. Socio-economic and community health impact assessment tools are designed to integrate the desires and aspirations of the community with those of the project proponent. In line with the EIA objectives, wide consultations were held and community aspirations were recorded. Public forums were held to create more awareness of the proposed project and to prompt community support. The three communities (Mgbede, Obrikomk and Omoku) in Ogba-Egbema-Ndomi LGA of Rivers State, Nigeria.

- **Demography of the area**

Ogba/Ndoni/Egbema Local Government Area (ONELGA) is bounded on the North by Ogbaru LGA of Anambra State; on the North-East by Ogwuta and Ohaji/Egbema LGAs of Imo State; on the west by Sagbama/Yenegoa LGAs of Bayelsa State and Ndokwa-East LGA of Delta State; on the South by Ahoada-West LGA and Emohua LGA of Rivers State on the East, and located on the Eastern bank of the River Niger. ONELGA has three (3) major ethnic/culture groups (Ogba, Egbema, and Ndoni) speaking distinct but familiar languages with their unique and peculiar self-sustaining cultures.

The population estimates for ONELGA following the 2006 national census, as published by the National Population Commission (NPC), was 283,294 people. The typical household unit in the study area has a head and several members. In many cases the head is the father and members include his wife, children and wards. Life Expectancy estimates for rivers state is the same as the national estimates. The World Health Organization (WHO) in its World Health Statistics 2006 estimated that life expectancy for men in Nigeria is 42 years and 47 years for women.

- **Livelihood Activities**

The physical landscape of Ali-Ogba presents a variety of natural resources: relatively well-drained land and rich soils in many areas, freshwater rivers, creeks and wetlands, secondary forests, and abundant sunshine and rainfall all year round. Underneath the earth's surface are pools of natural gas and oil. As a result of these endowments, the natural environment supports an agricultural economy based on fishing and farming for the production of a wide variety of crops such as cassava, yam, maize, coco-yam, plantain, and banana, including many vegetables such as okra, pepper etc.
The identified activities are mainly commerce and provision of services like petty trading, artisanship practices, and employment in the civil/public services. The largest proportion of household members in all the communities are engaged in trading. Artisanship practices inclusive of electrical repairs, boat building, tailoring, etc are significant in the study area

- **Landuse**

The land in the study area has been greatly affected mainly by the process of agricultural practices and development. A presentation of the land use in the study area and its environs as observed during the study shows that built up area accounts for 10.27%, fallowed bush 30.65%, Cultivated farmland 50.76%, and Swamp/wetland 1.76% and water body 6.56%.

- **Education and Literacy**

The estimated literacy rate in Rivers State in 2006 was 75.77%, which is higher than the estimated national rate of 68% (NDDC 2006). Field surveys show that less one third of the study area population is non-literate, while more than two thirds (2/3) of the people are academically and functionally (possess minimal literacy level to interact with other people in the course of their economic activities) literate.

- **Conflict and Security**

The study area is part of the Niger Delta region which has experienced several conflicts with violent outcomes. In particular, there was the issue of militancy and cultism in the region. The conflicts that gave rise to militancy involved the youth more than any other group. Many of them have become violence-prone and even social misfits. The disastrous impact of cult-related violence was witnessed in the study area and claimed a number of lives and properties worth billions of naira between 2008 and 2018. Though not given wide publicity the level of devastation done to the area has remained evident in the number of banks and other businesses that left the area. The violent outcome of cult activities in the area led to the closure of First and Zenith banks in the area with only UBA and unity banks serving the entire Local Government area.

- **Quality of Life**

All the communities have the characteristics of both linear and nuclear settlements. The linear characteristics derive from the concentration of houses along the main streets and lanes in the settlements. Their nuclear characteristics derive from the clustering of houses. Houses are built in clusters which in some cases may identify family lineages and kindred groups.

Development and limited access to land have generally encouraged this clustering of houses. Spacing between houses is not definite and could range from one or two meters to about six meters.

The houses are quite diverse in their design and construction materials. Some houses have modern designs and they are built with utilities like kitchen, toilet, and bath, in-house. These modern houses are also constructed with stable and permanent materials like cement blocks and roofed with corrugated iron and aluminum sheets. A majority of the houses in the communities are family bungalows and tenement (rooming) houses.

The available sources of energy for cooking household meals and for lighting in the community are kerosene, firewood, electricity and cooking gas. For lighting, a significant proportion of households depend on their kerosene lamps and personal power generating set.

- **Infrastructure**

As our study revealed, the availability of basic infrastructural necessities of life in the community is inadequate. The study area is accessible by road through Ebocha-Omuku road. There are high institution in the area namely River state Polytechnic. There is also a handful of public and private primary and secondary schools in the study area. There is generally a dearth of functional orthodox health facilities in the study area. Perhaps the only one that can be considered functional and patronized by a number of residents is the General Hospital.

- **Water and Sanitation**

The sources of water used in households in the study area include water from rainwater, well and water from public and private boreholes. In the surveyed area many households avoid the use of rainwater as a result of their belief that rainwater is being polluted by gaseous emissions from flares from oil and gas activities in and around their communities. For this reason, also, the use of rainwater is mostly limited to the washing of clothes and other things and not for cooking.

- **Waste Management Practices**

Waste disposal practices in the project-affected communities are quite similar. Refuse is, unfortunately, mostly deposited by the roadside and medians by households, for eventual collection and disposal by Rivers State Waste Management Agency, instead of the waste holding facility provided by RMAWA. Similarly, two methods of sewage disposal practices are the use of pier system toilets and water closet toilets. About 89% of households in the study communities dump their refuse in open space awaiting the government to evacuate, while 29% use the pit toilets. The common refuse and sewage disposal practices in communities across the study area are not modern, hygienic, or safe. Considering the terrain of the communities, most of these wastes eventually end up in the water bodies around the area or are carried downstream and deposited in other communities.

E.S 5 Stakeholders Engagement

The Stakeholders Engagement process has been designed to comply with regulatory requirements set out in Nigerian environmental legislation and, where possible, implement international good practice guidelines. The process was also used to facilitate information gathering between the EIA consulting team/proponent and the other stakeholders. The consultation exercise commenced at the very early stage of the environmental impact process and it is planned to continue throughout the project duration

Two levels of consultations, as are generally recognized in the EIA process, were held. These are institutional and Project affected communities (PACs) involvement. The public forum with Project Affected Communities, NGOs, and CBOs, youth groups, Women organizations, religious organizations, and traditional bodies held between 24-29 August 2020 in the project-affected communities with the various village heads and traditional rulers in attendance and also with major institutional stakeholders on 27 August 2020 in Port Harcourt.

The concerns and Expectations expressed by the host communities are

- Environmental damage: Most communities fear that the construction activities will destroy the vegetation, cause turbidity in the rivers and affect the water that is used by households for drinking and other purposes.
- Loss of livelihoods: PACs also fear families in the communities will lose their farmlands, fish ponds, grazing area, economic trees, and, therefore, lose their livelihood activities.
- Social problems: Introduction and increase in vices like drug use and prostitution, teenage pregnancy, school dropout, and insecurity during project construction.
- Health problems: Increase in the occurrence of STDs and HIV/AIDs.
- Payment of compensation: All compensation due to families and communities for loss of property should be adequately paid before the commencement of the project.
- Creation of employment opportunities for residents of the communities.
- Empowerment of community members through skills acquisition, an award of contracts, and provision of scholarships.
- Infrastructural development in communities in terms of provision of potable water, electricity, functional orthodox health care facilities, renovation, and equipping schools, and erosion control projects

E.S 6 Impacts and Mitigation Measures

The summary of impact analysis as described in the environmental impact assessment report is presented here. The impact analysis considers the various phases of the project:

- pre-construction phase
- construction phases
- operation phase, and
- decommissioning phase

This analysis is based on a cause/effect matrix between project-related impact sources and valued environmental and social components. Impacts are defined by their intensity (low, medium, major), their extent (regional, local, limited) and their duration (long, medium, short). The method used to identify, analyze and mitigate environmental and social impacts, or to improve positive impacts, places the project in a sustainable development perspective. The mitigation of anticipated negative impacts and the enhancement of positive impacts allow its environmental and social acceptability by stakeholders.

Anticipated Socio-Economic Benefits

- The potential socio-economic benefits that will arise due to the commencement of the project includes
- Increased earning to local labourers from vegetation clearing and site preparation
- Provision of social amenities like portable water supply, electricity, and asphalt road
- Direct employment to qualified Nigerians and local inhabitants
- Increased revenue to state and through payment of electrical bills
- Increased foreign and local investments in the area and in the country, leading to wealth creation, employment generation, infrastructural development, and economic empowerment
- Availability of land for alternative use, after project decommissioning

Potential Negative Impacts

- Environmental issues identified may involve negative impacts includes;
- The use of energy and non-renewable resources;
- Depletion of ecosystem resources and potential soil and water pollution
- More burden on local infrastructures
- Emissions to air (in particular dust); discharge of effluent/waste water to the aquatic environment and potential water pollution
- Occupational health and safety
- Public health issues involving waste management and community health.

E.S 6.1 Mitigation Measures

Mitigation impact hierarchy has been applied for the identified significant (adverse and beneficial) impacts, by considering prevention/avoidance, reduction, and control of adverse impacts in that order and enhancement for the beneficial impacts. Measures proposed are as follows with the Proponent, Polo-Cico being the responsible implementing entity during construction and operation phase;

Mitigation Measures During Pre-construction and Construction Phases

- Develop and implement stakeholder engagement plan for each phase of the project.
- Engage actively and activate the grievance resolution mechanism.
- Undertake revegetation planting agro-forestry trees that increase availability of fodder or fruit trees, to maximize livelihood benefits for local population.
- Carefully select the landing area of falling trees to minimize damages to crops.
- Secure equipment and demarcate any excavation work areas.
- Maintain equipment and machinery in good running condition, including brakes, mufflers and silencers, and catalysers.
- Manage all associated constructional risks through the use of competent professionals/engineers or isolating the source of risk or use of acceptable administrative measures in the workplace
- ensure all personnel wear appropriate personnel protective equipment (PPE).

- construct drainages to control runoffs
- maintain all vehicles and internal combustion engines at optimal working conditions.
- Require the Contractor to adopt policies and procedures that comply with national legislation and address all aspects of labor standards relevant to the project.
- Supply drinking water and maintain its quality and ensure sanitation at the construction sites.
- Develop and Implement an H&S management plan to protect every worker involved in construction activities, even temporary workers.
- Prepare and implement an HIV/AIDS prevention program.
- ensure that contractors do not unduly exploit the local workers through salary cuts and payment delay
- ensure all incidents are reported and documented and corrective actions taken
- Screen health of potential employees as part of the recruitment process.
- Ensure construction workers are discouraged from engaging in the exploitation of natural resources such as hunting and collection of forest products such as wood
- Carryout daily safety briefings before commencement of work each day.
- Maintain construction camps in a clean and healthy condition as prescribed by international worker health standards.
- Communicate with communities effectively and involve their representatives.
- Employ non-skilled and semi-skilled labour, where available and provide training in relevant skills needed by the project to enable community members participate.
- Encourage the recruitment of female workers.

- Apply the Physical Cultural Resources Management Plan, waste management plan, vegetation management plan, etc.

Mitigation Measures During Operations Phase

- Provide all internal combustion equipment with properly functioning silencers or mufflers.
- Ensure all personnel wear appropriate personnel protective equipment (PPE)
- Ensure only competent and well trained personnel are used for the job
- Employ the best available Waste technology in its operations
- Prepare and implement an Emergency Response Plan.
- Contain any spills and clean up spills as soon as possible.
- Ensure an inventory of waste is developed and maintained
- Enforce the use of safe fuel handling procedures
- Maintain all equipment at optimal working conditions
- Dispose of organic material properly and in line with waste management regulation and in collaboration with local communities.
- Ensure all equipment are periodically maintained and records kept
- Adopting procurement practices that favour skilled and semiskilled indigenes of the area
- Provide dedicated fire fighting personnel and equipment within the work area.

- Undertake monitoring of natural resources exploitation and implement a sensitization program in order to educate and increase local communities' awareness on natural resources protection.
- Ensure The use of trained personnel in handling electrical wires
- Assume its cooperate responsibilities by assisting the host communities in their developmental drive, such as provision of infrastructures and social amenities where possible
- Implement training programs to build local capacity.
- Ensure all personnel are medically fit before mobilization to base camp
- Also subject all workers to periodic medical test
- Ensure that process wastewater is treated before discharging to nearby water bodies
- Encourage mutual existence between the workers and the communities by appointing community liaison officers (CLO).
- Communicate with communities effectively and involve their leaders.
- Prompt payment of all bills and fees to the appropriate government authorities
- Ensuring that tax deductions from employees get to the appropriate government agencies

Mitigation Measures During Decommissioning

- consult with relevant stakeholders (FMEnv, Host communities etc.) to decide on the best option for landuse after abandonment.
- ensure re-vegetation is effected with local species
- Clear all concrete rubble or debris
- Sell reusable parts to locals at greatly reduced prices
- Ensure decommissioning in the daytime to limit night time noise impact to locals
- Ensure all machines are well serviced and in optimal working conditions

CHAPTER 1

INTRODUCTION

1.1 Introduction

The company, Polo-Cico Farming and Estate Ltd., wants to realize an agricultural business in Ebocha, in Ogba/Ndoni/Egbema LGA, Rivers State. Two adjacent plots of land with a total of approximately 183 hectares are available for this purpose. Both plots will be provided with a ring road and border-fence.

The proposed project consists of components as outlined in table 1.1. The common infrastructure to be established within the scope of this EIA will include the internal ring roads, Life Camp, Helipad and the artificial Lake.

Table 1.1: Proposed Project components

	Project components
1.	Perimeter fence
2.	Internal ring roads
3.	Space for agriculture, 122 ha (future)
4.	Space for Production Facility and supply units, 15h (future)
5.	Life Camp
i.	Helipad
ii.	Lake (from construction borrow pit)

The proposed project construction involves:

- Surveying
- Site Clearing
- Piling works
- Earth Work
- Construction
- Decommissioning of construction sites
- Commissioning, operation and maintenance

1.2 Applicant's Intent

Polo-Cico Farming and Estate Ltd., the proponent, intends to undertake this environmental impact Assessment (EIA), to predict the impacts of this proposed agricultural business on the environment and propose mitigation measures that will be incorporated into the project environmental management plan and detailed engineering design. The EIA covers:

- Baseline studies - including biophysical studies, social and health impact assessment
- Consultation programmes
- Environmental quality assessment and impact quantification, using predictive modelling tools.

The EIA is being carried out in parallel with the conceptual design of the project, to ensure that any identified adverse impacts are addressed in the detailed design and mitigated during the development activity stages which involves site preparation, construction, commissioning, operation, decommissioning and abandonment.

1.3 Proposed Project Location

The proposed Ebocha Farm Camp is located in Ebocha, Ogba/Ndoni/Egbema LGA, Rivers State. The proposed project location is defined by latitude 5°25'39.41"N, longitude 6°41'17.30"E along the Ebocha - Omuku Road, to meet a tributary of Orashi River bank on latitude 5°26'51.98"N, longitude 6°40'15.35"E. (Figures 1.1 and 1.2).

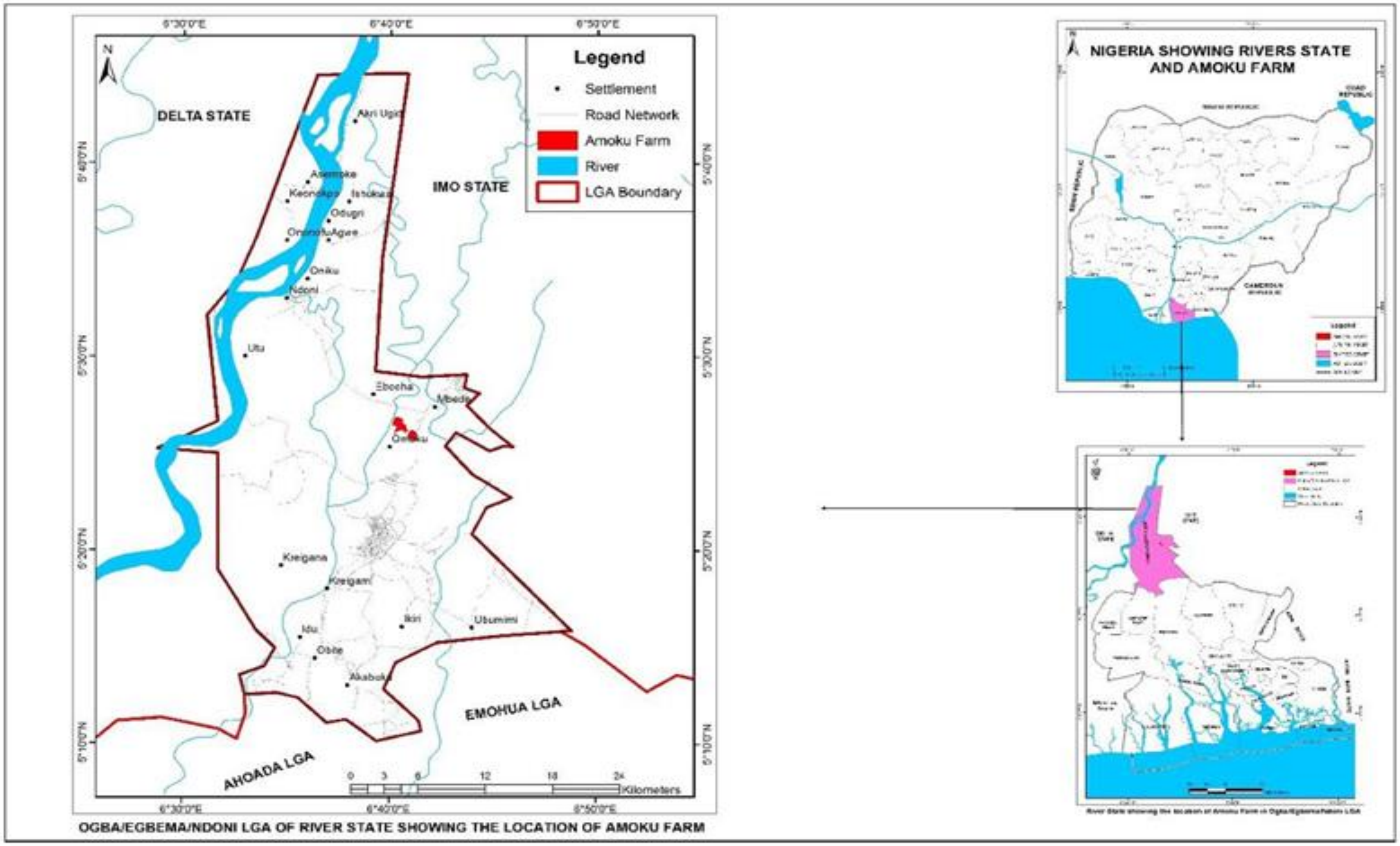


Figure 1.1: Map showing the location of the proposed Ebocha Farms

1.4 Site selection

The proposed site has been selected based on following considerations:

- Avoidance of human settlements as much as possible
- Limit of the number of property titles to be affected by the proposed project.
- Avoidance or maintenance of the minimum possible damages or losses on properties.
- Positioning of the proposed project in a reasonable distance from residential areas, play grounds, schools, health care centres, churches, community halls, etc.
- Avoidance, as much as possible, of archaeological sites, particularly shrines, burial grounds and historical sites.
- Avoidance of interference with environmentally sensitive areas particularly where Category 1 National Park exists.
- Avoidance of natural routes for the movement or migration of animals
- Avoidance of forest reserve and other critical ecosystems
- Minimization of water and road crossings
- Avoidance of areas with mineral deposits

1.5 Legal and Administrative Framework for EIA in Nigeria

The legal, regulatory and policy framework for carrying out the EIA of the proposed project is contained in the applicable acts and regulations of the Federal and State Government, statutes and international conventions to which the Nigerian Government is a signatory.

Various environmental studies and related strategic initiatives would meet or surpass the relevant Nigerian and international environmental legislative requirements and guidelines. These include but not limited to:

1.5.1 Federal Ministry of Environment

Federal Environmental Protection Agency (FEPA) now Federal Ministry Environment Act No 58 of 1988

Act 58 of 1988 established the Federal Environmental Protection Agency (FEPA) as the chief regulatory body for environmental protection in Nigeria. The Act establishing FEPA placed on it the responsibility of ensuring that all industries meet the limits prescribed in the national guidelines and standards and the associated various regulations of environmental pollution management in Nigeria (e.g. effluent limitation, management of solid hazardous waste, etc.). FMEnv may update the National Guidelines and Standards from time to time.

Relevant specific standards, discharge limits, and other environmental requirements of the FEPA guidelines (1991) and subsequent relevant directives were reviewed. In 1992, the Federal Government released the Environmental Impact assessment (EIA) Act CAP E12 LFN 2004. The Act makes the EIA process mandatory for any major development project and prescribes the procedures for conducting and reporting EIAs.

1.5.1.1 FMEnv's Guidelines on EIA

Federal Ministry of the Environment developed National EIA procedures following the enablement of the EIA Act CAP E12 LFN 2004. The procedure indicates the steps to be followed from project conception to commissioning to ensure that the project is implemented with maximum consideration for the environment.

EIA Sectoral Guidelines of the Federal Ministry of Environment

Federal Environmental Protection Agency (FEPA) was established by Act 58 of 1988 to monitor and prevent the pollution of the environment following the Koko toxic waste dump incident. This status empowered the then FEPA to prepare Environmental Guidelines and Standards as instruments for prevention of environmental pollution. This Act also gives specific powers to FMEnv to facilitate environmental assessment of projects.

In addition, FMEnv regulations S.I.8, S.I.9 and S.I.15 of 1991 provide guidelines and standards for the following:

- Solid and Hazardous waste management
- Effluent limitations
- Pollution abatement in industries generating waste.

In September 1995, EIA Sectoral Guidelines for proposed projects in Nigeria were published. The guidelines are intended to assist the proponent to conduct proper and detailed EIA Studies in compliance with the EIA Act of 1992.

The procedure for EIA involves the project proposal stage where the project proponent officially notifies FMEnv of the proposed project. This proposal is to contain concise information of the project including a land use map.

The legal and regulatory framework for carrying out EIA of the proposed project are contained in relevant national statutes and international environmental conventions to which Nigeria is a signatory.

This stage is followed by the screening phase, whereby an Initial Environmental Examination (IEE) is executed by the FMEnv then the projects are assigned into categories based on the following criteria:

Magnitude

- Extent or Scope
- Duration and Frequency
- Risks
- Potential Environmental Impacts

Another stage of FMEnv's EIA procedure is the scoping stage, the main feature of which the proponent is required to submit the Terms of Reference (ToR) for the proposed EIA. In some cases, the FMEnv may demand a Preliminary Assessment Report from the proponent to assist in vetting the scope and the ToR of the proposed EIA.

This stage is followed by:

- Actual Implementation of the EIA
- Preparation of Draft Report
- Final EIA Reports
- Review Process and Approval/Certification.

Apart from the general EIA Guidelines, the Ministry has issued sectoral guidelines for EIA in different infrastructural sectors.

National Environmental Standards and Regulatory Enforcement Agency (NESREA)

This is an agency under the Federal Ministry of Environment. It was established by Act 25 of 2007. The agency is charged with enforcing regulatory standards relating to environment. NESREA has developed the following twenty-four environmental regulations which have been published in the Federal Republic Official Gazette and are now in force. Table 1.2 lists the key regulations that are expected to be applicable to this proposed project.

Table 1.2: NESREA Environmental Protection Regulations Relevant to Project

Regulation	*Description*
National Environmental (Wetlands, River Banks and Lake Shores) Regulations (No 29 of 2009 Section 1 No 26)	Provides for the conservation and managed use of wetlands and their resources in Nigeria. It ensures the sustainable use of wetlands for ecological and tourism purposes and protect wetland habitats for associated species of fauna and flora.
National Environmental (Watershed, Mountainous, Hilly and Catchments Areas) Regulations (No 27 of 2009 Section 1 No 27)	Make provisions for the protection of water catchment areas.
National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28)	The purpose of this Regulation is to provide the legal framework for the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution.
National Environmental (Permitting and Licensing System) Regulations, 2009. S. I. No. 29	. The provisions of this Regulation enable consistent application of environmental laws, regulations and standards in all sectors of the economy and geographical region.
National Environmental (Access to Generic Resources and Benefit Sharing) Regulations, 2009. S. I. No. 30	The overall purpose of this Regulation is to regulate the access to and use of generic resources to ensure the regeneration and sustainability of threatened species.
National Environmental (Ozone Layer Protection) Regulation, 2009. S. I. No. 32.	This provision seeks to prohibit the import, manufacture, sale and the use of ozone-depleting substances.
National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35	The main objective of the provisions of this Regulation is to ensure tranquillity of the human environment or surrounding and their psychological well-being by regulating noise levels.
National Environmental (Soil Erosion and Flood Control) Regulations, 2010. S. I. No. 12	The overall objective of these Regulations is to check all earth-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.

Regulation	*Description*
National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, 2010. S. I. No. 15.	The principal thrust of these Regulations is to prevent and minimize the destruction of ecosystem through fire outbreak and burning of any material that may affect the health of the ecosystem through the emission of hazardous air pollutants.
National Environmental (Protection of Endangered Species in International Trade) Regulations, 2010. S. I. No. 16	The major objective of this Regulation is to protect species of endangered wildlife from extinction through the prohibition of trade, importation, etc.
National Environmental (Coastal and Marine Area Protection) Regulations, 2010. S. I. No 18.	This Regulation provides for the regulatory framework for the application of preventive, precautionary and anticipatory approaches to avoid degradation of the coastal and marine environment
National Environmental (Construction Sector) Regulations, 2010. S. I. No. 19.	The purpose of these Regulations is to prevent and minimize pollution from Construction, Decommissioning and Demolition Activities to the Nigerian Environment.
National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2010. S. I. No. 20	The purpose of these regulations is to restore, preserve and improve the quality of air. The standards contained herein provide for the protection of the air from pollutants from vehicular emission.
National Environmental (Non-Metallic Minerals Manufacturing Industries Sector) Regulations, 2010. S. I. No. 21	The principal thrust of this Regulation is to prevent and minimize pollution from all operations and ancillary activities of the Non-metallic Minerals manufacturing sector.
National Environmental (Surface and Groundwater Quality Control) Regulations, 2010. S. I. No. 22	The purpose of this Regulation is to restore, enhance and preserve the physical, chemical, and biological integrity of the nation's surface waters, and to maintain existing water uses

Source: *www.nesrea.com*

1.5.2 Other applicable national laws and regulations include

1.5.2.1 Harmful Waste (Special criminal Provisions etc) Act No 42

Activities relating to the purchase, sale, importation, transit, transportation, deposit and storage of harmful wastes are prohibited and declared unlawful under the Act. From the commencement of this Act, any person who, without lawful authority: (a) carries, deposits, dumps or causes to be carried, deposited or dumped, or is in possession for the purpose of carrying, depositing or dumping, any harmful waste on any land or in any territorial waters or contiguous zone or Exclusive Economic Zone of Nigeria or its inland waterways; or (b) transports or causes to be transported or is in possession for purpose of transporting any harmful waste; or (c) imports or causes to be imported or negotiates for the purpose of importing any harmful waste; or (d)sells, offers for sale, buys or otherwise deals in any harmful waste, shall be guilty of a crime under this Act. Remaining provisions deal with prosecution, crimes by body corporate and penalties.

1.5.2.2 Nigerian Airspace Management Agency (Establishment etc) Act CAP N90 LFN 2004

Establishment of the Nigerian Airspace Management Agency

(1) There is hereby established a body to be known as the Nigerian Airspace Management Agency (in this Act referred to as "the Agency").

(2) The Agency shall –

(a) be a body corporate with perpetual succession and a common seal;

(b) may sue or be sued in its corporate name; and

(c) Own, hold or dispose of property (whether movable or immovable).

PART III - Functions of the Agency

(1) The Agency shall-

(a) provide air traffic services in Nigeria, including air traffic control, visual and non-visual aids, aeronautical telecommunication services and electricity supplies relating thereto, to enable public transport, private, business and military aircraft fly, as far as practicable and as safely as possible;

(b) provide aerodromes at all the major Nigerian airports, the navigation services necessary for the operation of aircraft taking-off and landing and integrate them into the overall of air traffic within the Nigerian airspace;

(c) minimize or prevent interference with the use or effectiveness of all apparatus used in connection with air navigation and for prohibiting or regulating the use of all such apparatus and display of signs and lights liable to endanger aircraft and endanger the use of Nigerian airspace;

(d) generally secure the safety, efficiency and regularity of air navigation;

(e) require persons engaged in or employed in or in connection with air navigation, to supply meteorological information for the purpose of air navigation, as may be deemed appropriate from time to time;

(f) provide adequate facilities and personnel for effective security of navigational aids outside the airport perimeters;

(g) create conditions for the development, in the most efficient and economic manner, of air transport services;

(h) procure, install and maintain adequate communication, navigation and surveillance and air traffic management facilities at all airports in Nigeria.

(i) ensure an effective co-ordination in the use of Nigerian airspace in line with established standards and procedures;

(j) ensure the co-ordination at all levels of decisions relating to airspace management and air traffic control in Nigeria;

(k) hold meetings with the armed forces on Nigeria's international obligations as they relate to civil and military co-ordination;

(l) promote familiarisation visits by civil and military personnel to air traffic service units;

(m) maintain permanent liaison with the civil air traffic services units and all relevant air defence units, in order to ensure the daily integration or segregation of civil and military air traffic operating within the same or immediately adjacent portions of the Nigerian airspace, employing civil or military radars as necessary;

(n) obviate the need for civil aircraft to obtain special air defence clearance;

(o) take necessary steps to prevent, as far as possible, penetration of control airspace by any aircraft, civil or military without co-ordination with the air traffic control unit concerned;

(p) encourage research and development relating to all aspects of the Nigerian airspace designed to improve air safety;

(q) undertake systems engineering development and implementation for communications, navigation and surveillance and air traffic management;

(r) charge for services provided by the Agency;

(s) co-ordinate the implementation of search and rescue services; and

(t) discharge the operational, technical and financial air traffic service commitments arising from Nigeria's membership of international organization and other air navigation agencies.

1.5.2.3 Civil Aviation (Repeal and Re-Enactment) Act 2006

PART I- Control of Air Navigation

1. The Minister shall be charged with the responsibility for the formulation Control and of policies and strategies for the promotion and encouragement of civil supervision of civil aviation aviation in Nigeria and the fostering of sound economic policies that assure the provision of efficient and safe services by air carriers and other aviation and allied service providers as well as greater access to air transport in a sustainable manner and to assist with ensuring that Nigeria's obligations under international agreements are implemented and adhered to.

PART II – The Nigerian Civil Aviation Authority

(1) There is hereby established a body to be known as the Nigerian Establishment of Civil Aviation Authority (in this Act referred to as "the Authority"). the Nigerian Civil Aviation Authority

(2). The Authority

(a) shall be a body corporate with perpetual succession and a common seal.

(b) may sue or be sued in its corporate name; and

(c) may acquire, hold or dispose of property whether moveable or immovable.

PART VI - Information, Notices, etc.

(1) For the purpose of obtaining required information for the proper Power to request discharge of the functions conferred upon it by this Act, any authorised for information officer of the Authority may by notice in writing

(a) require any person who undertakes the business of air transport including carriage of passengers or goods in an aircraft for reward, to furnish such information relating to such business and flights as may be specified in the notices; and

(b) specify the times and the form and manner in which, any information required under paragraph (a) of this subsection shall be furnished.

(2) In carrying out the functions conferred on the Authority, an authorized officer of the Authority shall have unrestricted access to the business premises, aircraft, structures and other apparatus used by any operator for the purpose of air transport or related operations.

PART XV – General

(1) The Authority in consultation with other relevant government Power of Authority agencies may, make regulations for the prevention of danger arising to to make rules for Protecting Public public health by the introduction or spread of any infectious or Health contagious disease from aircraft arriving at or being at any aerodrome and for the prevention of the conveyance of infection or contagion by means of any aircraft leaving an aerodrome.

The Authority may, by regulation provide that a breach of any regulation made pursuant to subsection (1) of this section shall be punishable with imprisonment for a period not less than 1 month or a fine of not less N100,000.00 or both.

1.5.2.4 Criminal code

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

❖ violates the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carrying 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.

Land Use Act CAP 202 LFN 2004

The Land Use Act of 2004, the Constitution of 1999 and the Public Lands Acquisition Laws of the relevant states constitute the governing policy for land acquisition in Nigeria. As is the case with most national and state laws on compulsory acquisition of land in the public interest or for a public purpose, the legislation enables the State to acquire land (more precisely, to abrogate leases and other authorizations to occupy land). The Act also specifies the procedures the State must follow to clear the land, and defines the compensatory measures the State must implement in order to compensate the people affected.

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

This law established a Development Control Department (DCD) charged with the responsibility for matters relating to development control and implementation of physical development plans at Federal, State and Local Government levels within their respective jurisdiction.

FRSC Act CAP 141 LFN 2007

In February 1988, the Federal Government created the Federal Road Safety Commission through Decree No. 45 of the 1988 as amended by Decree 35 of 1992 referred to in the statute books as the FRSC Act CAP 141 Laws of the Federation of Nigeria (LFN). Passed by the National Assembly as Federal Road Safety Commission (establishment) Act 2007.

National Inland Waterways Authority (Act CAP N47 LFN 2004)

The National Inland Waterways Authority (NIWA), hitherto Inland Waterways Department (IWD) of the Federal Ministry of Transport, metamorphosed into an Authority vide an act of the National Assembly, CAP 47, Laws of the Federation of Nigeria (LFN), 2004 (Act No. 13 of 1997), established with the primary responsibility to improve and develop Nigeria's inland waterways for navigation.

The law establishing NIWA gave it the following statutory roles

- Provide regulation for inland water navigation;
- Ensure development of infrastructural facilities for a national inland waterways connectivity with economic centres using the River Ports and nodal points for inter-nodal exchanges;
- Ensure the development of indigenous technical and managerial skills to meet the challenges of modern inland waterways transportation; there are several other functions and powers of the authority properly enunciated and documented in laws establishing NIWA (NIWA ACT CAP N47 LFN 2004).

Harmful Waste (Special criminal Provisions etc) Act No 42

Activities relating to the purchase, sale, importation, transit, transportation, deposit and storage of harmful wastes are prohibited and declared unlawful under the Act. From the commencement of this Act, any person who, without lawful authority: (a) carries, deposits, dumps or causes to be carried, deposited or dumped, or is in possession for the purpose of carrying, depositing or dumping, any harmful waste on any land or in any territorial waters or contiguous zone or Exclusive Economic Zone of Nigeria or its inland waterways; or (b) transports or causes to be transported or is in possession for purpose of transporting any harmful waste; or (c) imports or causes to be imported or negotiates for the purpose of importing any harmful waste; or (d) sells, offers for sale, buys or otherwise deals in any harmful waste, shall be guilty of a crime under this Act. Remaining provisions deal with prosecution, crimes by body corporate and penalties.

Nigerian Standard for Drinking Water Quality (Industrial standard NIS554:2007)

This standard is intended to ensure the safety of drinking water supplies and protection of public health, and to encourage the improvement of management of all drinking water systems in the country. The standard parameters and maximum allowable limits for drinking water in Nigeria. It also includes normative references/laws guiding drinking water quality, definition of terminologies, institutional roles and responsibilities, monitoring, data management and compliance criteria.

Endangered Species Act 2016

Section 1 (prohibition of hunting of or trading in wild animals) of the Endangered Species Act ii of 1985 (amended in 1990) prohibits the hunting, capture and trade of endangered species such as otter, shrew, giant/tree/long-tailed pangolin, colobus monkeys, chimpanzee, gorilla, african palm squirrel, lion, leopard, cheetah, hyenas, immature elephant, giraffe, whales, dolphins, porpoises, crocodiles, etc. the endangered species Act, Cap E9, LFN 2016 focuses on the protection and management of Nigeria's wildlife and some of their species in danger as a result of overexploitation .

- Section 1: prohibits, except under a valid license, the hunting, capture or trade in animal species, either presently or likely being in danger of extinction.
- Section 5 define the liability of any offender under this act
- Section 7 provides for regulations to be made necessary for environmental prevention and control as regards the purposes of this act.
- The Act also stipulates pertinent permits, certificates, and the processes for trading of the identified endangered species as well as prescribes penalties for contraventions.

The Labour Act 1990

The Labour Act (1990) is the primary law protecting the employment rights of individual workers. The act covers protection of: wages; contracts; employment terms and conditions; and recruitment. It also classifies workers and special worker types. Union membership is governed by the Trade Union Amendment Act (1995). 1999 constitution includes stipulation of "equal pay for equal work without discrimination on account of sex, or any other ground whatsoever".

While Nigeria has ratified all eight core International Labour Organization Conventions and enacted laws to enforce the provisions, there are indications of restrictions on the trade union rights of workers in Nigeria, discrimination, child labour and forced labour.

1.5.3 Rivers State Ministry of Environment and Mineral Resources

The Rivers State Ministry of Environment (RMEnv) has the overall responsibility (directly or indirectly through various agencies) of environmental protection within the state. With respect to the proposed project the Rivers Environmental Protection and Waste Management Agency Law no. 8 of 2000 (an agency under the supervision of RMEnv) states that:

- No person shall cause any waste generated in the process of manufacturing of business operation to be discharged without treating or purifying it in accordance with the standards approved by the Agency;
- No person shall discharge or cause to be discharged untreated human waste into any public drain, watercourse, gorge storm water, drainage or into any land or water;
- No person shall discharge any form of oil, grease or spent oil produced in the course of any manufacturing operation or other type of business into any public drain, watercourse, water gorge or road verge, any such waste which is to be discharged by the person generating it shall have been certified as having complied with set-down and approved standards by the agency;
- No person shall discharge into the air inadequately filtered and purified industrial gaseous waste containing substances injurious to life and property, such as sulphur dioxide, oxides of nitrogen, hydrogen

fluoride, sulphide, carbon monoxide, ammonia, chlorine, smoke and metallic dust, particulate and other injurious gases;

- No person shall dump or burn or cause or allow to be buried or dumped in any land or water any toxic, hazardous substance or harmful waste;
- No person shall establish petrol stations, gas plants or other petroleum related activities without adherence to approved environmental standards; and
- No person shall engage in any form of petroleum exploration or production activities which cause pollution of the environment through spillage.

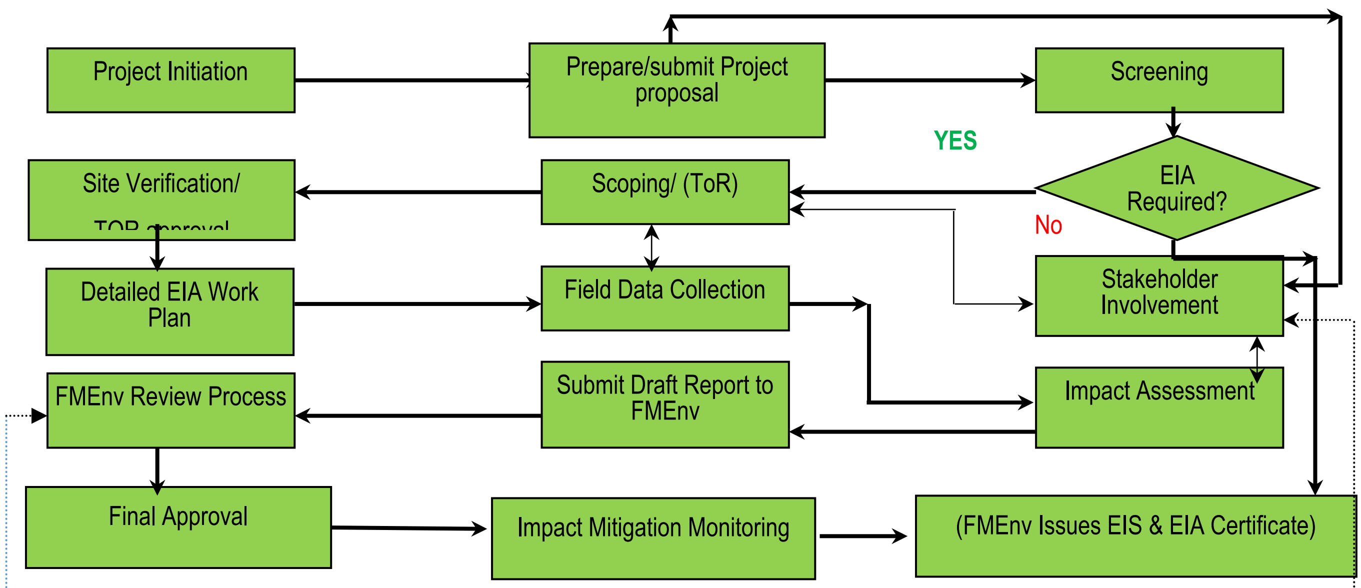


Figure 1.2: FMEnv.'s EIA Process

1.5.4 International Guidelines and Conventions

In addition to the national laws and regulations, Nigeria is signatory to several international conventions and treaties supporting the use of EIA as the key tool for achieving pollution control and sustainable environmental development.

- **Basel Convention on the Control of trans-boundary Movement of Hazardous Waste and their Disposal**

The Basel Convention addresses the worldwide concern over the risks posed by the generation and disposal of hazardous and other harmful substances. This Convention classifies the waste and controls the Trans-boundary movement of hazardous waste and other harmful substances against the adverse effects it can impose on human health and the environment. In the proposed road project, no waste generated shall be transported outside the country.

The objectives of this convention, in addition to the Montréal protocol and the London amendment (1994) are:

- To protect human health and the environment against adverse effects resulting or likely to result from human activities, which modify or are likely to modify the ozone layer; and
- To adopt agreed measures to control human activities found to have adverse effects on the ozone layer.

A comprehensive list of international regulations and conventions has been provided in Table 1.3. These treaties support the use of EIA as key tool to achieving pollution control and sustainable environmental development.

Table 1.3 International Legislation Summaries

S/NO	Regulations	Year Adopted
1.	World Bank Environmental Assessment Source Books	1998
2.	UN Convention on Biological Diversity	1994
3.	UN Framework Convention on Climate Change	1992
4.	Convention on the Control of trans-boundary Movements of Hazardous Waste an their Disposal of 1989 (Basal Convention)	1989
5.	Protocol on Substances that Deplete the Ozone Layer. Note: The Protocol was amended for the first time on 29 June 1990 in London. A second set of amendments was adopted in Copenhagen in November 1992; these entered into force on 1994.	1987
6.	Convention for the Protection of the Ozone Layer	1985
7.	Convention Concerning the protection of the World Cultural and National Heritag (World Heritage Convention)	1972
8.	African Convention on the Conservation of nature and Natural Resources	1968

1.6 Environmental Impact Assessment

Polo-Cico Farms and Estate Ltd has undertaken the environmental impact Assessment (EIA), to predict the impacts of this proposed project development on the environment and propose mitigation measures that will be incorporated into the project environmental management plan and detailed engineering design. The EIA covers:

- Baseline studies – including biophysical studies, social and health impact assessment
- Consultation programmes

- Environmental quality assessment and impact quantification, using predictive modelling tools.

The EIA is being carried out in parallel with the conceptual design of the project, to ensure that any identified adverse impacts are addressed in the detailed design and mitigated during the development activity stages which Involves site preparation, construction, commissioning, operation, decommissioning and abandonment.

Terms of Reference for the EIA

In line with the EIA Procedural guidelines (FMEnv, 1995) the terms of reference (ToR) for EIA of the proposed project was submitted to the FMEnv and approval obtained defining the scope of work, objectives, baseline data requirements and assessment tools and methods for the EIA. The document also outlined the regulatory and administrative framework within which the EIA is conducted, highlighting key issues and activities of environmental concerns in the proposed project planning and implementation.

EIA Methodology

The procedure adopted for completing this EIA involved site identification and characterization, consultation with stakeholders and experts, literature review, field sampling, laboratory analysis and interpretation, collection of data, impact identification and evaluation, environmental impact analysis, impact mitigation and environmental management planning. The preparation of the report was performed by a multi-disciplinary team. The team selection was based on characteristics of the project environment, experience and subject discipline of each specialist. A team leader coordinated the tasks of team members towards achieving set targets as well as liaison with client.

This EIA study was conducted in compliance with Federal Ministry of Environment requirements. The methods adopted in performing specific tasks of the EIA for the proposed project are as follows.

Desktop Research

The geography and the relevant environmental and socio-economic information on the proposed project location were gathered from maps, charts, articles, previous study reports on the area and similar environment, photographs, etc. The information generated enabled definition of limits of the area to be studied. Data gap analysis was carried out to identify areas where additional information was required and the result used in planning the execution of field sampling and measurement aspects of the EIA project.

Field data Collection

The information gathered from desktop research and site identification were used in categorizing the major habitats in the area, and their respective sampling requirements defined to effectively collect qualitative and quantitative data on the flora and fauna of the project area. The fieldwork covered all relevant elements of the ecological and socio-economic environments.

Consultation with Stakeholders and Experts

In order to efficiently deliver improved project sustainability and protect the interest of the affected communities, especially the poor and vulnerable, an elaborate public consultation process was undertaken as part of this EIA. It involved engaging each identified community in a dialogue characterized by two-way information flow. Consultation allowed obtaining from the affected population, information that might influence the decision-making process in scoping, project design, mitigation, monitoring and management plans, as well as the analysis of alternatives to be implemented.

Impact Identification and Evaluation

The environmental aspects of the proposed project that may interact positively or negatively with the environment at the construction, operation and decommissioning phases were identified at this stage of the assessment. In the identification and evaluation process, the information collated, were processed using procedures in the FMEnv EIA Sectoral guidelines for Infrastructure projects and the World Bank Environmental Source Book.

Impact Mitigation

Mitigation measures designed to prevent, reduce or control the adverse impacts of the proposed project activities were proffered using professional judgment based on scientific deductions and project experience. Other resource documentation referred to include the FMEnv Sectoral Guidelines for infrastructures projects, and the World Bank Environmental Assessment Source Book. Similarly, enhancement measures were proffered to ensure that beneficial impacts of the project were optimized. Furthermore, post-auditing or monitoring has been designed into the project and its environmental management plan.

Objectives of the EIA

This EIA is executed to establish the environmental baseline, sensitivities, impacts and mitigation measures with respect to the development (including operation) of the proposed project. EIA will ensure the effective systematic study process; these include:

- assessment of the present environment status, establishment of environmental issues and factors which are associated with the proposed project development;
- assessment and prediction of all possible and potential impacts of the project on components of the environment in terms of magnitude and importance;
- evaluation of alternatives and identification of the best options that is both cost effective and with least potential environmental impact; and
- incorporation of EIA recommendations into the proposed project's detailed design as well as other stages of the project development.

Benefits of the EIA

The benefits of the EIA will include, but not limited to:

- obtaining permits usually required by regulatory authorities before the commencement of any major development
- providing a forward-planning tool for environmental implications to be taken into account with other design considerations at the conceptual design stage which allow important decisions to be built into the project while avoiding undue damage to the environment;
- providing a design tool that will allow a systematic evaluation of potential environmental problems from the proposed project and identification of key issues which require special consideration for effective environmental management and controls;
- involving all stake holders through consultation so as to address common problems, impacts and mitigating measures that might be proposed; and
- informing and assisting management with a view to establishing and achieving long term management objectives and plans associated with specific activities, in order to minimize associated financial and environmental risks.

1.7 Structure of the EIA Report

The EIA Report is presented in eight chapters.

- Chapter one is an introduction containing relevant background information and the legal and administrative framework for EIA in Nigeria among other information;
- The second chapter presents the project justification, the need/value and its envisaged sustainability as well as the project development and site/route options considered;
- Chapter three contains detailed description of the proposed project including its location, overall layout, basis for design, type and specifications of equipment/facilities to be installed and operation/maintenance of the proposed project;
- The fourth chapter describes the baseline biophysical and socio-economic status of the study area respectively.
- Chapter five discusses the Information on consultation with stakeholders;
- Chapter six presents the identified potential and associated environmental impacts of the proposed project and the various mitigation measures proffered against the identified significant impacts;
- Chapter seven provides a cost-effective environmental management plan that would be adopted throughout the project’s lifecycle. It also enumerates the environmental monitoring programme, the waste management programme and the project’s decommissioning/abandonment plan.
- Chapter eight concludes the report and requests approval for project implementation.

Other sections of the report include (not in any chronological order) the table of content, the list of references, list of EIA preparers, list of abbreviations and acronyms, acknowledgement page, the executive summary and various appendices.

CHAPTER 2

PROJECT JUSTIFICATION

2.1 Introduction

This chapter provides information on the project in terms of the need for the project and the benefits. It also presents a number of project alternatives that were considered during the project design.

2.2 Need for the Project

The proposed Ebocha Farms project is timely and essential to exploit the features of the location and which has a prosperity feature of mechanized agriculture in a strategic manner for socioeconomic empowerment of the people and for a sustainable economic development.

The exploitation of these features would provide employment and skill acquisition opportunities for Nigerians through direct and indirect involvement of contractors, consultants, suppliers and other professionals especially during the construction and operations phases of the project.

2.3 Value of the Proposed Project

The total project estimated cost is three hundred and seventy-five billion naira to be raised via investment partnership within and outside Nigeria. It will also add to the infrastructural development, economic, social and health advancement of the host communities, Local, State and Federal Governments at large.

Also, it will add value in terms of improved and / additional infrastructural and social amenities, influx of businesses and people, etc. at all levels.

During the construction phase about 400 people on an average will be employed. The manpower requirement of the proposed Ebocha farms during operation and maintenance period is estimated to be over 500 people when fully completed.

2.4 Proposed Project Options and Alternatives

For project alternatives analysis, the proponent explored a number of alternatives to the proposed project action to identify the most environmentally-sound alternative that would also achieve the desired project objectives.

The proponent and the stakeholders identified the potential adverse environmental impacts of each alternative and then compared them to select the most appropriate alternative and in the process, arrived at two possible outcomes.

2.4.1 Option One – No Development Option

The no-development option simply means that the proponent does nothing to commence the construction of the infrastructure/structures designed for or associated with the project.

The obvious outcome of this alternative/option would be a negative effect on the housing, tourism and agricultural prospect of Nigeria. This would put a major constraint to socio-economic growth and opportunities (enabling environment for investors, industrialization, etc.) associated with such a world class institution/establishment.

This option was rejected on the grounds that although all associated impacts of the proposed project are mitigable, the no-development option will rob the state as well as Nigeria, whole of the benefits of the proposed project.

The environmental and social effects as well as the negative impacts of the construction and operations activities would therefore not occur. Additionally, there would be no additional noise, air and effluent emissions into the environment. If the project does not go ahead, the positive impacts would not occur.

There would be no additional employment during the construction and operational phases. At a national level, Nigeria will forgo foreign currency injections as a result of the operations.

2.4.2 Option Two – Delayed Project Option of Construction of Life Camp and Infrastructure at Polo-cico farms

This option means that the project will remain unconstructed adding to the number of years that it has remained so. This is a harbinger to the proposed development. It would mean leaving the large area of land to keep lying fallow and unproductive.

The original vision of the proposed project could go extinct as time waits for no one and the visioner may not live to see the dream come true.

Delaying the construction of the proposed project could lead to a change in interest of the original purpose for the acquisition of the land. A change in government policy can lead to the revocation of the land for other land use. All these add up to why this option was rejected.

2.4.3 Option Three – Construction of a Life Camp and Infrastructure at Polo-cico farms Option

This option means going ahead to implement the construction of the proposed project. This alternative is accepted and recommended for implementation. Apart from the fact that all envisaged impacts are mitigable, the project will provide access to high quality Agricultural, industrial and commercial infrastructure in the state and beyond. The goals of the proposed proposed are to:

- Foster a sense of place and community identity
- Ensure safety and security
- Provide diverse and mixed land uses and housing options
- Incorporate multi-functional green infrastructure
- Support sustainable and low impact developments
- Integrate productive landscapes and food systems planning
- Support employment and education opportunities
- Accommodate development phasing and expansion needs

2.5 Analysis of Project Alternatives

In developing the concept and the design of the project, a number of alternatives were considered. The following sub-section provides a description of the following:

- Alternative projects
- Power alternatives and
- Layout alternatives

Alternative Projects

The sole aim to construct the Life Camp and Infrastructure at Polo-cico farms was the only alternative considered in terms of projects alternatives. This sole alternative of constructing the proposed project was chosen based on the vision of the proponent. The vision is to construct a multifunctional facility which would accommodate housing, schools, hospitals, industrial and commercial activities, and very importantly, harnessing the orashi river for the future development of the modernized agriculture and the artificial lake.

No other project was considered best to carry out than the proposed project.

Power Alternative

There are various power sources common in Nigeria like gas-fired turbines and hydroelectricity which are evacuated to the national grid, transmitted and distributed to consumers. The grid is the facility's first choice of power. The reason for this is because it is less cumbersome to manage. It comes with no responsibility other than to pay as you use. The proposed project will also employ the use of solar and diesel generators as back-up for the facility.

Layout Alternative

The proposed project is being carefully designed bearing in mind the natural environment. The orashi river is adapted in the layout to suit the purpose of supplying water for the artificial Lake as shown in figure 3.2 and for agricultural activities in future development (figure 3.3).

Some trees in the lush green forest will remain and be incorporated into the existing layout; this will mitigate the effect of greenhouse gases, as most of the trees are older than twenty years and will be needed to maintain a good carbon cycle.

2.6 Envisaged Sustainability

The envisaged sustainability of the proposed Life Camp and Infrastructure anchors on the following points:

2.6.1 Technical sustainability

The proposed project will be technically sustainable since Polo-Cico farms is employing proven architectural conceptual designs who have proven construction management records for the project execution. The Polo-Cico farms proven experience and available technical manpower will also ensure the technical sustainability of this project and will also ensure judicious use of all resources.

2.6.2 Economic sustainability

Economic sustainability of the project is guaranteed by Polo-Cico farms and some development partners that have expressed interest on completing of the project since it shall be income generating because of the expected global patronage. In addition, the proposed project will create jobs during construction and operation to people in the area.

2.6.3 Social sustainability

In view of the proponent’s continuous consultations with stakeholders including host communities and institutions, a cordial relationship shall be maintained with the people. This no doubt, will create a sustainable social relationship between the proponents and the host communities and will in turn ensure social sustainability of the project.

2.6.4 Environmental sustainability

Integrating the results and recommendations of this Environmental Impact Assessment (EIA) and enforcing an effective Environmental Management Plan (EMP) at all stages (planning, design, construction, operation and abandonment) of the project is bound to ensure environmental sustainability.

CHAPTER 3

PROJECT DESCRIPTION

3.1 Introduction

The proposed project is an agricultural business in Ebocha, in Ogba / Egbema / Ndoni LGA, Rivers State. Two adjacent plots of land with a total of approximately 183 hectares are available for this purpose (Figure 3.1). Both plots will be provided with a ring road and border-fence.

The bigger plot of 122 ha is reserved for upstream agricultural purposes which are outside the scope of this EIA; while the 61 ha will accommodate the proposed Life Camp, the subject of this EIA. The Life Camp will have the following components:

i. Entrance Gate
   a. 6.0m wide; main entrance and emergency entrance

ii. Gate house
   a. 6m by 4m wide rounded by gravel around building;
   b. 1no 900m by 2100m door china imported door,
   c. 2nos 1.2m by 1.2m window sliding,
   d. 1no 750 by 2100mm door,
   e. 1no 600 by 600mm size window.

iii. Lake
   a. Area of coverage 2,405sqm,
   b. 5.0m depth, surrounded by retaining wall,
   c. link road of 2.0m to lakeside cottage.

iv. Lakeside cottage
   a. 7nos suite, lounge,
   b. reception,

c. dining area, gravel around building,

d. building area of 12m by 22m,

e. 5nos car parking area,

f. walk way to link to building 2.0m wide

v. Swimming pool area

a. 6m by 15m length,

b. 2.6m depth

vi. Club House/Canteen

a. covering a land area of 10m by 22m floor area,

b. 10nos car parking lots

vii. Wire mesh fence area

a. (36m by 2) by (30m by 2m) area,

b. 2m of height

viii. Sewage tank

ix. Water reservoir

a. ground tank,

b. water reservoir rounded gravel stone round the building,

c. access road to link all the building of 6m wide

x. Generator House

a. 5m by 12m wide,

b. concrete base for 2nos 250kva generator,

c. office/control room,

d. diesel storage, with sump 110% the combined capacity if the tanks

e. gravel around building

xi. Staff accommodation

a. 2nos kitchen,

b. 6nos rooms en-suite of 3.5m by 6.5m,

c. link walkway,

d. parking lots for 6nos cars

xii. 7nos 1bedroom flats, dining,
a. main lounge, kitchen,

b. 2bedroom,

c. sit out,

d. gravel around building,

e. 2nos space for car parking,

f. link walkway 1.5m wide,

g. 7m by 12m wide

xiii. 2-bedroom flat 2nos; 2nos bedroom en-suite, kitchen, dining, main lounge, parking lots 2nos cars, area 9m by 15m

xiv. Lawn tennis court
a. 30mby15m,

b. 10nos parking lot 10 cars,

c. walkway to link road and tennis court.

xv. Helipad landing; 27m by 27m area space, concrete base finish

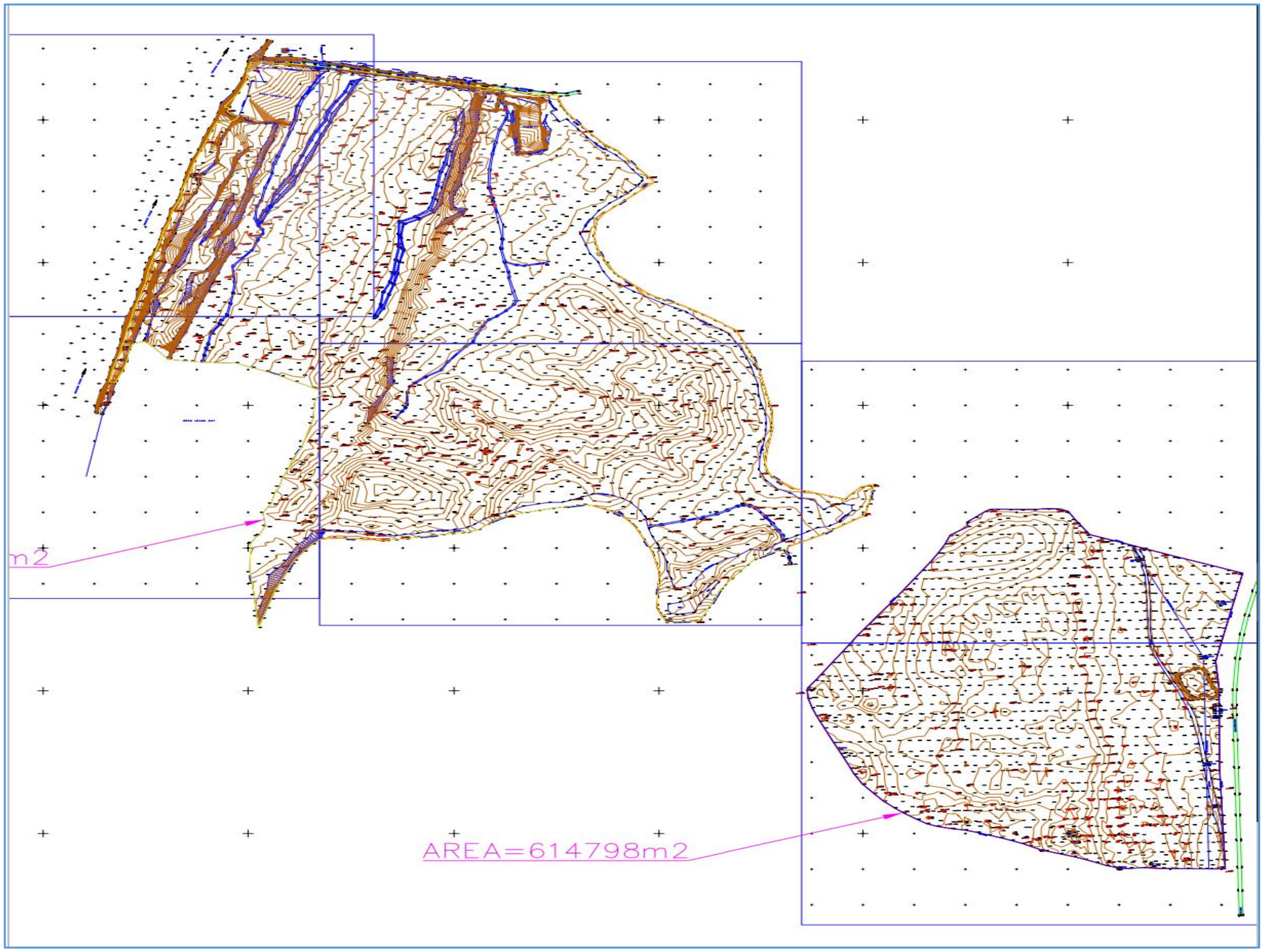


Figure 3.1: Layouts of the two Plots

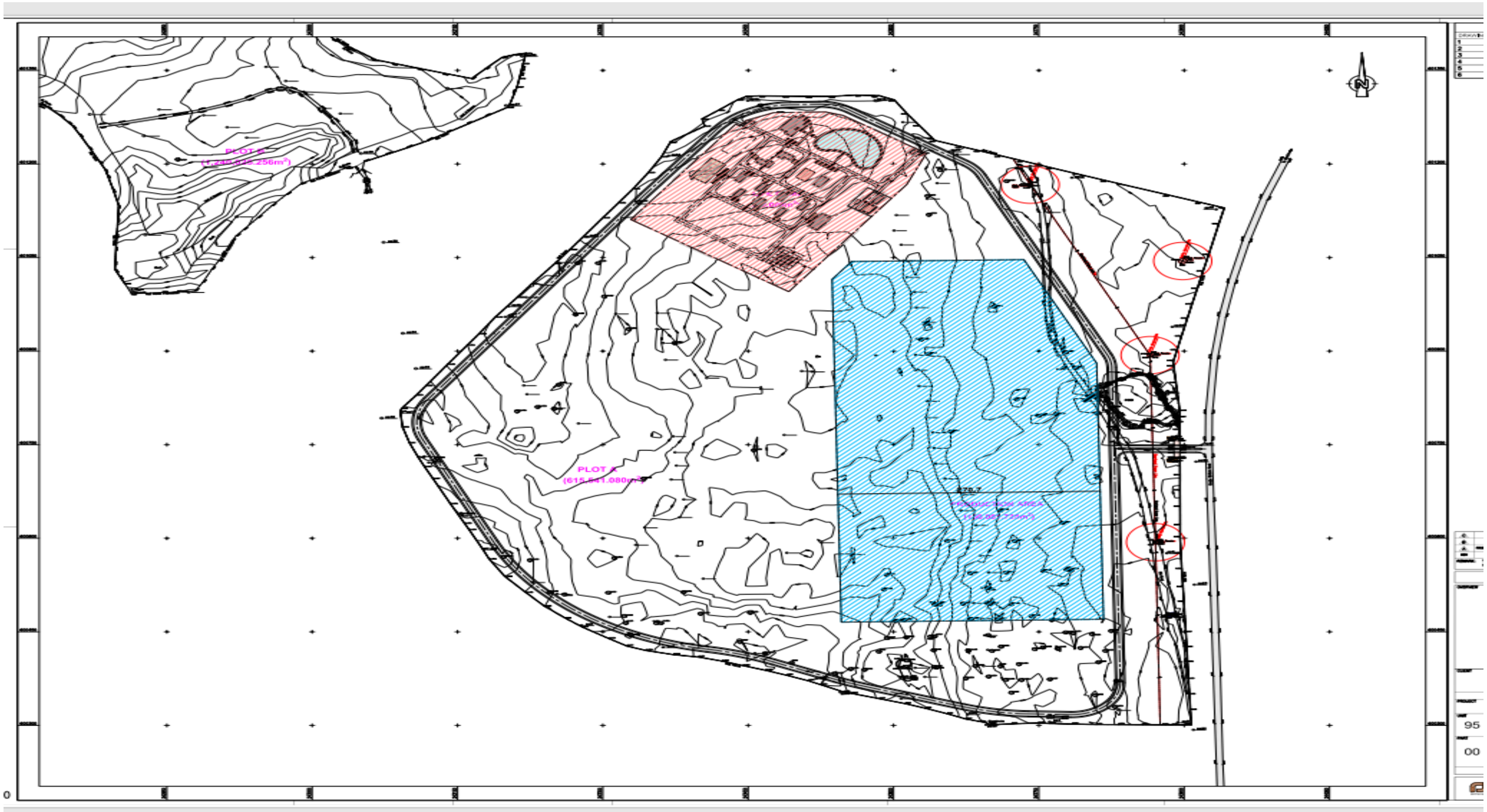


Figure 3.2: Layout of the plot of the proposed Life Camp

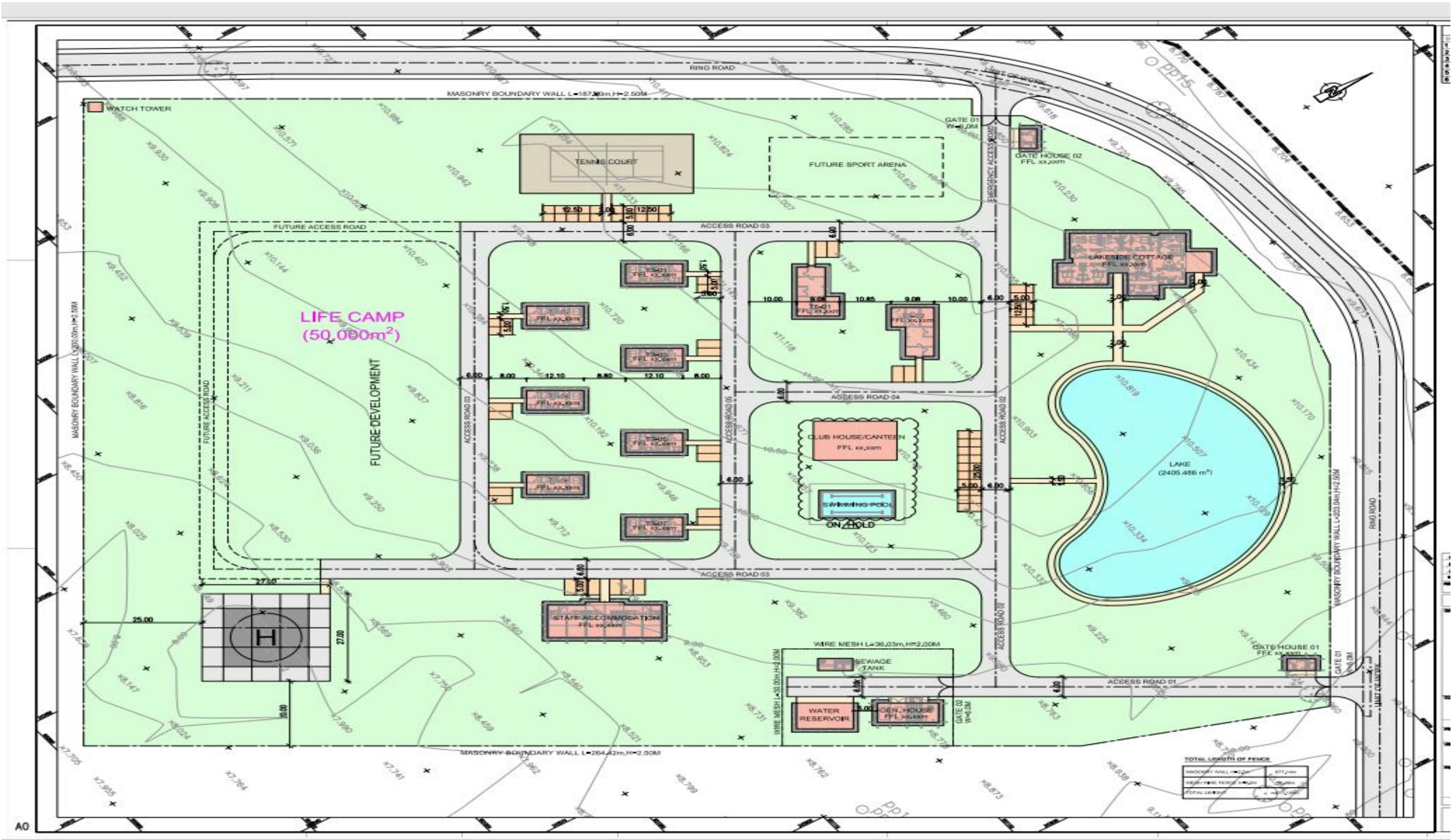


Figure 3.3: Layout of the Proposed Life Camp

3.2 Helipad Construction

The heliport, a designated helicopter landing area, will be constructed at the northeastern end of the proposed Life Camp facility (see proposed facility area layout, Figures 3.2 and 3.3). The proposed helipad will be constructed out of concrete and marked with a circle and/or a letter "**H**", so as to be visible from the air. The summary of the major features of the proposed construction are:

-Working in a heavily trafficked area including interfacing with the Public.
-Risk Management.
-Temporary hoarding.
-Earthmoving/Clearing of the site and excavation of trenches for electrical ducts and storm sewers. Tie-in to existing storm sewer-road crossing.
-Concrete works which will include the construction of the helipad.
- Installation of lighting and associated cabling.
-Installation of switchgear.

3.2.1 Proposed Helipad Basic Data

Definitions

- **Final Approach and Takeoff Area (FATO).** A defined area over which the final phase of the approach to a hover, or a landing is completed and from which the takeoff is initiated.

- **Safety Area.** A defined area on a heliport surrounding the FATO intended to reduce the risk of damage to helicopters accidentally diverging from the FATO. This area should be free of objects, other than those frangible mounted objects required for air navigation purposes.

- **Touchdown and Lift-off Area** (TLOF). A load bearing, generally paved area, normally centered in the FATO, on which the helicopter lands or takes off.

Helipad Thickness

The proposed helipad will be constructed to have a greater than 6-inch thick (>0.15m) Portland Cement Concrete (PCC) pavement that will be capable of supporting operations by helicopters weighing up to

≥20,000 pounds (≥9,070kg).

3.2.2 Proposed Helipad Design

The proposed helipad will be design to have a non-slip surface and silica sand will be added to the paint to maintain the integrity of the non-slip surface.

Reflective glass beads will be added into portions of the painted helipad surface, specifically boundary markings, to help to identify these areas more clearly at night.

3.2.3 Drainage and Wind Indicator

Drainage

The proposed helipad shall be pitched or sloped so that drainage flows away from access points and passenger holding areas.

Drains on and surrounding the helipad shall restrict the spread of fuel, this will reduce fire and explosion hazards from fuel spillage. A fuel/water separating system is a very important safety facility will be added to the proposed Life Camp Facility Helipad drainage structures.

Wind Indicator

The proposed helipad will have a windsock that will show the direction and magnitude of the wind. The windsock for the proposed helipad will have the following properties:

- -Minimum of 6-8 feet in length.
- -Lighted for night operations.
- -Not too close to the helipad.
- -Ground based, elevated at least 10-15 feet above ground level and not blocked by any structures or vegetation.
- -Placement to reflect accurate wind speed and direction.

3.2.4 Proposed Helipad Marking

A red capital letter **H** will be located in the center of the cross and oriented in the preferred direction of takeoff and landing taking into account obstacles and prevailing winds.

3.2.5 Proposed Helipad Lighting

Flush green lights will be installed to define the TLOF perimeter. A minimum of three flush light fixtures will be used per side of the hexagon TLOF. A light will be located at each corner with additional lights uniformly spaced between the corner lights with a maximum interval of 25 feet (8 m) between lights.

Flood lights will be installed at pad level and aimed down so as not to interfere with a pilot's night vision.

3.3 Operations and Maintenance

3.3.1 Proposed Facility Operations and Maintenance

The facility manager will provide the ongoing operation, maintenance and lifecycle management of the proposed Life Camp facility including the following services;

- General management services
- Sustainability services
- Help desk services
- Utilities management services
- Roads and grounds maintenance services
- Parking management services

The successful management consultant will be responsible for the provision, maintenance and repair, and as appropriate, replacing and upgrading of all physical plant, mechanical systems, electrical systems, building structure, fixed equipment, building finishes and fixed furnishings required to maintain the facilities in a condition fit for the intended uses.

3.3.2 Proposed Helipad Operations and Maintenance

- **Communication**

The proposed helipad will use the standard emergency Room Network frequency for reports.

- **Safety**

Do not approach a running helicopter unless instructed to do so by the crew.
Always approach from the front in full view of the pilot and only when the pilot says it is safe to do so.

Secure all loose items in the vicinity of the landing area.

- **Fire Extinguishers**

For safety purposes the proposed facility and helipad will be equipped with fire extinguishers of the appropriate types.

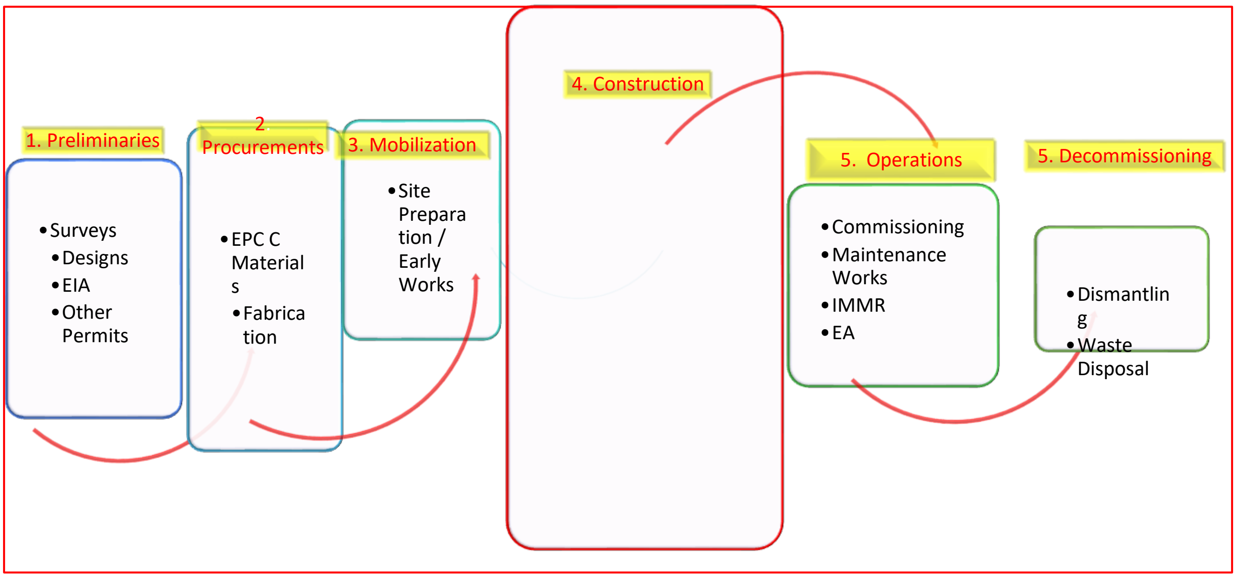
A fire hose cabinet or the appropriate extinguisher will be provided at each access gate/door and each fueling location. At the refueling station, a foam system will be installed.

3.4 Construction stages

These parts of the project are typically constructed in the sequence shown in Figure 3.4:

3.4.1 Life Camp Work Scope

Figure 3.4 presents flow chart of the work scope and the principal sequence of construction works process for the proposed Life Camp:



Figures 3.4: Flow Chart of the Work scope

Table 3.1: Material Balance

S/N	Material Input		Product Output	
	Material	Quantity/Month (Tons)	Product	Quantity/Month
1	Cement	513	Concrete	1426m^2
2	River sand	1975	Asphalt	7140 tons
3	Stone dust	2691		
4	Grave 5/15	3340		
5	Gravel 15/22	1890		
6	Bitumen	350		

Source: Resourcefield 2020

3.4.2 Energy Consumption

The project yard shall 4 Nos, 1275kVa generators which supply electrical energy for its operations. Three of the generators are operational for 24hrs while one is on standby. The generators consume about 800 litres of diesel (Automotive Gas oil – (AGO) per day (i.e. 400 litres per generator per day).

3.4.3 Major Construction Equipment

The major equipment to be deployed for the construction of the proposed Life Camp are listed in Table 3.2.

Table 3.2: Major Project Equipment

SN	Equipment	Number
	Air Compressor	3
	Ambulance	2
	Back-hoe Loader	3
	Borehole machine	2
	Bulldozer	6
	Concrete Batching Plant	1
	Concrete Mixing Machine	1
	Concrete Pump (Mobile)	3
	Crawler Crane	1
	Dump Truck	24
	Excavator	4
	Excavator + hammer	3
	Forklift	7
	Fuel Tanker	7
	Generator	6
	Grader	6
	Iron Cut and Bend	10
	Light Equipment	1
	Loader	6
	Lubrication, Maintenance and Rescue Truck	2
	Maintenance Workshop	2
	Mini Excavator	6
	Mini Loader	6
	Mixing Plant	3
	Mobile Crane	3
	Mobile welding machine	13
	Paver (Ballast Laying)	3
	Pick - up (double deck)	12
	Portal Crane	4
	Precast Plant	1

SN	Equipment	Number
	Refrigerated vehicle	2
	Road Car	15
	Rotary Driller	1
	Sand Washing Plant	1
	Scale	6
	Screen Plant	1
	Shotcrete Pump - Dry	8
	Shotcrete Pump - Wet	3
	Survey Equipment Set	1
	Survey Equipment Set for Machinery	1
	Tower Crane	2
	Tower Light	30
	Tractor	4
	Trencher	1
	Vibro roller	19
	Wagon	6
	Wastewater tanker	6
	Water tanker	6

Source: Resourcefield 2020

3.4.4 Load Transport

Load transported to site include rebar, batched concrete, wood, parapets, cross beams, formworks, filigram, sand, U-channels, stone base etc. The transport routes are the existing urban road network, utilising more, the roads that are closed to public use by the traffic diversion. These are transported in trucks and articulated vehicles at least peak periods to the site, from the yard.

3.4.5 Personnel Requirement and Transport

Approximately 400 personnel in the Life Camp and the fabrication yard. There are specialised sub-contractors that will be engaged by the main contractors when the needs arise. These will be sourced from JBN staff and host communities. Personnel carriers pick up workers at designated points within the town and in the outskirts, to work before 7am and return them at close of work.

3.5 Waste Management

The waste management plan for the proposed project has been informed by the understanding of the possible waste characteristics.

The construction waste to be considered includes: -

a) Soil: excavated soil which will be reused as backfilling materials for the Life Camp foundations.

b) Oil: oil & grease from malfunctioning vehicles and equipment at site

c) Office waste and domestic solid waste (refuse): this is generated at the construction site.

d) Demolition waste – concrete, soil, sand, metals

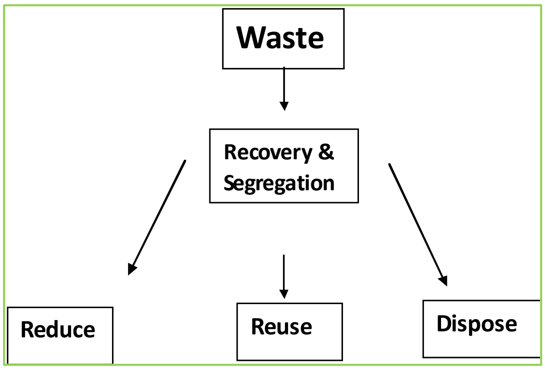
From the above, the Engineering, Procurement and Construction (EPC) Contractor will design its waste management plan under two categories:

- Solid Waste
- Emissions

The over-burden will be separated into top soil and sub-soil which shall be dumped in separate locations for reuse during phased construction-pit reclamation.

Generated scrap metals, paper, glasses and plastics will be sorted and sold out for recycling or reuse.

There will be at-source segregation of solid wastes (Figure 3.5). The Rivers Waste Management Agency will be contracted to collect and dispose of the waste that will be generated after the EPC Contractor has recovered those it can reuse. The waste shall be tracked and dumped in any of the existing approved dumpsites in the area.



On completion of construction works, the EPC Contractor shall demobilize from site and shall clear the site of all debris, including the remains of abandoned temporary structures erected in the vicinity of the Life Camp site by food and other vendors, to serve the workers at the site. These will be collected and disposed of also by the EPC Contractor's waste disposal subcontractor.

Figure 3.5: Waste Management flowchart for the proposed Life Camp project.

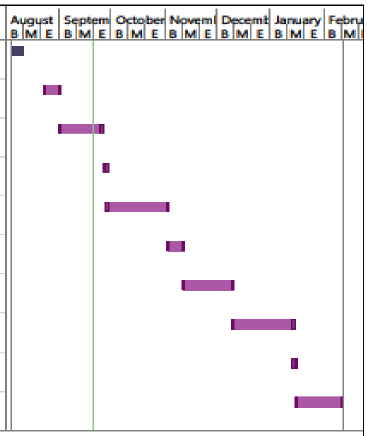
3.6 Project Schedule

The proposed project execution schedule, indicates construction commencement in Q1 2021 and commissioning scheduled for Q1, 2023

Figure 3.5 presents a simplified flowchart for proposed waste management strategy for the proposed Life Camp project.

Table 3.3: Project schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		Registration with FMEnv and ToR Approval	1 wk	Tue 8/4/20	Mon 8/10/20
2		Site Verification and Data Gathering	7 days	Mon 8/24/20	Tue 9/1/20
3		Preparation of Draft Report	18 days	Wed 9/2/20	Fri 9/25/20
4		Submission of Draft Report to FMEnv	1 day	Mon 9/28/20	Mon 9/28/20
5		Public Display by FMEnv	25 days	Tue 9/29/20	Mon 11/2/20
6		Technical Review	7 days	Tue 11/3/20	Wed 11/11/20
7		Submission of Final EIA Report	21 days	Thu 11/12/20	Thu 12/10/20
8		FMEnv Approval	5 wks	Fri 12/11/20	Thu 1/14/21
9		Project Flagoff	1 day	Fri 1/15/21	Fri 1/15/21
10		Procurement	4 wks	Sat 1/16/21	Thu 2/11/21



Project: Ebocha Life Camp
Date: Mon 9/21/20

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

Page 1

ID		Task Mode	Task Name	Duration	Start	Finish	Qtr 2	Qtr 3
1			**Construction Process**					
2			Take over site	1 day	Fri 2/12/21	Fri 2/12/21		
3			Mobilization/Setting out	4 wks	Sat 2/13/21	Thu 3/11/21		
4			Clearing of all road Networks	2 wks	Fri 3/12/21	Thu 3/25/21		
5			Setting out of all individual buildings	6 wks	Fri 3/26/21	Thu 5/6/21		
6			Excavation of all buildings	8 wks	Fri 5/7/21	Thu 7/1/21		
7			Sub structure /foundation works	13 wks	Fri 7/2/21	Thu 9/30/21		
8			Super structure work / all blockworks to Lintel level	15 wks	Fri 10/1/21	Thu 1/13/22		
9			Roofings	13 wks	Fri 1/14/22	Thu 4/14/22		
10			Plastering and Finishing works	15 wks	Fri 4/15/22	Thu 7/28/22		
11			Doors/Windows	10 wks	Fri 7/29/22	Thu 10/6/22		
12			Electrical, Mechanical works and tiling	10 wks	Fri 10/7/22	Thu 12/15/22		
13			External Works/ Road Networks etc	20 wks	Fri 12/16/22	Thu 5/4/23		

Project: Ebocha Life Camp
Date: Mon 9/21/20

Task	Inactive Summary	External Tasks
Split	Manual Task	External Milestone
Milestone	Duration-only	Deadline
Summary	Manual Summary Rollup	Progress
Project Summary	Manual Summary	Manual Progress
Inactive Task	Start-only	
Inactive Milestone	Finish-only	

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CHAPTER 4

DESCRIPTION OF EXISTING ENVIRONMENT

4.1 General

The prevailing ecological conditions of the environment within which the proposed project will be sited, as well as the socio-economic and health profiles of the affected community are presented in this chapter. Components described include the physico-chemical environment (meteorology, geology, soil type and distribution, groundwater characteristics), biological environment (location and distribution of flora and fauna characteristics), as well as socio-economic and health conditions describing the demographic structure, culture, heritage sites, social and health status of the people and their environment.

The summary of baseline conditions is based on information sourced from literatures (see relevant sections) as well as findings from a one season (Wet) field sampling program supplemented by secondary data from approved report. The data acquired will be used in further environmental management decisions and future monitoring of changes, if any, in the environmental components.

4.2 Scope of Study

Field studies and data collection for characterization of the baseline conditions of the proposed project environment covered, in line with the approved TOR by the FMEnv.

- Climate and meteorology
- Air quality and noise levels
- Geology/hydrogeology
- Ground water
- Soil
- Vegetation & fauna wildlife, and
- Socio economics/health impact, demography and community characteristics

4.2.1 Baseline Data Acquisition Methods

The acquisition of data basically involved field data gathering, measurements and the collection of representative samples used to establish the environmental conditions of the study area.

This exercise involved a multi-disciplinary approach and was executed within the framework of a QHSE management system approach. This approach assured that the required data and samples were collected in accordance with agreed requirements (scientific and regulatory) using the best available equipment, materials and personnel. Elements of this approach include:

- review of existing reports that contain environmental information on the study area;
- designing and development of field sampling strategies to meet work scope and regulatory requirements;
- pre-mobilization activities (assembling of field team, sampling equipment/materials calibrations/checks, review of work plan and schedule with team, and job hazard analysis);
- mobilization to field; fieldwork implementation - sample collection (including positioning and field observations), handling, documentation and storage protocols and procedures; and
- demobilization from field; transfer of sample custody to the laboratory for analyses.

The following sections present the field data gathering methodology/procedures and the descriptions of the environmental baseline conditions of the study area. The detailed documentation of the fieldwork execution including descriptions of the laboratory analytical methods and procedures, the detection limits for the various parameters analyzed as well as an overview of the general QHSE plan adopted for field data gathering and laboratory analysis is presented.

4.2.2 Desktop Studies

Desktop studies involved the acquisition of relevant background information on the environment of the study area. Materials that were consulted included approved reports on previous environmental surveys in the area, publications, textbooks, articles, maps, etc. on the area and similar environments. The list of materials consulted is specified in relevant sections.

4.2.3 Field Sampling/Measurement

In order to effectively characterize the ecology and meteorology of study area and determine seasonal variations of specific environmentally related parameters, a one season field data gathering exercise was performed between 24th and 26th August, 2020. The specific objectives of the ecological field sampling were to determine:

- ambient air quality and noise level of the study area;
- physico-chemical and microbiological characteristics of the soil within the study area;
- physico-chemical and biological characterization of groundwater samples within the study area;
- physico-chemical and biological characterization of surfacewater samples within the study area
- wildlife abundance and diversity of the study area and environs;
- vegetation characteristics of the area; and
- establish the socio-economic and health status of the host and impacted communities.

4.3 Field study & Sampling design

Sampling was designed to comprehensively capture all the ecological and socio-economic components peculiar to the study area. The coverage of various environmental attributes considered recipients and sensitivity of impacted areas.

Design of field activities was made prior to mobilization. This was aided by information obtained during reconnaissance survey of the project area. Sampling locations were decided as waypoints in Geographic Position System (GPS) and later plotted in a sampling map used during the field studies. Locations for biophysical sampling considered ecological types around the project areas, vulnerable environmental attributes with regards to the potential and associated impacts of the environment and control or buffer zones. Socio economic and health impact studies on the other hand, considered human habitations, infrastructures, cultural heritage sites and prevailing health conditions of people within the sphere of influence to the project area.

Table 4.1 presents an inventory of the biophysical and socioeconomics/health details collected during field studies, while the map (Figure 4.1) shows the spatial locations of the sampled points.

Table 4.1: Inventory of Biophysical and Socio/Samples

S/N	Environmental Component	Parameter/Details	No of samples requested by FMEnv	Actual no of samples collected
1	Ground water	Physico chemical & microbial	Three (3) representative samples in line with best analytical methods + one (1) control sample.	3 points + 1 control
2	Surface water and Sediments	Physico chemical & microbial	Six (5) representative samples of Orashi river and its tributaries in line with best analytical methods + one (1) control sample	5 points + 1 control
4	Soil	Physico chemical & microbial	Seven (7) Representative samples in line with best analytical methods + one (1) control sample.	8 points + 2 control
5	Ambient air quality	Criteria pollutants	Five (4) Nos. within the project site (in-situ @ different elevations) + one control	4 points + 1 control
6	Noise	Sound/pressure level	Five (4) within the project site and (in-situ @ sensitive receptors) + one control	4 points + 1 control
7	Terrestial Fauna and Flora	Amphibians and Reptiles, Vegetations of the project area	Amphibian and reptile, Vegetation study is mainly to arrive at a more complete overview of the diversity at the project site in line with best analytical methods.	300m radius, focal point of the Life Camp site

S/N	Environmental Component	Parameter/Details	No of samples requested by FMEnv	Actual no of samples collected
9	Fish and Aquatic Habitat	Fishes and aquatic community	fish and aquatic community of potentially affected rivers, streams and streams in and near the site.	300m radius, focal point Orashi River
10	Geology	-	Geologic field studies are proposed for geologic characterization and mapping	
12	Socio economics	Human and infrastructures	Project Affected communities	(Ebocha and Omuku)

Source: Resourcefield 2020

water samples were collected as appropriate. The exercise involved *in-situ* measurement of salinity, temperature, turbidity, pH, dissolved oxygen and conductivity. Samples were taken at defined sample points using bottle sampler for water quality determinants. These were stored and preserved as appropriate for each analysis. Groundwater samples were collected for laboratory analyses using

- 2-litre plastic bottle for water samples for physicochemical analysis;
- 2-litre plastic bottle for water samples for heavy metal analysis;
- 1-litre plastic bottle for water samples for microbiological analysis; and
- 1-litre glass bottle with Teflon seal cap for water samples to be analysed for hydrocarbon content (oil and grease, etc.).

All water samples were preserved in cool boxes for onward transmission to Akwa Ibom State Ministry of Environment/Science and Technology laboratory in Uyo.

Soil samples were collected with hand auger at two depth intervals (0-15cm and 15-30cm). These samples were preserved in plastic bags and stored in coolers.

Table 4.2: Samples Location

SN	Sample type	Code	Description	Lat	long
1	Soil	SS 1	Site for Utilities at the Life Camp	5°26'1.42"N	6°41'8.89"E
2	Soil	SS 2	Site of proposed production and supply area	5°25'43.00"N	6°41'7.94"E
3	Soil	SS 3	Western boundary of Life Camp parcel	5°25'51.35"N	6°40'49.45"E
4	Soil	SS 4	Southwestern boundary of AoI	5°25'22.53"N	6°40'29.55"E
5	Soil	SS 5	Northeast boundary of AoI, across the Ebocha - Omoku Road	5°26'55.37"N	6°41'42.92"E
6	Soil	SS 6	Southeast boundary of AoI, across the Ebocha - Omoku Road	5°25'15.48"N	6°41'27.49"E

SN	Sample type	Code	Description	Lat	long
7	Soil	SS 7	Southern boundary of farm parcel	5°26'4.16"N	6°40'43.87"E
8	Soil	SS 8	Northeast boundary of farm parcel	5°26'39.67"N	6°40'15.01"E
9	Soil control	SS 9	Western boundary of AoI, across Orashi River	5°26'1.42"N	6°41'8.89"E
10	Soil control	SS 10	Northwestern boundary of AoI, across Orashi	5°25'43.00"N	6°41'7.94"E
Groundwater					
11	Groundwater	GW 1	Northeastern boundary of AoI,	5°27'6.70"N	6°41'41.82"E
12	Groundwater	GW 2	Southeastern boundary of Life	5°25'40.24"N	6°41'20.09"E
13	Groundwater	GW 3	Close to Omuku Palace	5°27'6.70"N	6°41'41.82"E
14	Groundwater control	GW 4		5°25'40.24"N	6°41'20.09"E
Surface Water/Sediment					
15	Surface water/ Sediment	SW 1	Upstream Orashi River, north of bridge on Ebocha - Ndoni Road	5°27'35.55"N	6°40'24.89"E
16	Surface water/ Sediment	SW 2	Orashi River, by northwestern boundary of farm site	5°26'51.61"N	6°40'12.50"E
16	Surface water/ Sediment	SW 3	Orashi River, by southwestern boundary of farm site	5°26'2.12"N	6°39'56.90"E
17	Surface water/ Sediment	SW 4	Orashi River, by southwestern boundary of AoI	5°25'23.95"N	6°39'36.74"E
18	Surface water/ Sediment	SW 5	Orashi River tributary, by eastern boundary of AoI	5°25'56.62"N	6°41'57.28"E
19	Surface water/ Sediment control	SW 6	Orashi River tributary, by northeast of farm site by bridge on Ebocha - Omoku Road	5°27'44.66"N	6°42'13.04"E
Flora and Fauna Studies					
20	Flora & Fauna	EFFF 1	300m radius, focal point Orashi River at the western part of the farmland site	5°26'29.92"N	6°40'4.93"E
21	Flora & Fauna	EFFF 2	300m radius, focal point Orashi River tributary, across Ebocha - Omoku Road at the southern eastern part of the Life Camp site	5°26'14.76"N	6°41'49.85"E
Air/Noise					
23	Air / Noise control	AQ 1	Northeastern boundary of AoI, , T-junction Ebocha - Ndoni and Ebocha- Omuku Roads	5°27'6.70"N	6°41'41.82"E

SN	Sample type	Code	Description	Lat	long
24	Air / Noise	AQ 2	Southeastern boundary of Life Camp Site, across Ebocha - Omuku Road	5°25'40.24"N	6°41'20.09"E
25	Air / Noise	AQ 3	Site for Utilities at the Life Camp	5°26'1.42"N	6°41'8.89"E
26	Air / Noise	AQ 4	Building, across River Orashi on Western boundary of farm parcel	5°26'53.01"N	6°40'6.64"E
27	Air / Noise	AQ 5	Southwestern part of the farm parcel	5°26'4.56"N	6°40'15.28"E

Source: Resourcefield 2020

4.3.1 Analytical Methods

Samples collected from the field were analysed in Akwa Ibom State Ministry of Science and Technology laboratory using the various methods shown in Table 4.3. Also shown on the table are the equipment detection limits for the different parameters analysed.

Table 4.3 Laboratory Analytical Methods

Parameters	Methods	Detection Limits
Water Samples		
Temperature (°C)	APHA 2110B	-
pH	APHA 4500H$^+$B	-
TSS (mg/l)	APHA 2540D	1
TDS (mg/l)	APHA 2510A	-
Conductivity (µS/cm)	APHA 2510A	-
THC (mg/l)	ASTM D3921	1.0
DO (mg/l)	APHA 4500-O G	-
BOD (mg/l)	APHA 5210A	0.5
COD (mg/l)	APHA 5220D	0.8
Reactive Silica (mg/l)	APHA 4500-SiO_2	0.1
Nitrate (mg/l)	EPA 352.1	0.02
Phosphate (mg/l)	APHA4500-P D	0.002
Ammonium (mg/l)	APHA 4500-NH_3	0.02
Calcium (mg/l)	APHA 3111B/ASTM D3561	0. 1
Magnesium (mg/l)	APHA 3111B/ASTM D3561	0.1
Potassium (mg/l)	APHA 3111B/ASTM D3561	0. 1
Sodium (mg/l)	APHA 3111B/ASTM D3561	0.1
Lead (mg/l)	APHA 3111B	0.20
Total Iron (mg/l)	APHA 3111B	0.05
Copper (mg/l)	APHA 3111B	0.05
Polychlorinated biphenyls (PCBs)	EPA8082A	0.1

Parameters	Methods	Detection Limits
Zinc (mg/l)	APHA 3111B	0.05
Manganese (mg/l)	APHA 3111B	0.10
Cadmium (mg/l)	APHA 3111B	0.02
Total Chromium (mg/l)	APHA 3111B	0.10
Mercury (mg/l)	APHA 3112B	0.0002
Arsenic (mg/l)	APHA 3030B/3114B	0.001
Soil samples		
pH (H_2O)	ASTM D4972	-
TOC/TOM (mg/kg)	BS 1377	-
Conductivity (mg/kg)	APHA 2510B	-
THC (mg/kg)	ASTM D3921	10.0
Nitrate (mg/kg)	EPA 352.1	0.02
Phosphate (mg/kg)	APHA 4500-P D/CAEM	0.002
Sulphate (mg/kg)	EPA 9038	1.0
PSD (mg/kg)	ASTM D422	-
Calcium (mg/kg)	APHA 3111D	0.1
Magnesium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Potassium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Sodium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Zinc (mg/kg)	ASTM D5198/APHA 3111B	0.05
Lead (mg/kg)	ASTM D3111B /D5198	0.20
Mercury (mg/kg)	APHA 3112B/ASTM D 3223	0.0002
Arsenic (mg/kg)	APHA 3030F/3114B	0.001
Total Iron (mg/kg)	APHA 3111B/ASTM D5198	0.05
Copper (mg/kg)	APHA 3111B/ASTM D5198	0.05
Cadmium (mg/kg)	APHA 3111D/ASTM D5198	0.02
Polychlorinated biphenyls (PCBs)	EPA 9078	0.5
Total Chromium (mg/kg)	APHA 3111B/ASTM D5198	0.10

Source: Akwa Ibom State Ministry of Science and Technology Laboratory

4.3.2 Study Team

Field studies, analyses and report writing were undertaken by a multidisciplinary team from Resourcefield Limited. The key experts involved in this study include ecologists (flora and fauna), engineers, air quality specialists, waste experts, Geologist, soil experts and socio-economic experts. The full team list, their qualifications and designation is as shown in the List of EIA preparers.

4.4 Biophysical Sample Collection

4.4.1 Meteorological Data Acquistion

The existing meteorological and climatic data from PortHarcourt meteorological station are used for the write-up. However, additional field data were collected for atmospheric pressure, relative humidity, temperature, wind speed and wind direction. The measurements were taken at 5 stations within the project site and its spatial boundary. The measurements of the meteorological parameters were carried out using in situ portable pieces of equipment as shown in table 4.4.

Table 4.4: Meteorological Instruments

Parameter	Equipment
Atmospheric pressure, Relative humidity, Temperature	Multipurpose Hygro, Baro and Thermo (Hygro 20-100%, Thermo 10-50°C, Baro 740-777mmHg Model: - Baro, Germany
Wind speed	Portable wind vane Model: - Deuta Anemo Wind speed indicator (0-35m/s)
Wind direction	Digital compass

Source: Resourcefield 2020

4.4.2 Gaseous Emission Data Acquisition

Concentrations of air pollutants were measured at 5 locations. Highly sensitive digital portable meters were used for the measurement of NO_2, SO_2, H_2S, HCN, CH_4, NH_3 Cl_2, CO, CO_2, $PM_{2.5}$, PM_{10}, TVOC and CH_2O. The portable meters used in the measurement of gaseous pollutants are presented in table 4.5

Table 4.5: Gaseous Emissions and Noise Measuring Instruments

Parameter	Equipment	Range	Alarm levels
Sulphur dioxide (SO_2)	SO_2 Crowcon Gasman S/N: 19648H	0-10ppm	2.0ppm
Nitrogen dioxide (NO_2)	NO_2 Crowcon Gasman S/N: 19831N	0-10ppm	3.0ppm
Hydrogen sulphide (H_2S)	H_2S Crowcon Gasman S/N: 19502H	0-50ppm	10ppm
Carbon monoxide (CO)	CO Crowcon Gasman S/N: 19252H	0-500ppm	50ppm
Ammonia (NH_3)	NH_3 Crowcon Gasman S/N: 19730H	0-50ppm	25ppm
Chlorine (Cl_2)	Cl_2 Crowcon Gasman S/N: 19812H	0-5ppm	0.5ppm
Hydrogen Cyanide (HCN)	HCN Crowcon Gasman S/N: 19773H	0-25ppm	5ppm

Parameter	Equipment	Range	Alarm levels
Methane (CH_4)	XP-3160	0-5,000 ppm	250 or 500 ppm
Suspended particulate monitor (SPM)	Haz-Dust TM 10µg/m^3 particulate monitor	0.1-200 10µg/m^3	+1-0.0210µg/m^3
Noise Level Meter	NM 102	Auto Ranging(30-130dB)	-

Source: Resourcefield 2020 Unit for gaseous pollutants is ppm.

Plate 4.1: Pictures of some in-situ digital meters used to measure ambient air conditions

Measurements were conducted between 08:00 and 19:00hrs Nigerian time, for air measurements. Specific locations for measurements were selected with consideration for concentrations of human receptors such as residential areas, commercial areas, hospitals, churches, schools, and farmlands.

4.4.3 Precaution/Quality Assurance/Quality Control

In marking sampling location (table 4.6), special preference was given to the following:

- Accessibility
- Availability of open space with good configuration free from shed
- Meteorological consideration of upward and downward directions
- Areas with minimal local influence from vehicular moment.
- In sampling, consideration was given to: Sensitivity and stability of equipment used
- Re-calibration of equipment
- Reproducibility of results.

Table 4.6: Air samples locations

Sample Code	Description	Northing	Easting	Elevation (m)	Sample taken
AQ_1	Orashi River	05°27'25.0"	006°40'23.6"	3	Air, sediment, soil and water
AQ_2	Project site	05°25'54.1"	006°41'15.6"	8	Air, soil
AQ_3	-do-	05°26'03.9"	006°41'12.5"	10	Air, soil
AQ_4	-do-	05°25'58.4"	006°41'08.8"	9	Air, soil
AQ_5	-do-	05°25'51.1"	006°41'10.0"	15	Air, soil

Source: Resourcefield 2020

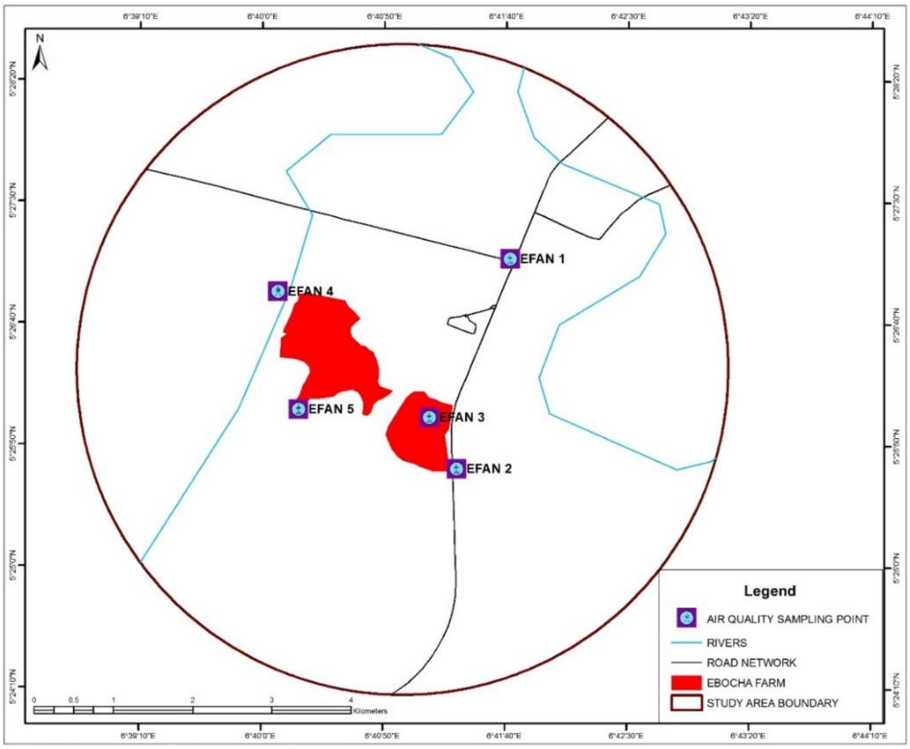


Figure 4.1: Air/Noise Sampling Location

4.5 Field Meterology - Results and Discussion

4.5.1 Results

The results of the air quality, noise levels, sensitive receptors, field meteorology, bio-aerosols and heavy metal content in the study area are presented in tables 4.7,4.8 and 4.9.

Table 4.7: Air Quality Measurements

Sample code	NO_2 (ppm)	SO_2 (ppm)	H_2S (ppm)	CO (ppm)	CO_2 (ppm)	NH_3 (ppm)	Cl_2 (ppm)	HCN (ppm)	TVOC (mg/m³)	CH_2O (mg/m3)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	CH_4 (PPM)
AQ_1	<0.1	0.1	<0.1	2	1051	3	0.2	1	1.845	0.215	41	71	0.4
AQ_2	<0.1	0.1	<0.1	3	632	3	0.1	1	0.622	0.082	42	73	0.6
AQ_3	<0.1	0.1	<0.1	2	588	3	0.1	1	0.443	0.069	45	77	0.7
AQ_4	<0.1	0.1	<0.1	2	563	5	0.1	1	0.306	0.045	46	81	0.6
AQ_5	<0.1	0.1	<0.1	3	551	4	0.1	1	0.257	0.041	48	82	0.8
Mean	<0.1	0.1	<0.1	2.4	677	3.6	0.12	1	0.695	0.09	44.4	76.8	0.62
Range	**<0.1**	**0.1**	**<0.1**	**2.0-3.0**	**551-1051**	**3.0-5.0**	**0.1-0.2**	**1**	**0.257-1.845**	**0.041-0.215**	**41-48**	**71-82**	**0.1-0.5**
SD	0	**0**	**<0.1**	0.55	211.36	0.89	0.04	**0**	0.66	0.07	2.88	4.82	0.15
FMEnv	**0.04-0.06**	**0.01-0.1**	-	**10.0-20.0**		**200**	-	-	-	-	-	-	-

Source: Resourcefield 2020

Table 4.8: Measurements of Noise Levels

Sample code	Noise level [dB(A)]	Minimum noise level [dB(A)]	Maximum noise level [dB(A)]
AQ_1	60.8	47.7	71.8
AQ_2	74.6	65.3	83.1
AQ_3	58.4	44.7	68.5
AQ_4	60	47.2	78.4
AQ_5	64.8	55.7	72.5
Mean	63.72	52.12	74.86
Range	**58.4-74.6**	**44.7-65.3**	**68.5-83.1**
SD	6.52	8.45	5.83
FMEnv limit	**90 [dB(A)]**		

Source: Resourcefield 2020

Table 4.9: Field Meteorological Measurements

Sample code	Temperature (°C)	Rel. Humidity (%)	Pressure (kpa)	Wind Direction	Wind Speed (m/s)
AQ_1	28.4	66.3	1009.5	220° SW	1.59
AQ_2	30.3	60.6	1009.5	20° N	1.68
AQ_3	31.4	61.2	1009.5	220° SW	0.68
AQ_4	34.1	58.1	1009.3	120° E	1.45
AQ_5	33.7	57.4	1009.4	240° SW	2.5
Mean	31.58	60.72	1009.44	-	1.58
Range	**28.4-34.1**	**57.4-66.3**	**1009.3-1009.5**	**-**	**0.68-2.50**
SD	2.38	3.51	0.09	-	0.65

Source: Resourcefield 2020

4.5.2 Discussion

4.5.2.1 Rainfall

The study area is situated within the tropical wet climatic belt. In this belt, rainfall variation is the most important parameter for the determination of season. In general, two seasons are characteristic of the climate in the region, namely the dry and wet seasons. In wet season, the annual distribution starts with the initial rains in March, which ceases in late November.

Typically, there are two major seasons, sometimes, heavier rainfall than usual may occur and the rain is extended into the dry season and often the August break may not even occur. Rainfall is the most important element of climate change and water resources potential. It impacts almost all areas of human life such as agriculture, health, transportation etc. The amount and distribution of rainfall in the study area is such that it plays an important role in moving pollutants from the atmosphere to other spheres of the environment.

The mean annual rainfall for the study environment is above 2300mm. The data retrieved from close meteorological station and shown in table 4.10 present the mean monthly rainfall distribution for 30 years (1985-2015) in the study area. Average highest rainfall peaks were attained in September (370mm), July (364mm) and August (325mm). Lowest rainfall values were attained in January (15.3mm) and December (19.2mm). It should be noted that rainfall is very important in managing construction projects since it may cause erosion and erode soil particles from ground level surfaces

4.5.2.2 Air Temperature

Analysis from the macro data shows that the months of July-September recorded lower temperatures (28-29 ^{o}C) due to rainy periods while the months December to March recorded higher temperatures (32-34^{o}C) due to intense solar radiation prevalent in the dry season (Uko and Tamunobereton-Ari, (2013) noted that the average maximum and minimum temperatures during the dry and wet seasons are within 31-33 ^{o}C and 21-23 ^{o}C as well as 25-33 ^{o}C and 18 23^{o}C respectively.

The degree of air temperature is dependent on the amount of solar radiation received, atmospheric conditions, such as cloud cover and humidity, which trap heat and this impacts on the stability pattern of the atmosphere in the area. Port Harcourt exhibit a very stable stability class F at nights that inhibits emission dispersion and slightly unstable/moderate stability classes C-B during the day periods that enhances emission dispersions (Edokpa and Nwagbara 2017).

Air temperature also affects nearly all other weather parameters. For instance, air temperature affects: the rate of evaporation, wind speed and direction, precipitation patterns as well as the unstable, stable and neutral conditions of the atmospheric environment. Measuring air temperature is critical to the proper identification of the micro and macro environment of living organisms. It is especially critical for researchers in the animal and biological sciences since ambient temperature can influence their physiological, nutritional and behavioral status.

The study environment is bounded heavily by open vegetation areas and this modifies ambient temperature. Ansari (2003) noted that the major parts of a healthy environment are vegetation associated with area. He emphasized that vegetation improves the environment by lowering the maximum temperature and increasing the minimum temperature most especially in locations of increased elevation. When air passes through vegetation it cools and obtains moisture which when mixed with the open environment reduces temperature thereby generating was is referred to as local precipitation (Ansari, 2003). Ayoade (2004) highlighted that the features which impact the distribution of temperature at any location include: the amount of insulation received, nature of the surface, distance from water bodies, relief, nature of prevailing winds and ocean currents.

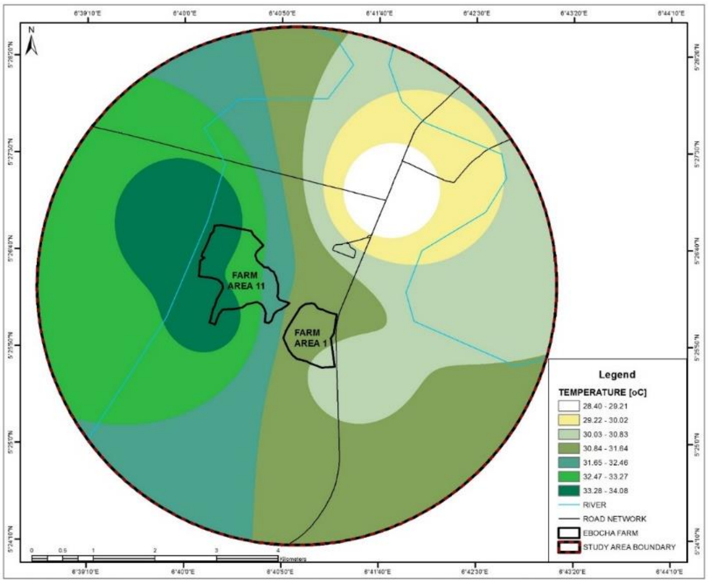


Figure 4.2: Air Quality dispersion model of air temperature around Ebocha Farm

The peak temperature concentration was recorded west of the Farm 11 ranging from 32.47-34.08 ^{o}C. The temperature reduced towards Farm 11 (30.84-31.84 ^{o}C). The temperature also reduced toward the north with the least concentration of 28.40 ^{o}C.

4.5.2.3 Relative Humidity

As ambient temperature increases, percentage humidity decreases and vice-versa. Relative humidity which measures water vapour in the atmosphere is noted to be low during dry season and high during the peak of rainy season due to the influence of moisture laden north- Westerly winds as seen from the macro average monthly results. A 30-year mean monthly relative humidity analysis shows that the study environment has high relative humidity throughout the year with peaks during the wet season. Oluyole *et al.*, (2013) disclosed that average annual relative humidity for the area is above

80%. Due to the moist nature of the atmospheric environment in the study area, relative humidity is always high throughout the years.

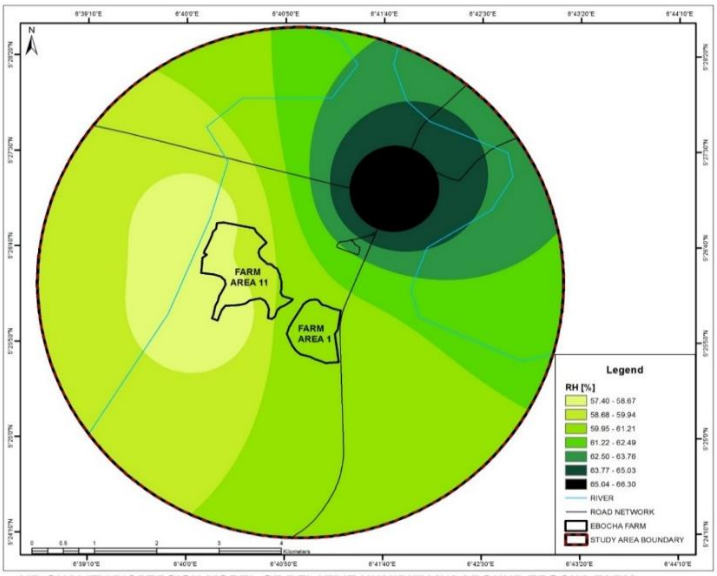


Figure 4.3: Air Quality dispersion model of air Relative Humidity around Ebocha Farm

The peak concentration of relative humidity (dark navy blue) was observed toward the northern part of the study area ranging between 65.04-66.30 %. The concentration reduces towards the south. The entire Farm Area 1 recorded a unique RH ranging from 58.88-59.94 %. Towards Farm Area II, RH decreased ranging from 57.40-59.94 % coded with Yucca yellow colour.

Table 4.10: Average Weather Trend for Port Harcourt (1985-2015)

S/N	Month	Average Temp (°C)	Rainfall (mm)	Pressure (kpa)	Relative Humidity (%)	Wind Speed (m/s)
1	January	33.5	15.3	1006.5	72	2.8
2	February	34.1	7.4	1005.8	77	2.5
3	March	33.7	92.7	1005.6	81	3.6
4	April	32.6	143	1005.7	83	3.6
5	May	32.1	247.4	1007.4	87	3.7
6	June	30.4	310	1008.4	89	3.8
7	July	28.3	364	1009.7	91	4.2
8	August	29.0	325	1009.6	91	4.1
9	September	28.6	370	1008.9	91	4.3
10	October	30.8	242	1007.7	88	3.5
11	November	32.1	72.8	1006.8	84	2.6
12	December	33.4	19.2	1006.7	73	2.4

Source: NIMET, Port Harcourt (EIA Report, 2017).

4.5.2.4 Wind Speed/Direction

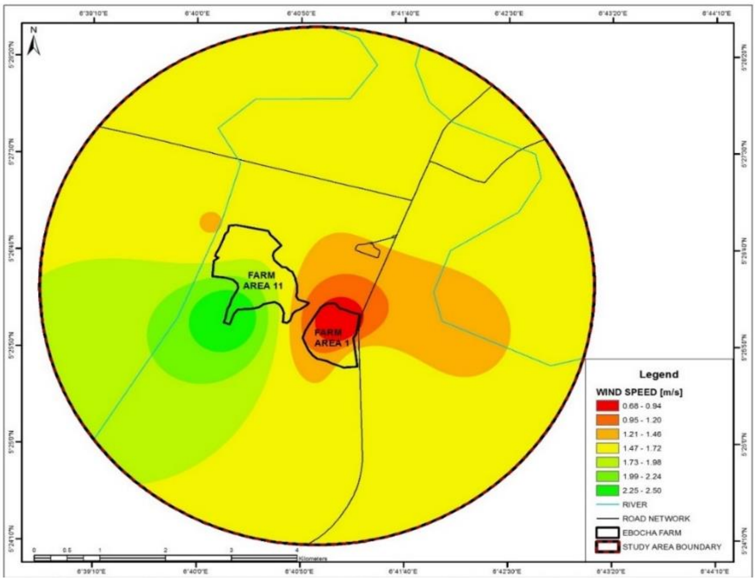


Figure 4.4: Air Quality dispersion model of air wind speed around Ebocha Farm

The speed of the wind recorded lowest around Farm Area 1 ranging from 0.68-1.48 m/s. The speed of the wind increases towards Farm Area 1 with its peak (green colour) not exceeding 2.50 m/s.

The prevailing wind direction was the easterly and south-westerly winds as presented in the wind rose below (Figure 4.5). This implies that any released air emissions will be blown towards the west and north-east direction of the study environment. It is however the period of calm that is of importance in evaluating emissions (8.33%). If the air is calm, pollutants cannot disperse, and then the concentration of these pollutants will build up. On the other hand, when strong, turbulent winds blow, pollutants disperse quickly, resulting in lower pollutant concentrations.

In pollution, meteorology calms are associated with inversions (temperature increasing with height). Inversion may result in fumigation; meaning that emissions are trapped at ground level close to their source as against other situations where it is dispersed and diluted much more easily. Inversion is widely known to be frequent during the early hours of the day. A 30-year mean macro data shows that wind speed over the study environment is generally minimal and this signifies a low to moderate dispersive potential of the local atmosphere.

Table 4.11: Wind Speed for Wind Rose

Wind Direction	Wind Sped (m/s)		
	0 – 1.50	**1.51 – 2.50**	**2.51 – 3.50**
N	0.75 = 14 %	2.43 = 18 %	3.37 = 22 %
NE	1.43 = 26 %	2.50 = 19 %	2.75 = 18 %
NNE	0 = 0 %	0 = 0 %	0 = 0 %
E	1.04 = 19 %	2.37 = 18 %	2.86 = 19 %
SE	0 = 0 %	0 = 0 %	0 = 0 %
SSE	0.06 = 1 %	1.75 = 13 %	0 = 0 %
S	0 = 0 %	0 = 0 %	0 = 0 %
SW	0.93 = 17 %	2.31 = 17 %	3.43 = 22 %
WSW	1.22 = 22 %	2.09 = 16 %	2.93 = 19 %
W	0 = 0 %	0 = 0 %	0 = 0 %
NW	0 = 0 %	0 = 0 %	0 = 0 %
NNW	0 = 0 %	0 = 0 %	0 = 0 %

Source: Resourcefield 2020

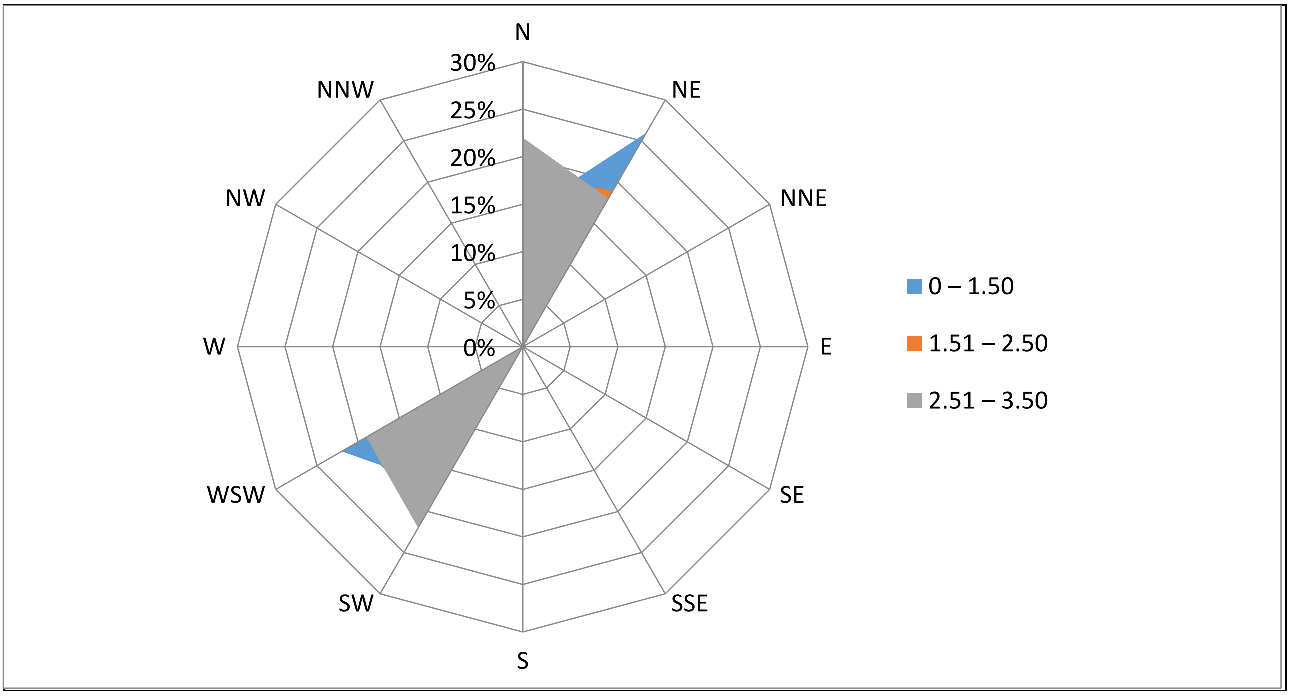


Fig. 4.5: Wind Rose for Proposed Area Based on Microclimatic Data

A wind rose gives a very succinct but information-laden view of how wind speed and direction are typically disturbed at a particular location. Presented in a circular format, the wind rose shows the frequency of winds blowing from the particular directions. The length of each "spoke" around the circle is related to the frequency of time that the wind blows from a particular direction. Each concentric circle represents a different frequency, emanating from zero at the centre to increasing frequency at the outer circles. The frequency categories that show the percentage of time that winds blow from a particular direction and at certain speed ranges.

In figure 4.5 above, wind speeds are indicated by colour. Here, the winds blew mostly at the wind speed denoted by the colours. For the blue section of the "spoke" which indicates winds at 0-1.50. The blue section is between 25 % and 0 %, subtracting these two numbers is equal to 25 %. This means that winds blew from the northeast (NE) at 0-1.50m/s for 25 % of the time. For red section, winds blew from the north-east at speeds between 1.51-2.50m/s for 15 % of the time. For green section, winds blew between SW at speeds between 2.51-3.50 m/s for 20 % of the time.

4.5.3 Noise

4.5.3.1 Literature Review

Noise is measured in decibels (dB) (BTCE and EPA, 1994), a logarithmic scale. A 10 dB increase represents a doubling in noise level. Decibels A-weighted, (indicated "dB A") units emphasize the frequency sensitivities of human hearing, and correlate well with subjective impressions of loudness. Common noise levels range from 30 to 90 dB (A).

It is a common experience that noise is unpleasant and affects the quality of life. It disturbs and interferes with activities of the individual including concentration, communication, relaxation and sleep (WHO Regional Office for Europe 2000b). Besides the psychosocial effects of community noise, there is concern about the impact of noise on public health, particularly regarding cardiovascular outcomes (Passchier-Vermeer and Passchier 2000). Non-auditory health effects of noise have been studied in humans for a couple of decades using laboratory and empirical methods. Biological reaction models have been derived, which are based on the general stress concept (Lercher 1996).

Amongst other non-auditory health endpoints, short-term changes in circulation including blood pressure, heart rate, cardiac output and vasoconstriction as well as stress hormones (epinephrine, norepinephrine and corticosteroids) have been studied in experimental settings for many years (Babisch 2003b).

However, not all biologically notifiable effects are of clinical relevance. Classical biological risk factors have been shown to be elevated in subjects that were exposed to high levels of traffic noise (Goto and Kaneko, 2002). From this, the hypothesis emerged that persistent noise stress increases the risk of cardiovascular disorders including high blood pressure (hypertension) and ischaemic heart disease:

Sound/noise is a psychosocial stressor that activates the sympathetic and endocrine system. Acute noise effects do not only occur at high sound levels in occupational settings, but also at relatively low environmental sound levels when, more importantly, certain activities such as concentration, relaxation or sleep are disturbed.

Major source of noise in the project area was traffic noise. Motor vehicles cause various types of noise, includes engine acceleration, tire/road contact, braking, horns and vehicle theft alarms. Heavy vehicles can cause vibration and infrasound (low frequency noise). According to an OECD report, "Transport is by far the major source of noise, ahead of building or industry, with road traffic the chief offender (OECD, 1990)." Motorcycles, trucks and buses are major contributors to traffic noise (Mackenzie and Chen, 1992). At low speeds most noise comes from vehicle engine, at higher speeds aerodynamic and tire/road noise dominate (Homberger et al., 1992).

Several factors affect the amount of noise emitted by traffic, and its costs: Vehicle type. Motorcycles, heavy vehicles (trucks and buses), and vehicles with faulty exhaust systems tend to produce high noise levels. Engine type. Older diesel engines tend to be the noisiest, followed by gasoline and natural gas, hybrid, and electric vehicles being quietest.

Traffic speed, stops and inclines. Lower speeds tend to produce less engine, wind and road noise. Engine noise is greatest when a vehicle is accelerating or climbing an incline. Aggressive driving, with faster acceleration and harder stopping, increases noise.

According to Wilson, (2005), certain pavement types and smoother road surfaces emit less noise. "Quiet pavement" research indicates that open-graded friction course (OGFC) and porous friction courses (PFC) asphalts, and whisper grinding and longitudinal tinning produce less traffic noise (FHWA, 2005). Noise declines with distance and is reduced by structures, walls, trees, hills and sound-resistant design features such as double-paned windows.

4.5.3.2 Noise Level

The highest noise level was recorded south of Farm Area 1 with concentration ranging between 69.98-74.69 [d(B)A]. It was also observed that noise level reduced with increase in distance towards the northern part with its least concentration painted deep green recording between 58.40-63.03 [d(B)A]. Nonetheless, major source of noise in the project area was traffic noise.

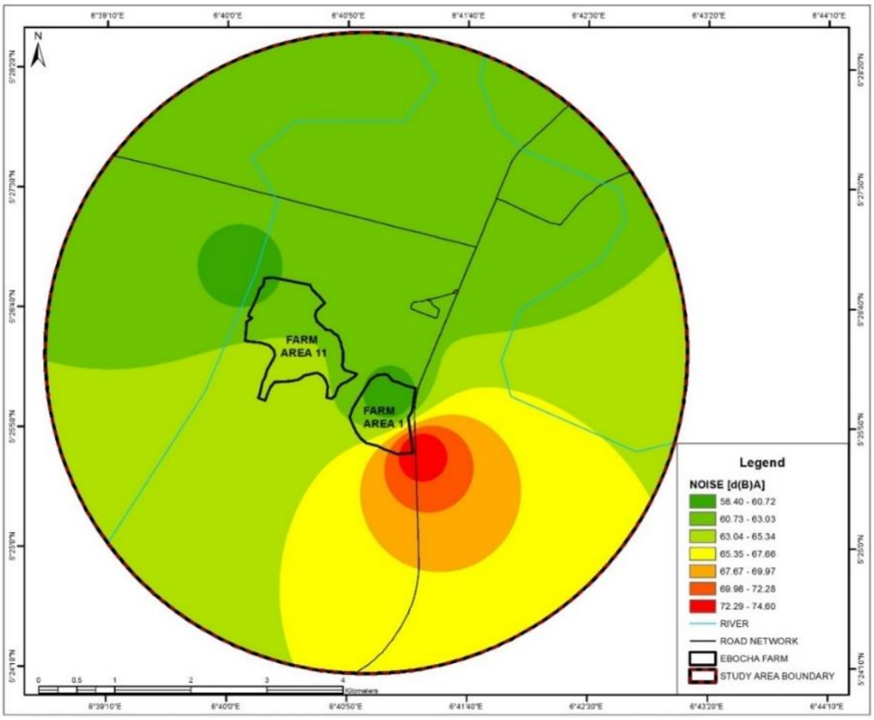


Figure 4.6: Air Quality dispersion model of Noise around Ebocha Farm

4.5.4 Ambient Air Quality

4.5.4.1 Literature Review

Clean air is considered to be a basic requirement of human health and well-being. However, air pollution continues to pose a significant threat to not only health worldwide but concrete structures. According to a WHO assessment of the burden of disease due to air pollution, more than 2 million premature deaths each year can be attributed to the effects of urban outdoor air pollution and indoor air pollution (caused by the burning of solid fuels).

Microbes have been detected in every conceivable environment on the Earth. The widespread presence of microbes is a result of microbes evolving to utilize the unique physical and chemical properties of their environment. Therefore, a microbial community at a specific site is determined by the physical and chemical characteristics of the surrounding environment, and as a result, a habitat that is favorable for one organism may be harmful or unsuitable for another.

The environment, however, is also affected by the presence of microbial life. Because of this impact on the environment, a setting that may not be initially suitable for certain microbes may become a viable habitat to newly introduced organisms. This occurs because the microbes that flourish carry out metabolic processes that remove some nutrients and excrete others (as waste products) into their surroundings. The environment and its ability to support additional microbes can change through this process. It is no wonder that populations of microbes rarely live alone. They typically live in association with other populations of microbes called communities. It is important to consider this issue as we study the impact microbes are having on the concrete bridge columns.

4.5.4.2 Carbon Monoxide (CO)

Maynard and Waller (1999) described carbon monoxide as a colourless, tasteless, odourless, non-irritating gas produced during incomplete combustion of gas or fossil fuels due to insufficient oxygen present. Production of carbon monoxide increases when trucks are moving slowly (which may likely be common scenario in project area) hence levels of carbon monoxide (CO) in the atmosphere is higher near busy environment during peak times when the flow of traffic is slow. Carbon monoxide production increases when the engine is cold, as catalytic converters take time to reach the operating temperature and thus petrol engine cars in closed garages are dangerous even with a catalytic converter. Levels may also increase in cold weather due to periods of still cold air as this affects the dispersal of carbon monoxide, as it is usually rapidly dispersed away from surrounding and destroyed by photochemical reactions over a period of months.

According to Fierro et al. (2001), adverse health effects of carbon monoxide exposure are related to the concentration of carboxy-haemoglobin in the blood. In general, carboxy-haemoglobin concentrations below 2 % are not associated with any adverse effects; 20 - 30 % causes neurological symptoms such as headache, dizziness, weakness, nausea, confusion, disorientation and visual disturbance; over 50 % causes convulsions, respiratory arrest and death. Following carbon monoxide exposure, tachycardia and tachypnoea may occur as compensatory mechanisms. Hypotension, vasodilation, cyanosis, shock and cardiac arrest may also occur. A decreased maximal oxygen consumption and decreased duration of exercise occurs in patients with impaired blood supply to the heart at lower carbon monoxide concentrations, and in healthy individuals at higher concentrations. Patients with angina are the most sensitive risk group for carbon monoxide intoxication.

Lavitrano et al. (2004) reported that the central nervous system is particularly sensitive to carbon monoxide-induced hypoxia and acute effects such as headache, dizziness, confusion, disorientation, memory loss, fainting, seizures, cerebral oedema, coma and death may arise. There is evidence from neuro-behavioural studies in volunteers that prolonged exposure to low levels (5-20 % carboxyhaemoglobin), below those causing clinical symptoms, may produce cognitive impairment. Neurological symptoms following severe exposures of acute toxicity may also appear 2 – 40 days after exposure, including headache, lethargy, irritability and lack of concentration.

Chronic carbon monoxide poisoning may not necessarily give typical symptoms associated with acute exposure. Chronic symptoms may include tiredness, lethargy, headaches, nausea, dizziness, personality changes, memory problems, Parkinsonian symptoms, visual loss and dementia (IPCS, 1999; NPIS, 2004).

4.5.4.3 Carbon Dioxide (CO_2)

According to Jarrell et al. (2002), CO_2 is a colorless, odorless, non-flammable gas at room temperature, and is required for plant and animal life. It is produced naturally in the body and during the burning of fossil fuels. Decaying vegetation and rotting carbon-containing wastes also produce CO_2. It can exist as a liquid or a solid (dry ice), depending on the temperature and pressure. CO_2 is used in fire extinguishers, as a coolant in the form of dry ice, and to produce artificial fog used in theatre productions. CO_2 is also used to carbonate sodas and seltzer water.

In research by Bierwirth (2018), CO_2 is considered to be minimally toxic by inhalation. The primary health effects caused by CO_2 are the result of its behavior as a simple asphyxiant. A simple asphyxiant is a gas which reduces or displaces the normal oxygen in breathing air. Symptoms of mild CO_2 exposure may include headache and drowsiness. At higher levels, rapid breathing, confusion, increased cardiac output, elevated blood pressure and increased arrhythmias may occur. Breathing oxygen depleted air caused by extreme CO_2 concentrations can lead to death by suffocation (Zhang et al., 2017).

4.5.4.4 Sulfur Dioxide (SO_2)

Sulfur dioxide (SO_2) is a colorless, smelly gas in the sulfur oxide family of gases. Sulfur dioxide is formed when sulfur-containing fuels, such as coal and oil, are burned. The primary sources of sulfur dioxide emissions are power plants, refineries and copper smelting facilities. Sulfur dioxide is also found in the exhaust of diesel fuel and gasoline. Volcanoes and decaying organic matter also produce sulfur dioxide. However, man-made emissions of sulfur dioxide have been the cause of some of the worst air pollution episodes in the last century in Nigeria.

Dejmek et al., (2000) found exposure to very high levels to be life threatening. Low concentrations of sulfur dioxide in outdoor air can irritate the eyes, nose, throat, and respiratory tract, causing coughing and shortness of breath. Long-term exposure to low concentrations can cause headache, nausea, dizziness, and temporary loss of smell. Breathing sulfur dioxide in polluted outdoor air may heighten sensitivities to other allergens, particularly in asthmatics. Some, but not all, studies of workers exposed to high levels of sulfur dioxide have found increased risk for lung cancer and non-Hodgkin lymphoma. Breathing high levels of sulfur dioxide can constrict airways, causing wheezing, chest tightness, coughing, and breathing problems. This can aggravate existing respiratory diseases, such as bronchitis, asthma, or emphysema, and trigger asthma attacks. Chronic exposure may cause bronchitis. Sulfur dioxide exposure may also impair the respiratory system's defenses against foreign particles and bacteria. Exposure to extremely high concentrations of sulfur dioxide can cause severe shortness of breath and pulmonary edema, a medical emergency characterized by fluid building up in the lungs (Dejmek et al., 2000)

4.5.4.5 Hydrogen Sulphide (H_2S)

Hydrogen sulphide is a colourless, flammable gas with a characteristic odour of rotten eggs. It is produced both naturally and through human activity. Hydrogen sulphide is one of the key compounds in the natural cycle of sulphur in the environment. It is produced during the decay of plant and animal protein and it occurs in volcanic gases. Some natural gas fields and geothermal active areas have found significant concentrations of hydrogen sulphide.

Hydrogen sulphide is usually produced as an undesirable by-product, such as in the production of coke from sulphur-containing coal, the refining of sulphur-containing crude oils and from producing wood pulp. However, in some processes it is an important reagent or intermediate such as in the manufacture of sulphuric acid, inorganic sulphides and as an agricultural disinfectant. Inhalation of high concentrations of H_2S may lead to collapse instantaneously, respiratory paralysis, cyanosis, convulsions, coma, cardiac arrhythmias and death within minutes.

Prolonged exposure causes respiratory tract irritation, with rhinitis, pharyngitis, bronchitis, dyspnoea and pulmonary oedema. Systemic effects include vomiting, diarrhoea, headache, nystagmus, dizziness, agitation, drowsiness, tremor, muscular weakness, seizures, tachycardia and hypotension. Dermal exposure causes discoloration, pain, itching, erythema and local frostbite. Ocular effects may be delayed and include irritation, inflammation, lacrimation, conjunctival hyperaemia, photophobia, conjunctivitis, keratitis and blepharospasm. Recovery is usually complete but Exposure to concentrations of about 700 mg/m^3 (500 ppm) hydrogen sulphide and above may be fatal.

Respiratory failure is the most common cause of death, but a wide range of health effects have been reported following exposure to high concentrations including respiratory, neurological and cardiovascular effects (IPCS, 2003; ATSDR, 2006). Neurological effects at high exposure have included nausea, headache, delirium, disturbed equilibrium, poor memory, neurobehavioral changes, olfactory paralysis, loss of consciousness, tremors and convulsions.

In those surviving exposure to high concentrations some of the neurological effects may be permanent or persistent. Cardiac irregularities including arrhythmias as well as hypertension have been reported (IPCS, 2003; ATSDR, 2006) permanent damage.

4.5.4.6 Nitrogen Dioxide (NO_2)

Oxides of Nitrogen (NOx) consist of nitric oxide (NO), nitrogen dioxide (NO_2) and nitrous oxide (N_2O) and are formed when nitrogen (N_2) combines with oxygen (O_2). Their lifespan in the atmosphere ranges from one to seven days for nitric oxide and nitrogen dioxide to 170 years for nitrous oxide. Nitric oxide has no colour, odour, or taste and is non-toxic. In the air it is rapidly oxidized to nitrogen dioxide. Nitrogen dioxide is a reddish-brown gas with a pungent, irritating odour. It absorbs light and leads to the yellow-brown haze sometimes seen hanging over cities. It is one of the important components of smog. Nitrous oxide is a colourless, slightly sweet-smelling, non-toxic gas which occurs naturally in the atmosphere.

Nitrogen oxides occur naturally and also are produced by man's activities. In nature, they are as a result of bacterial processes, biological growth and decay, lightning, and forest and grassland fires. The primary sources of man-made nitrogen oxides are from the burning of fossil fuels, industrial boilers and flare stack. Of the nitrogen oxides emitted, most is nitric oxide, some are nitrous oxide and less than 10 per cent are nitrogen dioxide.

The amount of nitrogen dioxide emitted varies with the temperature of combustion; as temperature increases so does the level of nitrogen dioxide. Nitric oxide by itself is non-toxic, but it is readily converted in the air to nitrogen dioxide. At high concentration levels, nitrogen dioxide is potentially toxic to plants, can injure leaves and reduce growth and yield. In combination with either ozone (O_3) or sulphur dioxide (SO_2), nitrogen dioxide may cause injury at even lower concentration levels. As one of the components of smog, nitrogen dioxide is known to irritate the lungs and increase susceptibility to respiratory infections. Nitrogen oxides are important components in acid deposition (OEHHA, 1999).

4.5.4.7 Hydrogen Cyanide (HCN)

Hydrogen cyanide is a colourless or light blue liquid or gas and is extremely flammable. It has a faint bitter almond odour, though not everyone is able to detect this. Other names for hydrogen cyanide include prussic acid and hydrocyanic acid. Hydrogen cyanide is an important industrial chemical and over a million tonnes are produced globally each year.

It is produced industrially by reacting methane and ammonia in air at high temperature. Because it is widely used, exposure may occur in a number of situations. Exposure may occur in the workplace although safe levels allowed are enforced to protect the employees. Such levels are below those that are thought to cause harmful effects (Baud et al., 2002).

Hydrogen cyanide is not used domestically, but may be given off in fires involving plastics. Hydrogen Cyanide is also present in car exhausts fumes and cigarette smoke. Hydrogen cyanide is poisonous and prevents oxygen being used by the body. Exposure to low concentrations or small amounts may cause headaches, dizziness and nausea; symptoms usually improve soon after removal from an exposure. At higher concentrations, a rapid loss of consciousness, coma or death may occur.

People surviving a serious exposure may have term effects from damage to the brain. Hydrogen cyanide is unlikely to cause harm to the unborn child. Hydrogen cyanide is not considered to be a cancer-causing chemical (Seidl et al., 2003).

The presence of hydrogen cyanide in the environment does not always lead to exposure. Clearly, in order for it to cause any adverse health effects you must come into contact with it. One may be exposed by breathing, eating, or drinking the substance or by skin contact. Following exposure to any chemical, the adverse health effects you may encounter depend on several factors, including the amount to which you are exposed (dose), the way you are exposed, the duration of exposure, the form of the chemical and if you were exposed to any other chemicals (Zaknun et al., 2005).

4.5.4.8 Ammonia (NH_3)

Ammonia (NH_3) is one of the most commonly produced industrial chemicals. It is used in industry and commerce, and also exists naturally in humans and in the environment. Ammonia is essential for many biological processes and serves as a precursor for amino acid and nucleotide synthesis. In the environment, ammonia is part of the nitrogen cycle and is produced in soil from bacterial processes. Ammonia is also produced naturally from decomposition of organic matter, including plants, animals and animal wastes.

At room temperature, ammonia is a colorless, highly irritating gas with a pungent, suffocating odor. In pure form, it is known as anhydrous ammonia and is hygroscopic (readily absorbs moisture). Ammonia has alkaline properties and is corrosive. Ammonia gas dissolves easily in water to form ammonium hydroxide, a caustic solution and weak base. Ammonia gas is easily compressed and forms a clear liquid under pressure. Ammonia is usually shipped as a compressed liquid in steel containers. Ammonia is not highly flammable, but containers of ammonia may explode when exposed to high heat.

About 80% of the ammonia produced by industry is used in agriculture as fertilizer. Ammonia is also used as a refrigerant gas, for purification of water supplies, and in the manufacture of plastics, explosives, textiles, pesticides, dyes and other chemicals. It is found in many household and industrial-strength cleaning solutions. Household ammonia cleaning solutions are manufactured by adding ammonia gas to water and can be between 5 and 10% ammonia. Ammonia solutions for industrial use may be concentrations of 25% or higher and are corrosive (Fraser and Cass, 1998).

Most people are exposed to ammonia from inhalation of the gas or vapors. Since ammonia exists naturally and is also present in cleaning products, exposure may occur from these sources. The widespread use of ammonia on farms and in industrial and commercial locations also means that exposure can occur from an accidental release or from a deliberate terrorist attack. Anhydrous ammonia gas is lighter than air and will rise, so that generally it dissipates and does not settle in low-lying areas.

However, in the presence of moisture (such as high relative humidity), the liquefied anhydrous ammonia gas forms vapors that are heavier than air. These vapors may spread along the ground or into low-lying areas with poor airflow where people may become exposed.

4.5.4.9 Chlorine (Cl_2)

Chlorine is a chemical element and has the symbol 'Cl'. It is part of the group of chemicals called 'halogens' which include fluorine, bromine and iodine. Chlorine does not naturally exist as a gas as it is too reactive. Instead, it reacts with other earth elements to form halogen salts. For example, common salt (also known as sea salt or 'halide') is a combination of sodium and chlorine.

Chlorine gas is produced on an industrial scale by passing electricity through water containing a chlorine salt. The process (known as electrolysis) can also produce other useful chemicals such as hydrogen gas and sodium hydroxide (caustic soda) (Meier et al., 1985).

Chlorine is a poisonous gas that may cause delayed, fatal lung damage at high concentrations. At lower concentrations, chlorine may cause eye irritation and coughing (Winder, 2001). People who have been exposed to chlorine gas generally make a complete recovery, although a proportion may acquire a condition known as Reactive Airways Dysfunction Syndrome (RADS) in which the lungs become more sensitive to chemical irritants.

Chlorine is a reactive chemical and as such does not normally exist in its gaseous form in the environment. The most likely cause of chlorine in the environment is the accidental release from an industrial site or transport vehicle (Winder, 2001).

4.5.4.10 Particulate Matter

Airborne particulate matter represents a complex mixture of organic and inorganic substances. Mass and composition tend to divide it into two principal groups: coarse particles mostly larger than 2.5µm in aerodynamic diameter, and fine particles mostly smaller than 2.5µm in aerodynamic diameter ($PM_{2.5}$).

The smaller particles contain the secondarily formed aerosols (gas-to-particle conversion), combustion particles and re-condensed organic and metal vapors. The larger particles usually contain earth crust materials and fugitive dust from roads and industries. The fine fraction contains most of the acidity (hydrogen ion) and mutagenic activity of particulate matter; although in fog some coarse acid droplets are also present (Clark, 1992).

Suspended particulate matter is a term used to cover a range of finely divided solids or liquids that originate from a number of natural or man-made sources. Particulate matter of thoracic size may be emitted from a number of sources, some of them natural (e.g. volcanoes and dust storms) and many others that are more widespread and more important to public health (e.g. power plants and industrial processes, vehicular traffic, domestic coal burning, industrial and municipal waste incinerators).

The majority of these man-made sources are concentrated in limited areas, i.e. the urbanized areas, where populations are also concentrated (Symposium, 1983).

Hildemann (1993) showed that industrial-scale boilers, fireplaces, cars with and without catalytic converters, diesel trucks and meat cooking operations all emit particles primarily in the range 0.1µm – 0.2µm. Petrol fuelled cars with catalytic converters emitted much lower particle masses than those without, while diesel trucks emitted about 100 times the particle mass, per kilometre driven, of a passenger car with a catalytic converter.

Diesel particulate matter is almost pure carbon and exists as submicrometre-sized aggregates of ultrafine carbon spheroids with aerodynamic diameters of around 0.1µm.

Traditionally, particulate matter air pollution has been thought of as a primarily urban phenomenon. It is now clear that in many areas of Europe; urban–rural differences in PM_{10} are small or even absent, indicating that particulate matter exposure is widespread. Indeed, several of the health effect studies were conducted in (semi-)rural rather than urban areas.

This is not to imply that exposure to primary; combustion-related particulate matter may not be higher in urban areas. At present, however, data are lacking on the specific health risks of such exposures. Evidence is emerging also that long-term exposure to low concentrations of particulate matter in air is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function.

Two cohort studies conducted in the USA suggest that life expectancy may be shortened by more than a year in communities exposed to high concentrations compared to those exposed to low concentrations (Symposium, 1983).

4.5.4.11 Total Volatile Organic Compound (TVOC)

VOCs are compounds comprised primarily of hydrogen and carbon atoms. Internal combustion associated with motor vehicle usage is the major source of hydrocarbons. VOCs themselves are not criteria pollutants; however, they contribute to O3 formation (Chin et al., 2014). Volatile organic compounds (VOCs) are organic chemicals that have a high vapor pressure at ordinary room temperature. Their high vapor pressure results from a low boiling point, which causes large numbers of molecules to evaporate or sublimate from the liquid or solid form of the compound and enter the surrounding air, a trait known as volatility. For example, formaldehyde, which evaporates from paint, has a boiling point of only –19 °C (–2 °F).

VOCs are numerous, varied, and ubiquitous. They include both human-made and naturally occurring chemical compounds. Most scents or odors are of VOCs. VOCs play an important role in communication between plants, and messages from plants to animals. Some VOCs are dangerous to human health or cause harm to the environment. Anthropogenic VOCs are regulated by law, especially indoors, where concentrations are the highest. Harmful VOCs typically are not acutely toxic, but have compounding long-term health effects. Because the concentrations are usually low and the symptoms slow to develop, research into VOCs and their effects is difficult. Respiratory, allergic, or immune effects in infants or children are associated with man-made VOCs and other indoor or outdoor air pollutants.

Some VOCs, such as styrene and limonene, can react with nitrogen oxides or with ozone to produce new oxidation products and secondary aerosols, which can cause sensory irritation symptoms (Canright and Kellineyer, 2012). Health effects include eye, nose, and throat irritation; headaches, loss of coordination, nausea; and damage to the liver, kidney, and central nervous system. Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans. Key signs or symptoms associated with exposure to VOCs include conjunctiva irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, vomiting, nose bleeding, fatigue, dizziness (Ernstgard et al., 2007).

The ability of organic chemicals to cause health effects varies greatly from those that are highly toxic, to those with no known health effects. As with other pollutants, the extent and nature of the health effect will depend on many factors including level of exposure and length of time exposed. Eye and respiratory tract irritation, headaches, dizziness, visual disorders, and memory impairment are among the immediate symptoms that some people have experienced soon after exposure to some organics. At present, not much is known about what health effects occur from the levels of organics usually found in homes (Sarigiannis et al., 2011). Many organic compounds are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans.

4.5.4.12 Formaldehyde

Formaldehyde is a colorless, strong-smelling gas often found in aqueous (water-based) solutions. Commonly used as a preservative in medical laboratories and mortuaries, formaldehyde is also found in many products such as chemicals, particle board, household products, glues, permanent press fabrics, paper product coatings, fiberboard, and plywood. It is also widely used as an industrial fungicide, germicide and disinfectant (Hult et al., 2014).

Formaldehyde is a common chemical that can be emitted from a number of products in the home. Smoking, pressed wood, and particle board have all been shown to be sources of formaldehyde. Higher formaldehyde levels are usually found in newer homes or homes with new construction. The levels decrease over time. Formaldehyde levels also increase with increases in temperature and humidity (Hult et al., 2014).

Formaldehyde irritates the airways. People with asthma, bronchitis, or other breathing conditions are especially sensitive to formaldehyde. People with other chronic diseases also may be less able to tolerate formaldehyde exposure. Pregnant women and their unborn children may not be at higher risk, but they should be careful about exposure. If anyone in your home has any of these conditions, it is important to reduce their exposure to formaldehyde (Centers for Disease Control and Prevention, 2008).

4.5.4.13 Methane (CH_4)

Research done by IPCC (2013); methane (CH_4) is an atmospheric trace gas considered to be the second-most important greenhouse gas after carbon dioxide (CO_2). The estimated warming potential per molecule of CH_4 is 28 times greater than CO_2 over a 100-years horizon, and 72 times greater over a 20-years horizon. The global average atmospheric concentration of CH_4 has more than doubled since the pre-industrial era, reaching values of over 1,800 ppb (WDCGG, 2015).

CH_4 is emitted to the atmosphere by natural and anthropogenic sources, however, the rapid increase in the atmospheric CH_4 concentrations has been attributed to anthropogenic activities. Great uncertainties on the temporal and spatial variability of the individual sources of CH_4 still exist. The ocean is a net source of CH_4 to the atmosphere. Considering biogenic, geological and hydrate sources, the global oceanic emissions have been estimated at 14 Tg yr−1 (range 5-25) value that represent about 1–3% of the total global sources of atmospheric CH_4 (Saunois et al., 2016).

According to Winterstein et al. (2019), Methane (CH_4) is a potent greenhouse gas (GHG), subject to strong anthropogenic emissions that contribute substantially to global warming. It is not just a radiatively active gas by itself but is chemically active as well, strongly influencing the chemical composition of the atmosphere. Ma et al. (2017) found the sources of methane to be prone to temperature changes and it is generally expected that climate change (i.e. surface warming) will lead to enhanced CH_4 emissions, accelerating the temperature rise.

Globally, rice and ruminant animal production arc the two largest sources of anthropogenic CH_4. While the actual magnitude of the emissions from each source remains uncertain, it has been estimated that these two sources (including emissions from animal waste management facilities) account for about 40 % of global CH_4 emissions. Methane is also produced in anaerobic environments such as marine and aquatic sediments and the hindgut of many animals and insects, but the rumen produces CH_4 at a considerably higher rate per unit of biomass than these other systems.

Methane is also produced in soil during microbial decomposition of organic materials and carbon dioxide reduction under strictly anaerobic conditions, such as in natural freshwater wetlands and in flooded rice. Methane emissions from a particular ecosystem are basically controlled by two different microbial processes. CH_4 production and CH_4 oxidation. Only that part of CH_4 which is not oxidized will enter the atmosphere.

As one of the most commonly produced gases in natural biochemical process, methane widely distributes in natural environment and it is the main component of natural gas, biogas, coal gas, and the rest. In recent years, methane attracts intensively attentions because of its significant effects on environment, industry and daily lives. The heat value released from methane combustion reaches 50.2 kJ/kg and it is convenient to transport by pipelines, so it is widely used for energy and heat supplement in human's lives.

Nadezhdinskii et al. (1999) reported that the methane concentration in the atmosphere is only 1.4 mg/m3 but greatly contributes to greenhouse effects. The greenhouse effect from methane is considered as 25 times of that from carbon dioxide (Li et al., 2017). It was reported the average surface temperature increased by 0.31 oC due to the raise of methane content since the industrial revolution (Xie et al., 2017). Basically, methane is non-toxic gas for human's health, while it will lead to unsuitable feelings at the concentration as high as 25-30 % and it is easy to explode in the concentration range of 4.9 %-15 % (Zhang, 2008).

4.5.5 Baseline - Ambient Air Quality

4.5.5.1 Carbon Monoxide

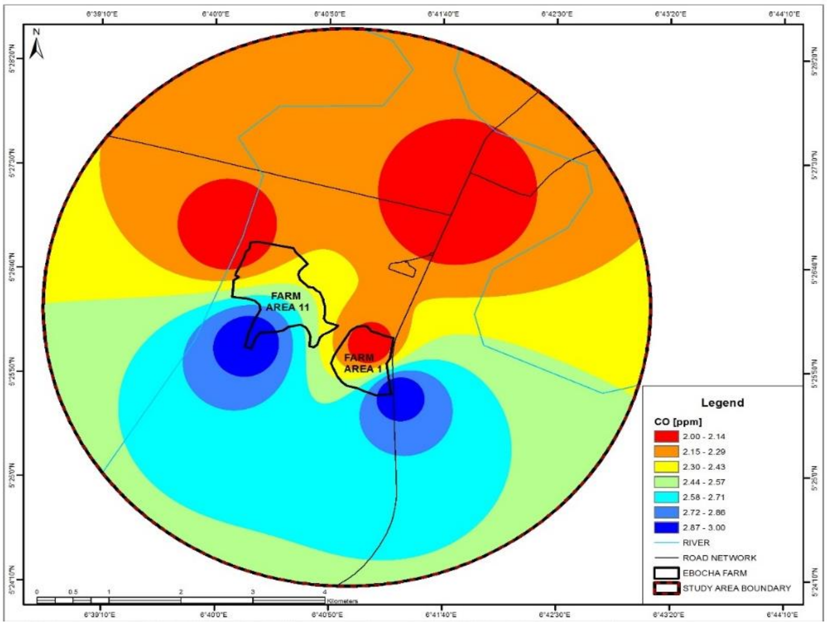


Figure 4.7: Air quality dispersion model of carbon monoxide around Ebocha Farm

In the above model, it can be seen that towards the southern part of both Farm Areas 1 and 11, CO recorded the highest concentration ranging from the deep blue to sky blue colour between 2.58-3.00 ppm. Lowest concentration was recorded in the northern part of the project site showing light to deep red colour ranging from 2.00-2.43 ppm.

However, CO is within the FMEnv limit of 10.0 – 20.0ppm. Long term exposure of CO, no matter the concentration, could result in adverse impact on human health which could lead to instant death. The presence of the gas in the ambient air of the study area was largely due to vehicular emissions, domestic and industrial activities.

4.5.5.2 Sulphur dioxide

As observed in Ebocha farms' environment, SO_2 did not differ in its concentration (uniform concentration of 0.1ppm). Although long-term exposure to low concentrations can cause headache, nausea, dizziness, and temporary loss of smell, the concentration of SO_2 in Ebocha environment is not enough to cause harm to the residents of the environment. The recorded levels of SO_2 were above the FMEnv regulatory limits of 0.01ppm – 0.1ppm for daily average of 8-hourly values in Nigeria.

Almost every activity at the project area had the potential to generate considerable amounts of sulfur dioxide

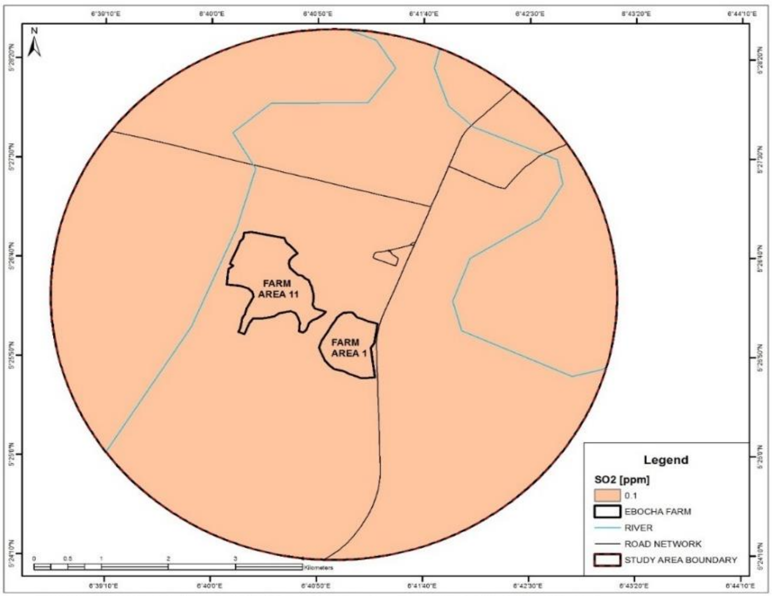


Figure 4.8: Air quality dispersion model of Sulphur dioxide around Ebocha Farm

4.5.5.3 Hydrogen Sulphide

The concentration of H_2S was the same across the entire study area (<0.1 ppm). .No permissible value for H_2S has been given by Federal Ministry of Environment.

Figure 4.9: Air quality dispersion model of Hydrogen Sulphide around Ebocha Farm

4.5.5.4 Nitrogen dioxide

The concentration of NO_2 as observed in the model above, Ebocha Farm assumed a unique nature. That is, no significant variation in its concentration across the study area with a uniform record of <0.1ppm.

However, the recorded values were all above the Federal Ministry of Environment's limits of 0.04 - 0.06 ppm. Generators, vehicular traffic, industrial boilers, etc contributed to the emissions of this gaseous pollutant.

Figure 4.10: Air quality dispersion model of Nitrogen dioxide around Ebocha Farm

4.5.5.5 Hydrogen cyanide (HCN)

In the study area, the concentration of HCN follows a unique pattern; all recording 1ppm. However, the FMEnv has no limit for HCN.

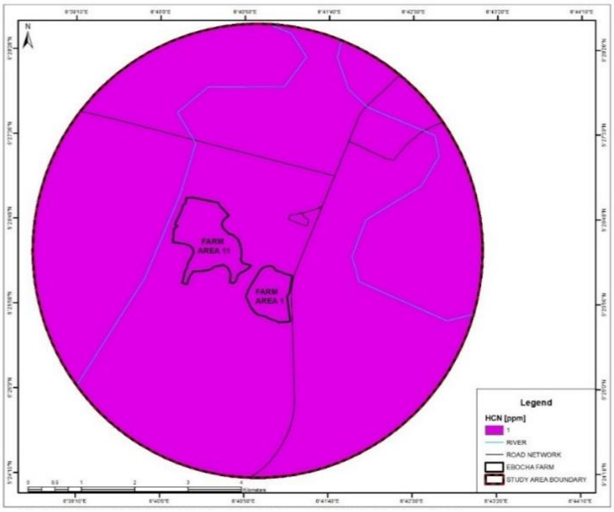


Figure 4.11: Air quality dispersion model of Hydrogen cyanide around Ebocha Farm

4.5.5.6 Ammonia (NH_3)

Farm area 1 recorded the least Ammonia level (deep green colour) ranging from 3.00-3.29 ppm. The concentration increased towards Farm area 11 with its peak concentration observed in north-western part of Farm area 11 ranging between 4.75-5.00 ppm with Tuscan red colour.

The recorded levels of ammonia were below FMEnv limits of 200ppm. Detection of ammonia in the study area may be due to vehicular traffic, cow dung, glass cleaning agents, disinfectants, etc., used within the study.

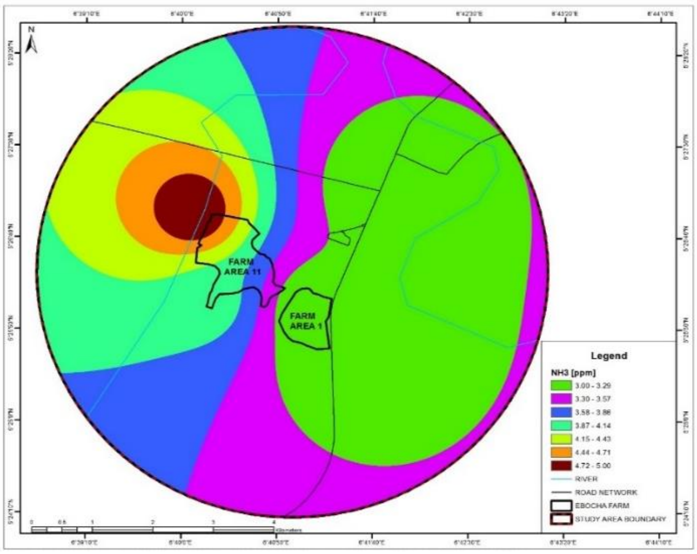


Figure 4.12: Air quality dispersion model of Ammonia around Ebocha Farm

4.5.5.7 Chlorine (Cl_2)

Chlorine concentration did not exceed 0.20 ppm. The two Farm area (green colour) recorded the lowest Cl_2 level (<0.13 ppm). the concentration increased towards the north with a peak concentration (red colour) ranging from 0.18-0.20 ppm. Federal Ministry of Environment has not given permissible value for Cl_2. Its presence in the study site might be attributed to transportation, cleaning agent, disinfectant, preservative agents, production or utilization of chemicals, etc.

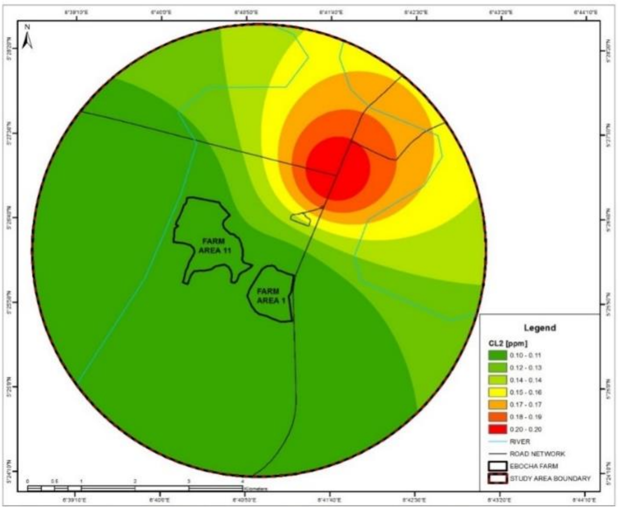


Figure 4.13: Air quality dispersion model of Chlorine around Ebocha Farm

4.5.6 Particulate Matter ($PM_{2.5}$ and PM_{10})

4.5.6.1 $PM_{2.5}$

The western part of Farm area 11 with Tuscan red colour represented areas with high concentrations of $PM_{2.5}$ ranging from 46.01-48.00 µg/m3. The concentration was in moderation towards Farm area 1 ranging from 44.01-46.00 µg/m3 (Autunite yellow colour). However, the lowest concentration was observed towards north of the study area ranging from 41.00-43.00 µg/m3.

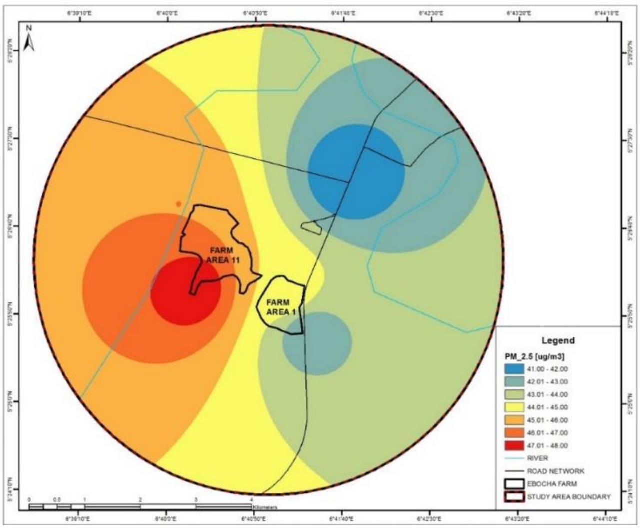


Figure 4.14: Air quality dispersion model of $PM_{2.5}$ around Ebocha Farm

4.5.6.2 PM_{10}

The highest concentration of PM_{10} was recorded west of Farm area 11 (dark navy colour) ranging from 80.44-82.00 µg/m3. PM10 appeared moderate towards Farm area 1 with light green colour ranging from 75.72-78.88 µg/m3 while the least concentration was observed north of the study area (flame red) ranging between 71.00-74.14 µg/m3).

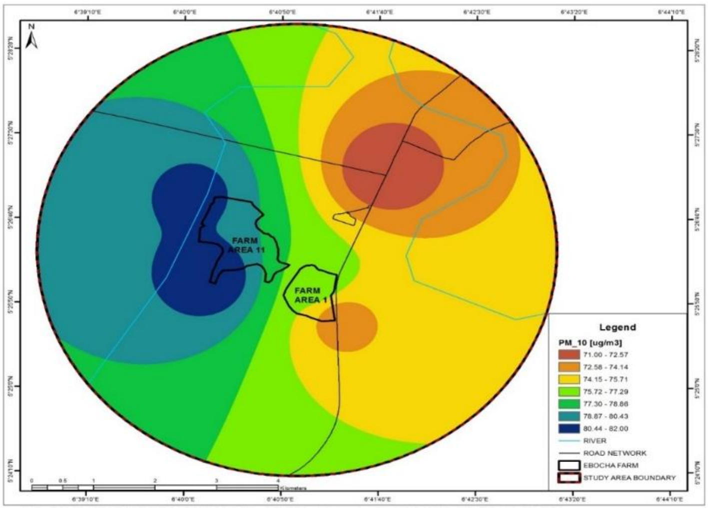


Figure 4.15: Air quality dispersion model of $PM_{1.0}$ around Ebocha Farm

4.5.7 Total Volatile Organic Compound (TVOC)

Across the two Farm areas, TVOC recorded lowest ranging from (0.26-0.71 mg/m3) Seville Orange colour. However, the concentration increased towards the northern part ranging from 1.17-1.84 mg/m3 with colour palette from Beryl Green to Lepidolite Lilac colour.

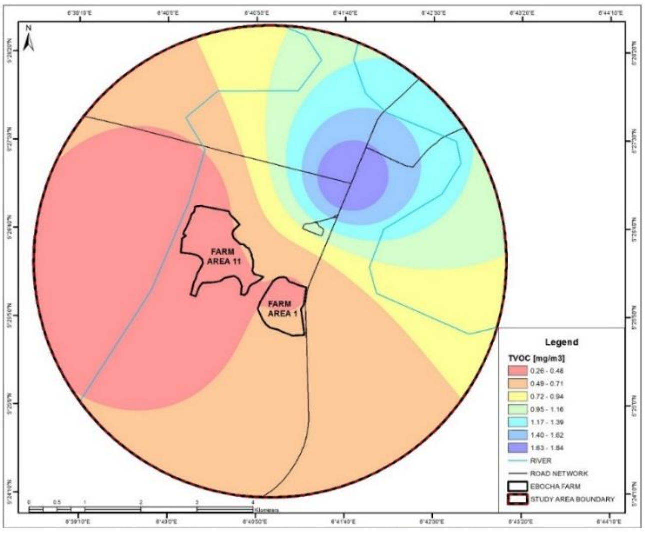


Figure 4.16: Air quality dispersion model of TVOC around Ebocha Farm

4.5.8 Formaldehyde (CH_2O)

In the dispersion model below, formaldehyde recorded lowest concentration around the two Farm areas ranging from 0.04-0.09 mg/m3. The concentration increased northward to a peak of 0.21 ppm (Tuscan red colour).

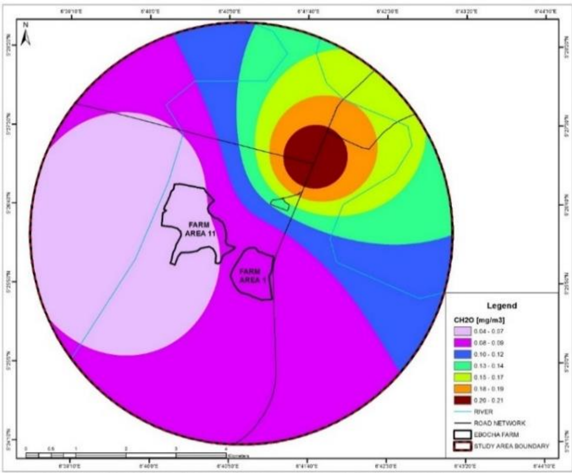


Figure 4.17: Air quality dispersion model of CH_2O around Ebocha Farm

4.5.9 Methane (CH_4)

In the above model, CH_4 was observed to be highest around the Farm areas ranging from 0.69-0.80 ppm. The concentration reduced towards the north to a concentration of 0.40 ppm.

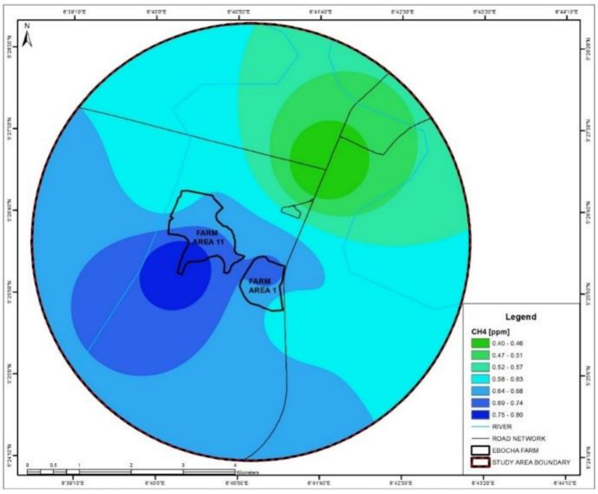


Figure 4.18: Air quality dispersion model of CH_4 around Ebocha Farm

4.5.10 Carbon Dioxide (CO_2)

Low level of CO_2 was recorded around the Farm area ranging from 551.02-693.07 ppm. Its concentration increased towards the northern part of the study area ranging between 908.15-1050.99 ppm.

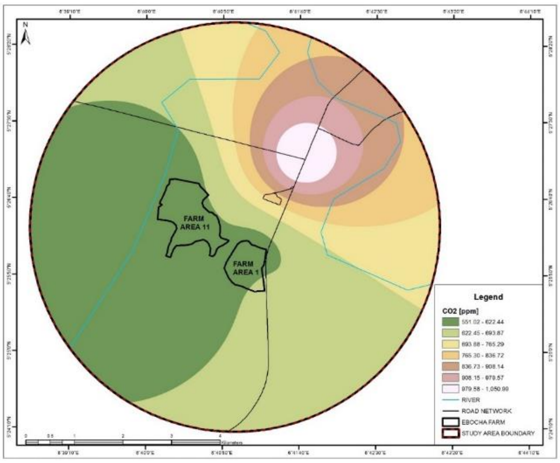


Figure 4.19: Air quality dispersion model of CO_2 around Ebocha Farm

4.6 Geology, Hydrogeology and Hydrology

4.6.1 Methodology

The geologic study for the proposed project involves geologic field studies such as geologic characterization and mapping, hydrogeologic study, fossils identification (if any), geologic structure and lithological identifications obeying the law of uniformitarianism which states that in an undisturbed geologic environment, the present is the key to the past.

This can be achieved through field studies and high impact approved papers of previous research carried out within the geologic terrain from the Department of Geology, University of Port Harcourt. These researches addressed various aspects such as basin evolution and tectonics, biostratigraphy, sedimentology, sequence stratigraphy etc.

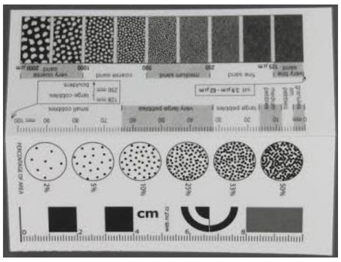
4.6.2 Field Equipments Used for this study

For this study, some of the field equipment used are outlined in table 4.10;

Table 4.10: Field equipment used

Basemap  *It is used for outcrop identification if any.*	*Geologic Hammer*  *Geologic hammer is used for collection of geologic samples (if any) and where necessary used to create fresh surfaces and minerals within it can be described.*

<table>
<tr>
<td>Compass clinometer

Is used to measure the orientation of geological bedding planes such as the dip and strike of beds.</td>
<td>Comparator


This is used for classification of sandstone with respect to grain sizes, texture and sorting.</td>
</tr>
<tr>
<td colspan="2">Global Positioning System (GPS)


For Navigation</td>
</tr>
</table>

Source: Resourcefield 2020

4.6.3 Regional Geology

The Tertiary Niger Delta Basin located in southern Nigeria at the inland margin of the Gulf of Guinea and is situated at the southernmost part of the intra-continental Benue Trough as shown in above (fig. 4.11). The basin which was formed at a recognized triple junction of the south Atlantic rifting (Delhaya et al, 2009), is bounded by the Calabar Flank to the east, Benin Flank to the west, Gulf of Guinea to the south and to the north by the Anambra Basin and Afikpo Syncline (Tuttle et al. 1999).

The Niger delta basin is one of the largest subaerial basins in Africa. It has a total area of 300,000 km^2, and a sediment fill of 500,000 km^3 (Fatoke, 2010). The evolution of the Niger delta is controlled by pre- and syn-sedimentary tectonics described by Brooks, 1990. The tectonic framework is controlled by cretaceous fracture zones expressed as trenches and ridges in the deep Atlantic.

The fracture zone ridges subdivide the continental margin into individual basins, and in Nigeria, form the boundary faults of the cretaceous Benue-Abakaliki trough, which cuts far into the West African shield. The trough represents a failed arm of a rift triple junction which led to the formation of Niger delta basin and is composed of different geologic Formations.

Throughout its history, the delta has been fed by the Niger, Benue and Cross rivers, which between them drain more than 10^6 km^2 of continental lowland savannah. Its present morphology is that of a wave-dominated delta, with a smoothly seaward-convex coastline transverse by distributary channel

(Brook J., 1990). The formation of the Niger Delta began in the early Palaeocene times and was as a result, buildup of fine – grained sediment eroded and transported by the River Niger and its tributaries.

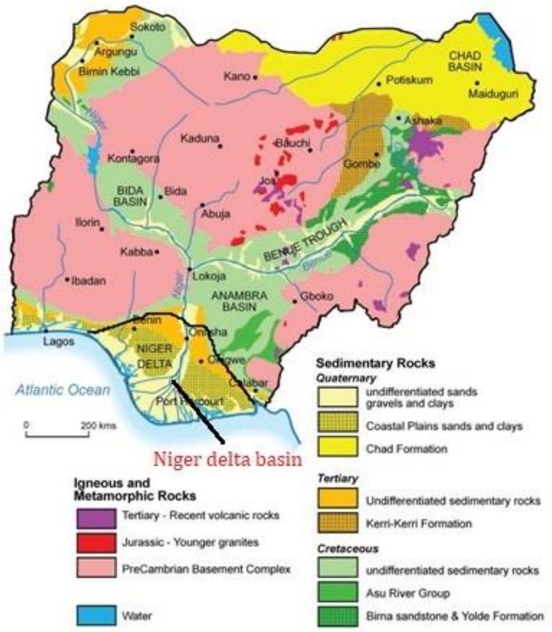
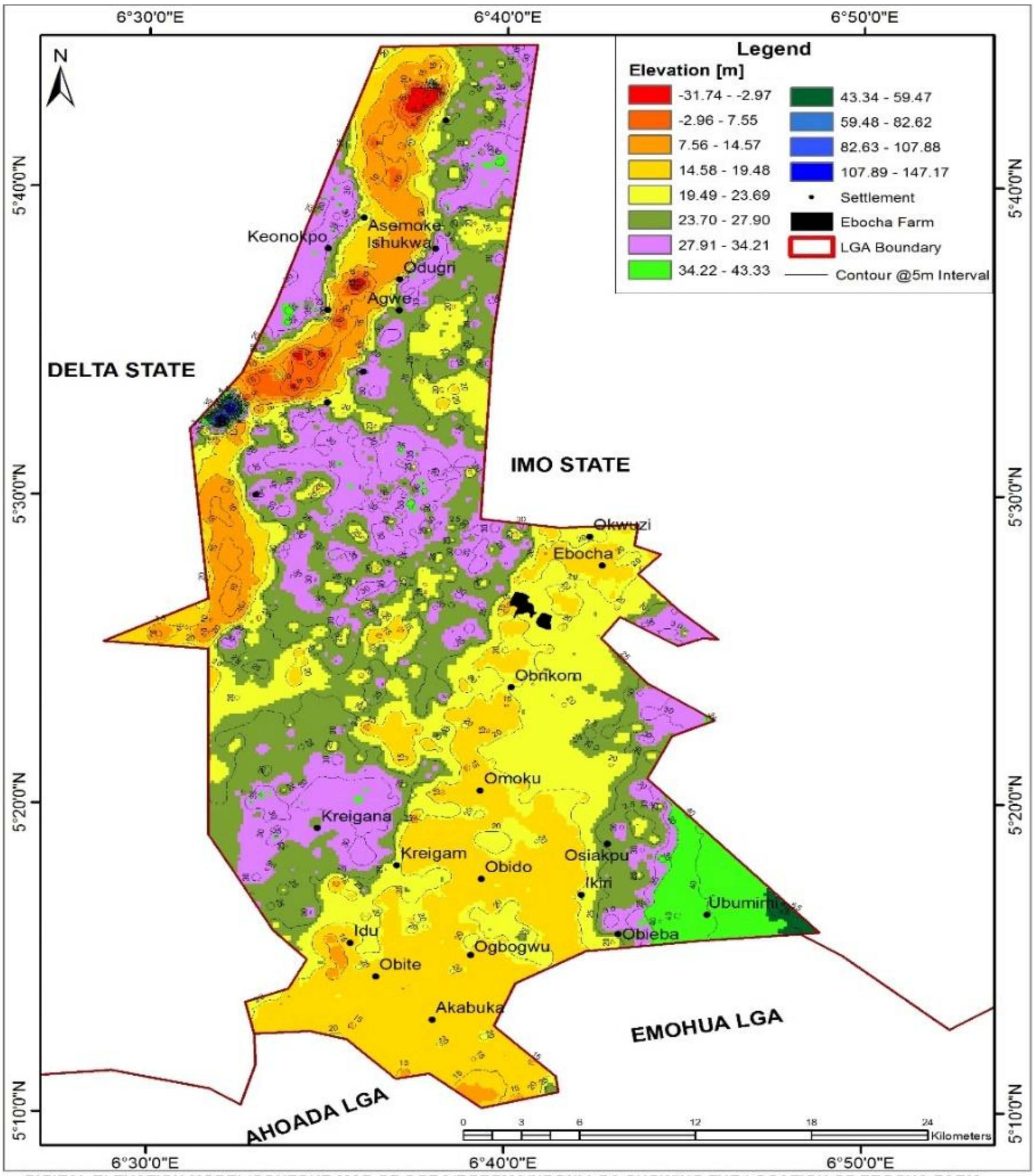


Fig 4.20: Geologic map of Nigeria showing Niger delta basin

4.6.4 Local Geology

The study area has a flat topography and its elevation varies between 20m to 30m above sea level. thus, no outcrop was observed within the study area as shown in fig 4.21.



DIGITAL ELEVATION MODEL/CONTOUR MAP OF OGBA/EGBEMA/NDONI LGA SHOWING THE LOCATION OF EBOCHA FARM
Source: 30m by 30m USGS ASTER Digital Terrain (2020)

Fig 4.21: Topographic map of the study area

The study area consists of alluvial and fluvial sediment deposits of fine to medium sandstone, brown dense silty sand, clay and pebbles in which sand percentage increases as observed (5.45686^0 N, 6.67320^0 E) along the river bank of Orashi river.

Plate 4.2: sandstones and pebbles images from the Orashi river bank.

According to Etu-Efeotor et al, 1990 the Niger Delta is composed of three subsurface lithostratigraphic units (Akata, Agbada and Benin formations overlain by various deposits of Quaternary Age. The Benin formation (2100m thick) is the most prolific aquifer in the region and constitutes over ninety percent (90%) massive, porous sands with localized clay/shale interbeds. The quaternary deposits (40 – 150m thick) generally consist of rapidly alternating sequences of sand and silt/clay, with the latter becoming increasing more prominent seawards.

The Agbada formation underlies the Benin formation and was deposited under transitional environment, makeup of sands and shales. However, increasing clay may occur with depth. Underlying the Agbada formation is the Akata formation, which was deposited, in marine environment. It consists of marine clays, silts and shales with occasional turbidite sand lenses.

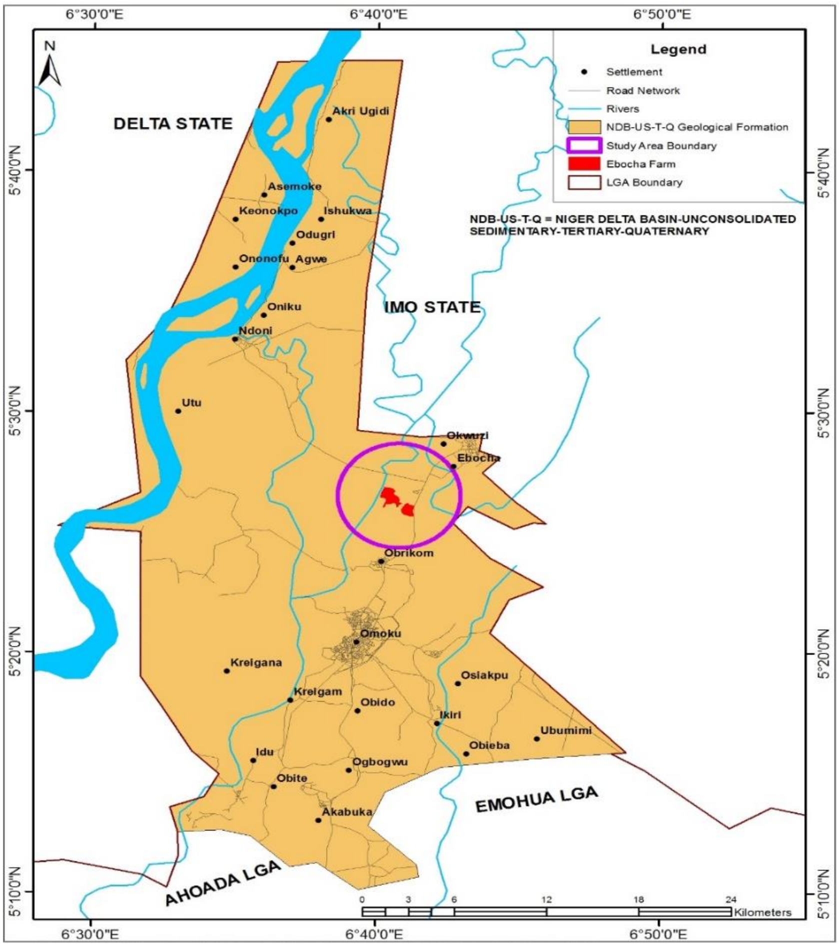


Fig 4.22: Geologic Map of the study area

The formation is rich in organic matter and is the source rock of oil in the Niger Delta which explains the presence of Nigerian Agip oil company. It has a relative thickness of 20,000ft (5882m).

Table 4.11: Geologic units of Niger delta (Short & Stauble 1967)

Geologic Units	Lithology	Age
Alluvium (general)	Gravel, sand, clay, silt	Quaternary
Fresh water back swamp meander belt	Sand, clay, some silt, gravel	Quaternary
Mangrove and salt water/back swamps	Medium fine sands clay & some silt	Quaternary
Active & abandoned beach ridges	Sand, clay and some silt	Quaternary
Sombreiro-Warri Deltaic Plain	Sand, clay and some silt	Quaternary
Benin Formation (coastal plain sand)	Coarse to medium sand with subordinate silt & clay	Miocene
Agbada Formation	Mixture of sand, clay & silt	Eocene
Akata Formation	Clay	Palaeocene

4.6.5 Soil and Flood Potential

The soils of the study area are part of the coastal soils. Edet, A.E. 1993 had earlier stated that coastal soils are composed of coastal sand deposits originally laid down at or near sea level in Oligocene to Pleistocene times. The soils are dark to brown in colour. coarse grained, locally fine grained, poorly sorted, subangular to well rounded (Doust and Omatsola, 1990). Olobaniyi et al (2006) stated that the genesis of these soils have resulted from cycles of soil formation which alternated with cycles of erosion in the mid tertiary to Holocene era in Nigeria. Soil consistency as observed during the field exercise were between wet (slightly sticky and non-sticky) and moist (friable), while soil colour were between black, Dark red and Brown.

According to Atipko et al, 2018, the soil is poorly graded and implies a relatively high permeability potential. The high proportion of silty clay size fractions in the soil indicates a considerable amount of compressibility. The strength properties of the soil evaluated based on CBR reveals that the soil materials are suitable for subbase and subgrade materials.

According to Abam at el 1993, the study area falls within the Niger flood zone as shown in the figure 4.23. thus, the area is prone to flooding and inundation hazards.

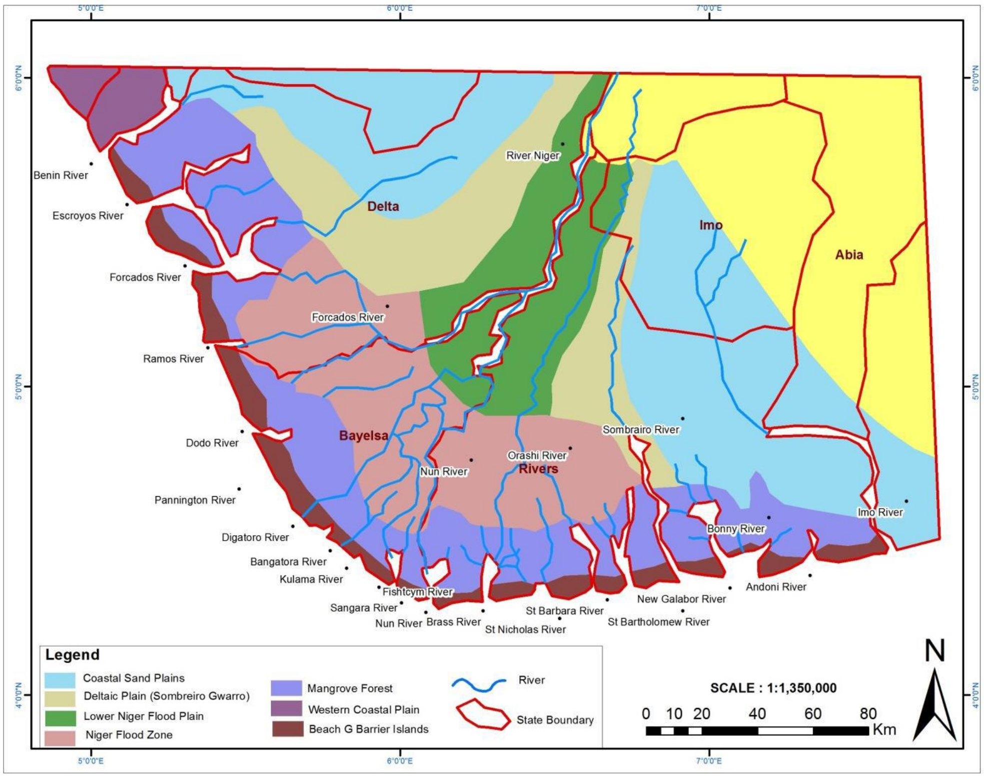


Figure 4.23: Map of Niger Delta showing, rivers, states and flood zones (Abam TKS, Okogbue CO (1993))

Low lying areas suffer the most from flooding because during intensive storm rainfall, the basin receives more than it could transfer as surface water in a short period of time (Zekai, 2018). The closer the urban land use to the main channel stream, the more prone is to flood, and consequently, drainage cross sections that have not been prone to flood hazard before, may become under the threat of flood danger (Akpokodje, 2007).

Using rainfall data, soil texture and other factors Chiadikobi et al 2011 conducted flood risk assessment within the study area and the result of the study showed that there is risk of occurrence of potentially damaging floods with increasing rainfall intensity.

4.6.6 Hydrogeology and Hydrology

Geologically, the site is underlain by the coastal plain sands, overlain by firm – stiff clay/sandy clay sediments belonging to the pleistocenic formation. The area essentially reflects the influence of movements of water runoff in their search for lines of flow to the sea with consequent deposition of transported sediments from Orashi river and its tributaries as shown in fig 4.24.

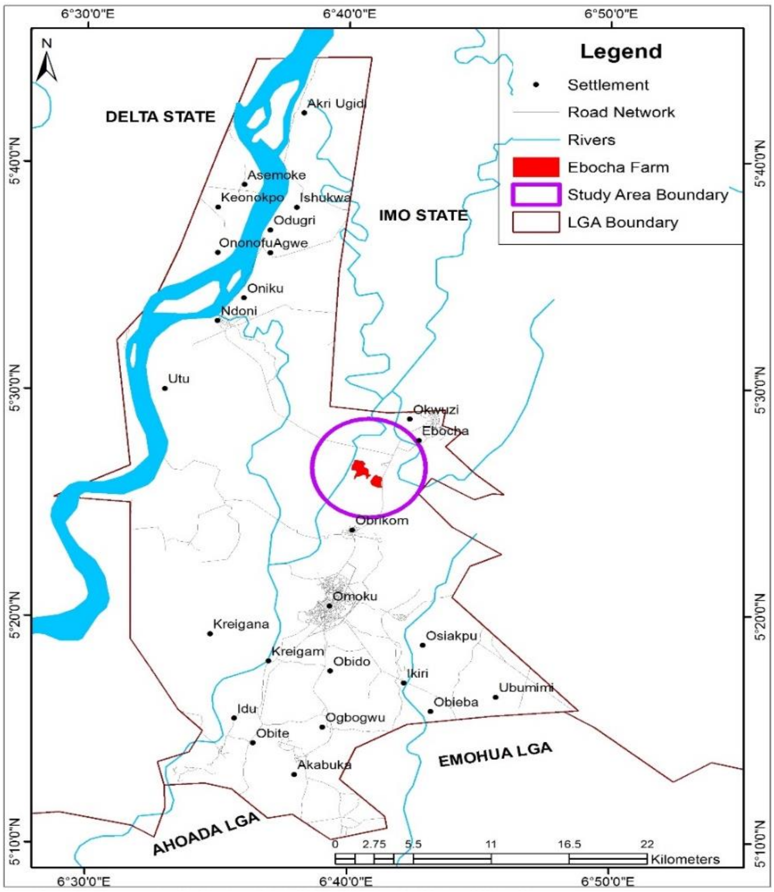


Fig 4.24: Hydrogeology Map of the study area

Given the permeability of sands (from medium to high), they are excellent reservoir rock. The clayey intercalations, when present acts as aquitard or aquiclude, depending on the thickness, areal continuity and permeability of the layer. The litho-stratigraphic succession described above indicates the existence of a powerful alluvial aquifer hosted in sandy deposits.

According to Amakiri at el 2014, the groundwater potentials of Omoku and its environs are enormous based on the positive indicators of high resistivity values, clean coarse sand formation materials, the thickness of the established aquiferous saturated zone and the shallow depth to locating the aquifer, which is about from 22m that can facilitate the easy harnessing and supply of safe, sustainable and portable water to the people of the area.

Given the variability of the sedimentary deposition and energy of the surface waterway flows, the existence of two types of aquifers (Multilayer and Monolayer aquifers) can be hypothesized.

A multi-layer aquifer is made up of several overlapping water bearing layers, hydraulically separated by less permeable clayey layers. Figure 4.25 gives an example of an alluvial aquifer of the multi-layer type, with continuous impermeable strata which defines a hydraulic separation.

The sedimentary Formations hosts several strata hydraulically separated by impermeable strata as seen in the figure 4.25 by the various piezometric loads with hypothetical measuring pipes positioned at various depths. Thus, a Monolayer aquifer is made up of one sedimentary body in which there is absence of less- permeable separation strata; the sedimentary body hosts a single water-bearing layer. In this case, the hydraulic loads measured at different levels are identical.

In the case of multi-layer aquifer, the supply to the 1st aquifer is given by the direct recharge produced by rainfall in the area where the clayey cover is absent and by the exchange with surface waterways. The groundwater circulation of the 1st aquifer is strictly connected to the fluvial regime. Depending on the season, the Niger river may drain or be drained by the groundwater of the 1st aquifer. The mono-layer aquifer is fed by direct recharging due to rainfall and by the exchange with the surface waterways.

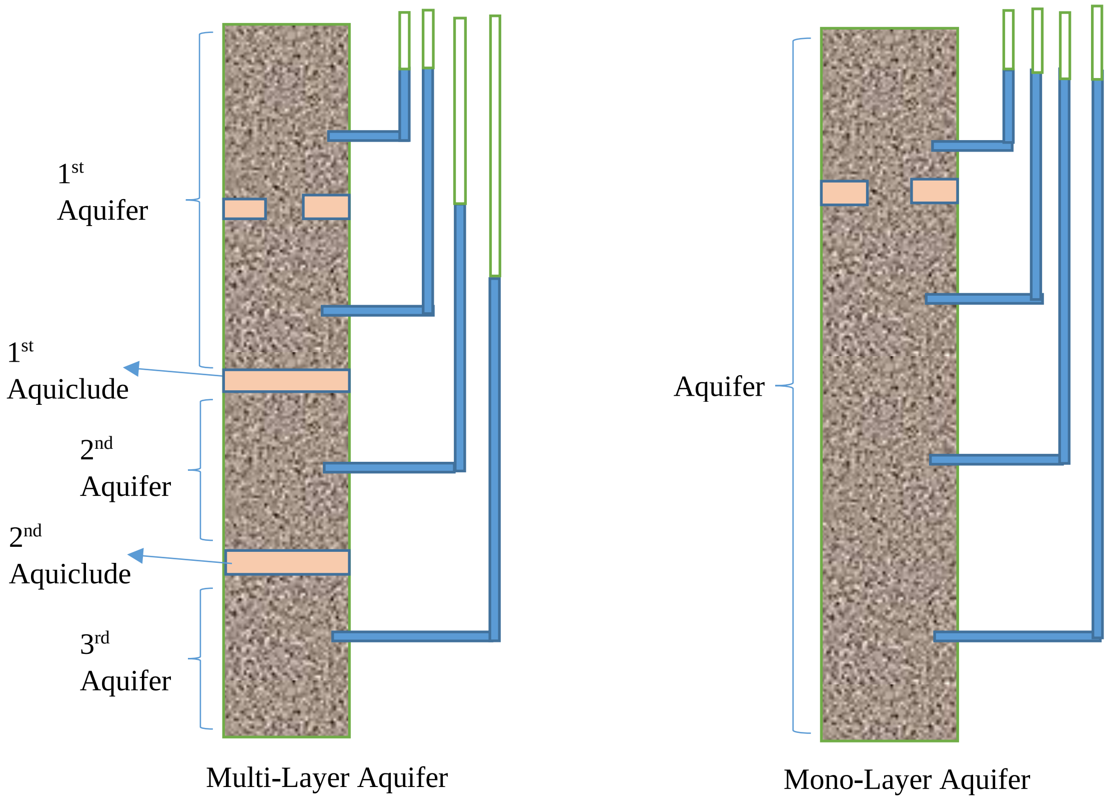


Figure 4.25: Examples of Multi-layer and Mono-layer Aquifer

According to Owamah et al, 2018, the constant head method was used to determine the hydraulic conductivity of the soil due to its sandy nature from five sample boreholes. *The* hydraulic conductivity values obtained for borehole 1 to borehole 5 were$1.5x10^{-1}$, $2.4x10^{-1}$, $3.5x10^{-1}$, $3.5x10^{-1}$, and $3.5x10^{-1}$cm/sec respectively. These high hydraulic conductivity values indicate fine to medium sandy soil. The implication of high hydraulic conductivity values is that the aquifer system within the study area is prolific (Etu-Efeotor, 2000).

4.7 Surface water and Groundwater Quality

4.7.1 Surface water

Eight (8) water samples were collected for surface water in close proximity to the proposed project area. These include 6 stations as sampling point and 2 stations as control point as shown in Table 4.12 and these were analysed for physico-chemical and microbiological properties and were subsequently sampled.

Table 4.12: Surface water sampling locations.

Sample Code	Coordinate	
	Northing	Easting
SW 1	5°27'35.55"N	6°40'24.89"E
SW 2	5°26'51.61"N	6°40'12.50"E
SW 3	5°26'2.12"N	6°39'56.90"E
SW 4	5°25'23.95"N	6°39'36.74"E
SW 5	5°25'56.62"N	6°41'57.28"E
SW 6	5°27'44.66"N	6°42'13.04"E
SWc 7	5°27'35.55"N	6°40'24.89"E
SWc 8	5°26'51.61"N	6°40'12.50"E

Source: Resourcefield survey, 2020.

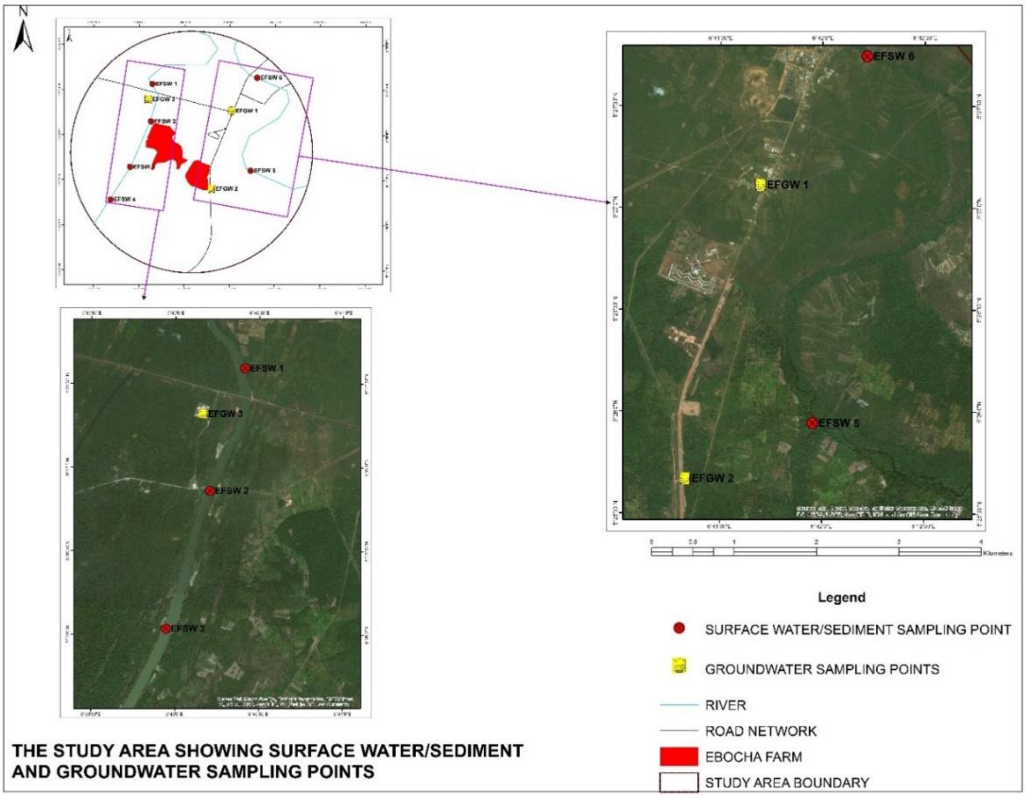


Figure 4.6: Surface water and Groundwater sampling points

4.7.1.1 Sampling Methodology

Bottle sampler for water quality determinant was lowered into the river to collect surface water samples. Water samples were collected directly into various ampoules. These were stored and preserved as appropriate for each analysis.

The exercise involved *in situ* measurement of salinity, temperature, turbidity, pH, dissolved oxygen and conductivity. These are parameters with short holding time. Water samples for heavy metal analysis were collected in 2ml plastic bottles and acidified with 10% HNO_3.

4.7.1.2 Physico Chemical Results

The physico-chemical characteristics of the surface water bodies within the proposed project areas are summarized in Table 4.13 (see appendix 3 for detailed result)

Table 4.13: Summary of Results of Physio-chemical Analyses of Surface water

Parameters	Range	Mean	WHO Limit	FMEnv Limit
Color (Pt Co Units NCASI)	8.14-8.27	8.21	5.0-15.0	-
pH	5.79-6.53	6.25	6.5-8.5	6.5-9.0
Temperature (oC)	32.4-35.1	33.97	-	-
Turbidity (NTU)	35.77-56.82	44.05	5	5
Salinity (ppt)	0.069-0.079	0.074	-	-
Hardness (mg/l)	38.9-40.3	39.52	250	250
Conductivity (µS/cm)	98.7-112.4	106.15	1000	400
Dissolved Oxygen (mg/l)	5.53-5.71	5.58	5	>4.0
Biological Oxygen Demand (mg/l)	0.55-0.85	0.71	-	-
Chemical Oxygen Demand (mg /l)	0.16-0.25	0.217	-	150
Total Hydrocarbon Content (mg/l)	0.114-0.151	0.128	-	-
Phosphate (mg/l)	0.22-0.62	0.418	-	-
Sulphate (mg/l)	4.04-4.15	4.09	250	250
Nitrate (mg/l)	3.49-3.66	3.55	10	10
Total Dissolved Solids (mg/l)	69.09-78.68	74.31	1000	1000
Total Suspended Solids (mg/l)	14.90-23.68	18.36	-	-
Copper (mg/l)	0.175-0.214	0.2002	1	0.01
Iron (mg/l)	2.164-2.216	2.2007	0.36	0.36
Lead (mg/l)	<0.001	<0.001	0.05	<1.0
Zinc (mg/l)	0.72-0.87	0.8	3	<1.0
Cadmium (mg/l)	<0.001	<0.001	0.003	<1.0
Chromium (mg/l)	<0.001	<0.001	0.05	0.05
Potassium (mg/l)	0.14-0.28	0.217	-	-
Barium (mg/l)	0.14-0.23	0.16	-	-
Faecal Coliform (cfu/100ml)	7.0-13.0	10.33	0	0
Total Coliform (cfu/100ml)	11.0-17.0	14.33	0	0
Total Heterotrophic Bacteria (cfu/ml)	1.1×10^5-2.8×10^5	2.1×10^5	100	100

Source: Resourcefield Survey, 2019

Appearance

The presence of dissolved and suspended organic materials and compounds of calcium and iron (Shelton, 1991) can cause colour in drinking water. All samples conformed to WHO recommended standard for any water suitable for drinking.

pH

The pH plays an important role in all chemical reactions associated with formation, alteration and de-solution of minerals in water. Water pH is widely used to express the intensity of acidity or alkalinity of water. Recorded pH values for surface water ranged from 5.79-6.53 with the mean of 6.25. This value is within WHO and FMEnv permissible limits of 6.5-8.5 and 6.5-9.0 respectively.

Temperature

Temperature refers to degree of hotness or coldness and it can be measured in degree Celsius. Temperature is also important because of its influence on water chemistry. The rate of chemical reactions generally increases at higher temperature. Temperature values obtained for surface water ranged from 32.4-35.1°C with the mean of 33.97°C.

Salinity

Salinity is the total of all non-carbonate salts dissolved in water, usually expressed in parts per thousand (1 ppt = 1000 mg/L). Unlike chloride (Cl^-) concentration, you can think of salinity as a measure of the total salt concentration, comprised mostly of Na^+ and Cl^- ions.

Salinity values ranged from 0.069-0.079 ppt with the mean of 0.074ppt. Neither WHO nor FMEnv has assigned permissible limit for salinity in drinking water.

Turbidity and TDS

Turbidity varies fairly proportional to the total suspended solids in the various analysed samples. Although the suspended particles that reduce clarity can include organic particles, turbidity in the water bodies in the study area is a measure of the inorganic particles that account for most of the TSS. Regulatory limits of 10 and 25 NTU are the upper intervention values for safe drinking water and sustenance of aquatic lives respectively. From the result, the turbidity level ranges from 35.77-56.82 with mean value of 44.05. This recorded value is far above WHO/FMEnv permissible limit of 5NTU. This high turbidity level is attributable to influx of allochthonous organic materials from storm water runoff.

Possible sources of TDS could be through runoff from industrial wastewater and chemicals used in the water treatment process. Thus, the TDS test is an indicator test to determine the general quality of the water. The concentration values TDS range from 69.09-78.68 with mean value of 74.31mgl^{-1}This value is below 1000 mgl^{-1} WHO/FMEnv assigned permissible limit.

Total Hardness

The principal cause of hardness in surface water is the presence of calcium and magnesium ions which however, indicates the level of surface water pollution (Olumuyiwa *et al.,* 2012). Total hardness values ranged from 38.9-40.3mg/l with the mean of 39.52mg/l. The recorded value is below WHO/FMEnv permissible limit of 250 mg/l.

Conductivity (EC)

Solids can be found in nature in a dissolved form. Salts that dissolve in water break into positively and negatively charged ions. Conductivity is the ability of water to conduct an electrical current, and dissolved ion are conductors. Electrical conductivity values ranged from 98.7-112.4µS/cm with the mean of 106.15µS/cm. The recorded value is below WHO and FMEnv permissible limit of 1000 and 400 mg/l respectively.

Total Hydrocarbon Content (THC)

The concentration of dispersed THC is an important parameter for water quality and safety. THC in water can cause surface films and shoreline deposits leading to environmental degradation, and can induce human health risks when discharged in surface or ground waters. Additionally, THC may interfere with aerobic and anaerobic biological processes and lead to decreased wastewater treatment efficiency. The concentrations of the THC in the water samples of the study area ranged from 0.114-0.151mg/l with mean value of 0.128mg/l. There is no recommended WHO/FMEnv permissible limit for THC in drinking water.

Biochemical-Oxygen Demand (BOD)

The measured value of BOD level ranged from 0.55-0.85mg/l with mean concentration value of 0.71mg/l. There is however, no recommended WHO/FMEnv limit for BOD in drinking water.

Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) describes the amount of oxygen required to breakdown chemical substance in industrial effluent. The measured COD level ranged from 0.16-0.25mg/l with mean value of 0.217mg/l. The obtained value is below FMEnv permissible limit of 150mg/l.

Dissolved Oxygen

Fish and other aquatic organisms cannot survive without dissolved oxygen, making it one of the most important parameters for measuring the integrity of fresh water ecosystems. Aquatic lives are put on stress when DO falls below 4 mgl^{-1}. Good fishing waters have a DO concentration of around 9 mgl^{-1}. Large fish kills have been reported for DO less than 2 mgl^{-1}. Water with high dissolved nutrients leading to DO above 6 mgl^{-1} is not good for the human health (UNICEF, 2004). DO values ranged from 5.53-5.71mg/l with the mean of 5.58mg/l. This value is slightly greater than 5mg/l WHO permissible limit for drinking water. Direct absorption of oxygen into surface water from the atmosphere by rapid movement or as a waste product of plant photosynthesis could lead to an increase in the DO level.

Heavy Metals

The availability of heavy metals such as lead in potable water is controlled by physical and chemical interactions. These interactions are affected by factors like pH, temperature, type and concentration of available legands and chelating agents, as well as type and concentrations of the metal ions. Concerns over heavy metals in drinking water relate to their toxicity, bio-accumulation and hazards to human and animal health (Kikuchi *et al*., 2009; Seshan *et al*., 2010). The heavy metal analysed include Cu, Fe, Pb, Zn, Cd, Cr, and Ba. The concentration level of lead, cadmium, and chromium were below equipment detection limit of 0.001. The mean concentration value recorded for Cu (0.2002mgl^{-1}), Zn (0.8 mgl^{-1}), and Ba (0.16 mgl^{-1}) were observed to be below WHO permissible limit of 1mgl^{-1} and 0.36mgl^{-1} respectively with no assigned WHO/FMEnv permissible value available for barium. However, Fe with mean value of 2.2007 mgl^{-1} exceeded WHO/FMEnv permissible limit of 0.36 mgl^{-1}. This could be attributed to domestic washing of shores and run off from many artisanal activities (Iwegbue et al 2014).

4.7.2 Groundwater Quality and Contamination

Ground water samples were obtained from 4 boreholes. These include 3 stations as sampling point in close proximity to the study area and 1 station as control point as shown in Table 4.14 and these were analysed for physico-chemical and microbiological properties

Table 4.14: Groundwater sampling locations.

Sample Code	Coordinate	
	Northing	Easting
EF-GW1	5°27'6.70"N	6°41'41.82"E
EF-GW2	5°25'40.24"N	6°41'20.09"E
EF-GW3	5°27'6.70"N	6°41'41.82"E
EF-GW-C1	5°25'40.24"N	6°41'20.09"E

Source: Resourcefield survey, 2020.

4.7.2.1 Sampling Methodology

The boreholes were sampled using Niskin bottle. The Niskin bottle was flushed with distilled water before used at every station.

4.7.2.2 Hydro-Geochemistry

The results of the physical and chemical characteristics of groundwater sample obtained from the boreholes within the spatial influence of the project area are summarized in Table 4.15 (see appendix 3 for detailed result).

Table 4.15: Groundwater Physico-chemical parameters

Parameter	Range	Mean	WHO Limit	FMEnv Limit
Appearance	Clear	Clear	-	-
Odour	Nil	nil	-	-
pH	5.69-6.61	6.27	6.5-8.5	6.5-9.0
Turbidity (NTU)	2.21-3.8	3.17	5.0	5.0
Salinity	0.04-0.08	0.06	-	-
TDS (mg/l)	20.1-43.8	37.6	1000	-
TSS (mg/l)	2.1-3.2	2.5	50	500
Conductivity (µS/cm)	20.2-180	65.6	1000-1500	-
Total Hardness (mg/l)	4.0-24.0	13.4	250	150
Temperature (oC)	27.1-28.8	27.9	40^{oc}	Ambient
DO (mg/l)	0.27-5.27	2.82	<5	5
BOD (mg/l)	1.36-2.83	2.04	10	-
COD (mg/l))	1.40-4.7	3.2	10	-
THC (mg/l)	<0.001	<0.001	< 0.01	-
Nitrate (mg/l)	1.08-2.6	1.74	10	50
Phosphate (mg/l)	0.15-0.28	0.19	10	-
Sulphate (mg/l)	8.3-12.2	9.7	500	100
Chloride (mg/l)	2.0-9.4	5.3	500	250
Magnesium (mg/l)	0.21-3.33	1.6	≤ 50	-
Aluminium (mg/l)	<0.01	<0.01	≤ 0.2	-
Arsenic (mg/l)	<0.01	<0.01	0.025-0.01	-
Barium (mg/l)	ND	ND	-	-
Cadmium (mg/l)	<0.01	<0.01	-	≤ 0.005
Chromium (mg/l)	0.015-0.04	0.02	0.03-0.05	-
Cobalt (mg/l)	<0.01	<0.01	0.0002	0.0002
Copper (mg/l)	0.026-0.12	0.05	0.03-2	-
Iron (mg/l)	0.1-0.24	0.20	≤ 0.3	≤ 0.3
Lead (mg/l)	<0.01	<0.01	≤ 0.01	≤ 0.01
Manganese (mg/l)	<0.01	<0.01	≤ 0.01	-
Mercury (mg/l)	<0.01	<0.01	≤ 0.01	-
Nickel (mg/l)	<0.01	<0.01	0.02 - 0.05	-
Vanadium (mg/l)	<0.01	<0.01	-	-
Zinc (mg/l)	0.05-0.23	0.15	0.1-5.0	-

Source: Resourcefield Survey, 2020 ND = Not Detected

All parameters analysed were within WHO/FMEnv permissible limits.

Heavy Metals

The heavy metals and metalloid investigated in the groundwater samples include arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, vanadium and zinc. The availability of metals in water depends on the interplay between several factors including pH, redox potentials, and CO_2 levels. Metal are of environmental health concerns because it has the potential to accumulate or concentrate in biotas. They enter the food chain in the process and can affect man (GEM, 1992). Besides, metal exhibits a wide range of toxicity effects including cancer, impairment of reproductive and nervous system, cardiovascular and renal system disorder, lung damage, skin problem etc (Iwegbue *et al.,* 2016). Arsenic, cadmium, cobalt, lead, manganese, mercury, nickel, vanadium, and barium were below limit of detection. The concentrations of chromium, copper, iron, and zinc ranged from 0.015-0.04, 0.026-0.12, 0.1-0.24, and 0.05-0.23 mg L^{-1} respectively. The recorded values were within WHO/FMEnv permissible limit.

4.8 Soil Resources

Soil is a complex natural material made of disintegrated rocks and decayed organic material that provides nutrients, moisture, and support for land plants. One of the most severe and widespread problems facing the agriculture industry is the degradation of soil quality due to changes and alteration to various physical and chemical parameters.

4.8.1 Soil Resources

Soil samples were collected at ten (10) stations. At each station, soil samples were collected at two depths (0-15cm for top soil and 16-30cm for sub soil).

Table 4.16: Soil sampling locations.

Sample Code	Coordinate	
	Northing	Easting
SS 1	5°26'1.42"N	6°41'8.89"E
SS 2	5°25'43.00"N	6°41'7.94"E
SS 3	5°25'51.35"N	6°40'49.45"E
SS 4	5°25'22.53"N	6°40'29.55"E
SS 5	5°26'55.37"N	6°41'42.92"E
SS 6	5°25'15.48"N	6°41'27.49"E
SS 7	5°26'4.16"N	6°40'43.87"E
SS 8	5°26'39.67"N	6°40'15.01"E
SS 9	5°26'1.42"N	6°41'8.89"E
SS 10	5°25'43.00"N	6°41'7.94"E

Source: Resourcefield survey, 2020.

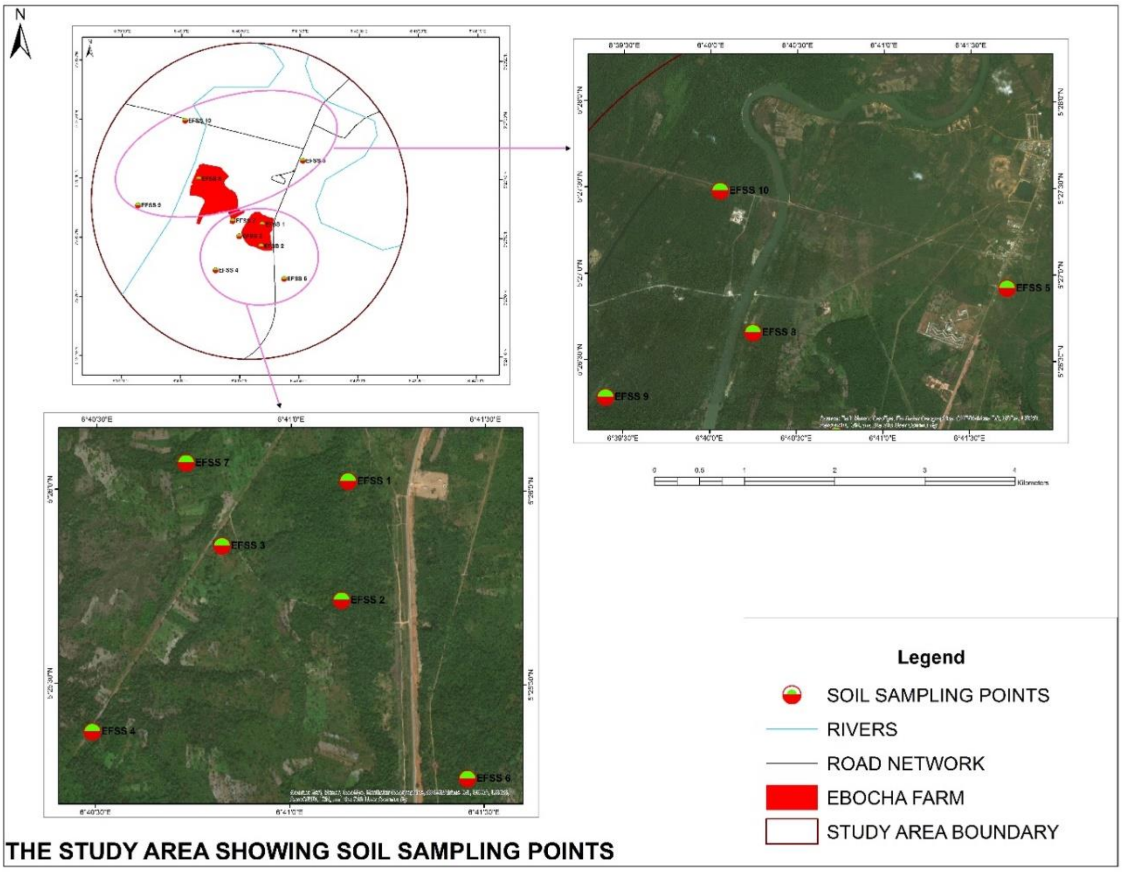


Figure 4.7: Soil Sampling Map

Each sample was collected in ziplock bags, labelled and stored appropriately, and were transported to an approved Federal Ministry of Environment Laboratory. Table 4.17 is a summarized physico chemical results for soil sample (see appendix 3 for detailed result).

Table 4.17: Summarized of physico chemical parameters of soil samples

Parameter	Range	Mean	SD	FMEnv/WHO Limits
Permeability (%)	40.1-46.7	43.91	2.62	-
Porosity (%)	62.3-67.3	64.91	1.73	-
Bulk density (mg/kg)	0.1-0.8	0.45	0.23	-
% Sand	75-84	78.4	2.63	-
% Silt	9.0-17	13.7	2.63	-
% Clay	5.0-9.0	7.9	1.29	-
pH	5.45-5.76	5.675	0.09	6-8
Conductivity (dS/m)	42.3-48.3	45.28	2.16	30

Parameter	Range	Mean	SD	FMEnv/WHO Limits
Moisture content (%)	43.4-46.3	44.6	1.07	-
Nitrate (mg/kg)	6.28-6.51	6.379	0.08	50
Phosphate (mg/kg)	2.08-2.18	2.127	0.03	5
Sulphate (mg/kg)	3.35-3.47	3.419	0.04	500
Calcium (mg/kg)	30.3-35.5	32.67	1.74	-
Magnesium (mg/kg)	2.65-2.87	2.761	0.08	-
Potassium (mg/kg)	1.38-1.63	1.511	0.08	-
Sodium (mg/kg)	0.18-0.31	0.239	0.03	-
THC (mg/kg)	<0.001	<0.001	<0.001	30
Vanadium (mg/kg)	<0.001	<0.001	<0.001	-
Nickel (mg/kg)	<0.001	<0.001	<0.001	35
Iron (mg/kg)	57.8-64.7	62.36	2.69	45
Lead (mg/kg)	<0.001	<0.001	<0.001	85
Copper (mg/kg)	0.03-0.24	0.155	0.07	45
Zinc (mg/kg)	2.05-2.17	2.118	0.04	3

Source: Resourcefield Survey, 2020

Permeability

The permeability is a measurement of how easily liquid flows through a material (or soil). The permeability of the soil ranged from 40.1-46.7% with the mean of 43.91%.

Porosity

The porosity of a material is a measurement of how much of its volume is open space (also called pore space). Porosity is usually expressed as a percentage of the material's total volume. The porosity of the soil ranged from 62.3-67.3% with the mean of 64.91%.

Bulk density

Bulk density is the weight of soil for a given volume. It is used to measure compaction. Generally, the greater the density, the less pore space for water movement, root growth and penetration, and seedling germination. The bulk density of the soil in the study area ranged from 0.1-0.8mg/kg with the mean of 0.45mg/kg

Particle size distribution:

As expected, the particle size of sand is larger followed by silt and clay in order.

pH

This is an indication of the acidity, neutrality or alkalinity of a particular soil and indicates the availability of exchangeable cations (e.g., Ca^{2+}, Mg^{2+}, K^+ etc). Factors influencing soil pH include organic matter decomposition, NH_4^+ fertilizers, weathering of minerals, parent material, climate and land management practices. The pH values of a soil have effects on plants by influencing the availability of macro and micro-nutrients, which are building blocks of sugars and proteins needed by plants. Soil pH of 4.8 is regarded as the lower limit for optimum growth of crops while pH of 9.5 is regarded as the upper limit of alkalinity beyond which crops become stressed. The pH values of the soil of the project area ranged from 5.45-5.76 with the mean of 5.675, which is below WHO/FMEnv permissible limit of 6-8. This indicates a predominantly acidic soil which is consistent in all locations in the study area. Generally, the soils of the area vary from the order Oxisols to Ultisols which are strongly acidic, extensively weathered soils of tropical and subtropical climates.

Electrical Conductivity

In this study, the Electrical conductivity of the soil samples analysed ranged from 42.3-48.3 µS/cm with mean concentration value of 45.28 µS/cm. These results are below WHO permissible limit of 30 µS/cm.

Moisture Content

The moisture content of soil also referred to as water content is an indicator of the amount of water present in soil. Soils normally contains a finite amount of water, which can be expressed as the "soil moisture content." The moisture content of the soil ranged from 43.4-46.3% with the mean of 44.6%.

Soil Nutrients

The nitrate, phosphate and sulphate ions (NO_3^-, PO_4^{3-}, and SO_4^{2-}) are the ionic and utilizable forms of nitrogen, phosphorus and sulphur, which are essential plant nutrients present in the soil.

- Nitrate: Nitrate concentrations in the soil samples ranged from 6.28-6.51mg/L with a mean value of 6.379 mg/L. The obtained value is within the WHO/FMEnv permissible limit of 50 mg/L.
- Sulphate: Sulphate ions was found to be within WHO recommended limit of 500 mg/L. The concentrations in the soil samples ranged from 6.28-6.513.35-3.47mg/L with a mean value of 6.379 mg/L.
- Phosphate: Phosphate concentrations in the soil samples ranged from 2.08-2.18mg/L with a mean value of 2.127 mg/L. This value is within the WHO/FMEnv permissible limit of 5 mg/L.

Total Hydrocarbon Content (THC)

Indiscriminate spills, careless disposal and mismanagement of waste and other hydrocarbon by-products of the society constitute the major sources of hydrocarbon contamination in the environment. Due to its carcinogenic, mutagenic and toxic effects, high concentration levels of hydrocarbon pose a health risk to humans, plants and animal lives. The THC concentration in the soil samples analysed were below equipment detection limit of <0.001

Heavy Metals

The heavy metals constitute a large class of organic and inorganic compounds that are both essential and toxic to human and the environment. In agriculture, they are referred to as micronutrients, stressing their low requirement in the soil and their importance for plant growth.

- Iron**:** Iron concentrations in the soil samples ranged 57.8-64.7 mg/kg with mean value of 62.36 mg/kg. This is within WHO/FMEnv permissible limit of 45 mg/kg.
- Copper: Copper concentration in the soil samples were within WHO/FMEnv permissible limit of 45 mg/kg with mean value of 0.155 mg/kg.
- Zinc: Zinc (Zn) plays an important role in various plant developmental processes and can help to produce growth hormone in plants. However, excessive presence of zinc can become counterproductive and may cause zinc toxicity. In our investigations, the zinc concentration ranged from 2.05-2.17 mg/kg with mean value 2.118 mg/kg and this falls within the WHO/FMEnv permissible limit of 3 mg/kg.

Vanadium, nickel and lead concentration in the soil samples analysed were below equipment detection limit of <0.001.

4.9 Microbial Analysis

4.9.1 Soil, Sediments and Water

The microbial loads in sediment, soil and water samples were determined using standard method for the enumeration of microorganisms (APHA, 1992).

4.9.1.1 Enumeration of Bacteria

Total heterotrophic bacteria were enumerated using standard plating techniques (SPT) as described by Hakovirta (2008).

- The samples were diluted using 10-fold serial dilution
- 1ml of appropriate dilutions (10-7 for soil and 10-5 for water) was transferred with sterile pipette into sterile Petri dish.
- Prepared molten nutrient agar (Biotec) at 40 – 45^{0}C was poured over the inoculums. Each Petri dish was gently rocked to ensure uniform distribution or homogeneity of the water sample.
- When the agar had solidified, the plates were inverted and incubated as follows: Duplicate plates were incubated at 3 different temperatures for each sample at 37^{o}C – 44^{o}C for 24 hours and 28 ± 2^{0}C (room temperature) for 48 hours.
- At the end of the incubation period, the total number of colonies were counted and multiplied by the dilution factor and the result expressed as colony forming units/ml (cfu/ml) for water or cfu/g for soil.

4.9.1.2 Enumeration of Fungi

Total fungal counts (TFC) were determined using 0.1ml of the supernatant from 10-3 to do surface plating on Potato Dextrose Agar (PDA) [Oxoid]. The inoculums were spread on PDA surface using a sterile bent glass rod. The samples were plated in duplicate and incubated at 28 +_20C (room temperature) for 3 – 5 days. Fungal colonies were counted at the end of the incubation period and expressed as cfu/ml or cfu/g for water and soil respectively.

4.9.1.3 Characterization and Identification of Microbial Isolates

Pure cultures of bacteria isolated were characterized and identified on the basis of their cultural, morphological and biochemical properties and by reference to Bergey's Manual of Determinative

Bacteriology (Noorjahan, 2014) and Cowan and Steel's Manual for the identification of Medical Bacteria.

The fungal isolates were characterized based on their macroscopic appearance on culture medium, microscopic morphology and types of asexual spores produced and were identified by reference to illustrated Genera of Imperfecti Fungi and Fungi in Agricultural Soil (Domingo et al, 2011).

4.9.2 Results and Discussion

Table 4.18: Physicochemical Characteristics of Surface water Samples

Parameter	Surface water samples						Mean	Range	SD	WHO Limit	FMENV Limit
	SW1	SW2	SW3	SW4	SW5	SW6					
Total coliform Count (cfu/100ml)	18	13	21	17	23	14	17.67	13-23	3.88	0	0
Fecal coliform (cfu/100ml)	12	8	7	10	11	16	10.67	7.0-16	3.2	0	0
Total heterotrophic bacteria (cfu/ml)	2.8×10^5	2.1×10^5	3.1×10^5	3.3×10^5	2.9×10^5	2.4×10^5	2.8×10^5	$2.1\text{-}3.3 \times 10^5$	0.45	100	100
Total heterotrophic fungi (cfu/ml)	3.5×10^5	2.6×10^5	3.4×10^5	3.8×10^5	3.3×10^5	2.7×10^5	3.2×10^5	$2.6\text{-}3.8 \times 10^5$	0.47	-	-
Hydrocarbon utilizing bacteria (cfu/ml)	1.1×10^5	1.0×10^5	1.3×10^5	1.1×10^5	1.2×10^5	1.5×10^5	1.2×10^5	$1.0\text{-}1.5 \times 10^5$	0.18	-	-
Hydrocarbon utilizing fungi (cfu/ml)	1.4×10^5	1.6×10^5	1.5×10^5	1.8×10^5	1.7×10^5	1.7×10^5	1.6×10^5	$1.4\text{-}1.8 \times 10^5$	0.15	-	-

Source: field Work Laboratory Analysis 2020

Table 4.19: Microbiological Characteristics of Sediment Samples

Parameter							Microorganisms identified	
	Sed_1	**Sed_2**	**Sed_3**	**Sed_4**	**Sed_5**	**Sed_6**	**Bacteria**	**Fungi**
Total Heterotrophic Bacteria (cfu/g)	3.5×10^5	4.0×10^5	3.8×10^5	4.4×10^5	3.7×10^5	3.5×10^5	*Staphylococcus aureus*, **Micrococcus* sp, *Pseudomonas aeruginosa*, *Proteus* sp, *Enterobacter aerogenes,*	*Agaricus campestris*, *Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Fusarium* sp,
Total Heterotrophic Fungi (cfu/g)	3.7×10^5	4.3×10^5	4.2×10^5	4.7×10^5	4.1×10^5	3.8×10^5		

Parameter							Microorganisms identified	
	Sed_1	Sed_2	Sed_3	Sed_4	Sed_5	Sed_6	Bacteria	Fungi
Hydrocarbon Utilizing Bacteria (cfu/g)	1.8×10^5	1.5×10^5	2.1×10^5	2.4×10^5	1.9×10^5	1.5×10^5	*Clostridium* sp. *Klebsiella* sp, **Pseudomonas* sp, *Bacillus brevis*, *Chrococcus* sp., *Aphanocapsa* sp. *Enterobacter faecium*. *Achromobacter* sp, *Bacteroids* sp, *Acinetobacter* sp, **Bacillus subtilis*, *Streptococcus faecalis*	*Aspergillus niger*, *Rhizopus stolonifer*, **Candida tropicalis*. **Penicillium* sp, **Candida albicans*. *Alternaria* sp, *Geotricum* sp, **Penicillium* sp, **Candida* sp.
Hydrocarbon Utilizing Fungi (cfu/g)	2.0×10^5	1.8×10^5	2.4×10^5	2.6×10^5	2.2×10^5	1.8×10^5		

Source: Laboratory Analysis (2020) *US = Upstream *MS = Midstream *DS = Downstream

Table 4.20: Microbial characteristics of soil samples

Parameter	SS_1	SS_2	SS_3	SS_4	SS_5	SS_6	SS_7	SS_8	SS9	SS_{10}
THB (cfu/g)	3.5×10^5	4.3×10^5	3.2×10^5	3.7×10^5	4.0×10^5	3.8×10^5	3.5×10^5	4.2×10^5	4.5×10^5	3.9×10^5
THF (cfu/g)	3.7×10^5	3.4×10^5	3.9×10^5	3.5×10^5	4.1×10^5	4.3×10^5	3.5×10^5	3.8×10^5	4.8×10^5	4.2×10^5
HUB (cfu/g)	1.5×10^5	2.1×10^5	1.6×10^5	1.4×10^5	1.1×10^5	1.3×10^5	1.6×10^5	1.6×10^5	1.8×10^5	1.6×10^5
HUF (cfu/g)	1.2×10^5	1.7×10^5	2.4×10^5	2.0×10^5	1.5×10^5	1.7×10^5	1.4×10^5	1.8×10^5	2.2×10^5	1.8×10^5

Table 4.21: Microbial Characteristics of Soil Samples

Sample Code	Microorganisms identified	
	Bacteria	Fungi
SS_1	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*, Nitrosomonas sp., *Nitrobacter* sp.	*Aspergillus fumigatus*, *Rhizopus stolonifer, Fusarium* sp, *Aspergillus niger*, *Candida albicans*.

Sample Code	Microorganisms identified	
	Bacteria	**Fungi**
SS_2	*Bacillus brevis, Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Enterobacter faecium*.	*Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida* albicans, Chrysogenum sp, *Alternaria* sp.
SS_3	*Chondrococcus* sp., *Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Escherichia coli*, *Enterobacter faecium*, , *Lyngbya* sp., *Oscillatoria* sp., *Phormidium* sp., *Microcoleus* sp., *Cylindrospermum* sp., *Anabaena* sp., *Nostoc* sp., *Scytonema* sp. *Fischerella* sp.	*Saccharomyces* sp, *Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans*, **Candida tropicalis, Rhizopus stolonifer*
SS_4	*Staphylococcus aureus*, *Micrococcus* sp, *Actinomyces* sp, *Pseudomonas aeruginosa*,	*Penicillium* sp, *Aspergillus fumigatus*, *Agaricus campestris* , *Pichia* sp, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_5	*Achromobacter* sp, *Chrococcus* sp., *Aphanocapsa sp.*, *Bacteroids* sp, *Acinetobacter* sp, **Bacillus* sp. *Thiobacillus* sp.	*Geotricum* sp, **Penicillium* sp, *Aspergillus niger*, **Candida* sp,
SS_6	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*, Myxococcus sp., *Chondrococcus* sp., *Archangium* sp., *Polyangium* sp, *Cytophaga* sp. *and Sporocytophaga* sp.	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_7	*Proteus* sp, *Micrococcus* sp, *Pseudomonas aeruginosa*, *Enterobacter aerogenes, Clostridium* sp. *Archangium* sp.	*Fusarium* sp, *Neurospora* sp., *Saccharomyces cerevisiae* , *Aspergillus niger*, **Candida tropicalis*.
SS_8	*Klebsiella* sp, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus brevis*, *Enterobacter faecium*, *Ferrobacillus* sp.,	**Penicillium* sp, **Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans.*
SS_9	**Bacillus* sp, *Achromobacter* sp, Thermoactinomyces sp., *Streptomyces* sp. *Bacteroids* sp, *Acinetobacter* sp, **Bacillus* subtilis, *Streptococcus faecalis*,	*Alternaria* sp, *Rhizopus stolonifer,* *Geotricum* sp, **Penicillium* sp, *Aspergillus niger*, **Candida* sp,
SS_{10}	*Staphylococcus aureus*, *Enterococcus* sp, *Pseudomonas aeruginosa*, *Acetobacter* sp. *Polyangium* sp, *Cytophaga* sp.	*Fusarium* sp, *Agaricus campestris* , *Aspergillus niger*, **Candida tropicalis*, *Chrysogenum* sp.

*Hydrocarbon degrader

4.9.3 Soil Microbiology

Generally, soil biology is the scientific study of life in and on the soil. This entails the study of various kinds of micro-organisms; those studied are bacteria and fungi, which are most important organic matter decomposers in the sediment and soil. They form symbiotic and mutual relationships in which two different organisms live together and benefit from each other.

The summary of microbial organisms of the soil samples is presented in Table 4.21. In soil samples, total heterotrophic bacteria (cfu/g) ranged between 3.2 × 105 and 4.3 × 105; total heterotrophic fungi (cfu/g) ranged between 3.4 × 105 and 4.8 × 105; hydrocarbon utilizing bacteria (cfu/g) ranged between 1.1 × 105 and 2.1 × 105, and hydrocarbon utilizing fungi (cfu/g) ranged between 1.2 × 105 and 2.4 × 105. 48 genera of microorganisms were isolated in soil samples, out of which 31 were bacteria and 17 fungi.

4.9.4 Water Microbiology

The coliform groups of organisms (total and faecal coliform) are the primary bacterial indicator used in determining the potability or otherwise of particular water quality should not contain any of all the coliform group of organisms. Ideally, drinking water should not contain any micro organisms known to be pathogenic and should also be free from bacteria indicative of pollution with excreta (faecal pollution).

Pathogens and indicator organisms include Faecal streptococci (Enterococci) and E. coli. Total viable plate count can be used to determine the total microbial load and other suspended particles in the sampled water. It gives an aggregate of the total number of micro-organisms contained in a water sample. However, the total coliform counts ranged from 1.3 × 102- 2.3 × 102 cfu/100ml with the mean of 1.8 × 102±3.88; the fecal coliform counts ranged from 0.7 × 102- 1.6 × 102 cfu/100ml with the mean of 1.1 × 102±3.2.

Also, total heterotrophic bacteria (cfu/ml) ranged between 2.1 × 105 and 3.3 × 105 with the mean of 2.8 × 105±0.45; total heterotrophic fungi (cfu/ml) ranged between 2.6 × 105 and 3.8 × 105 with the mean of 3.2 × 105±0.47; hydrocarbon utilizing bacteria (cfu/ml) ranged between 1.0 × 105 and 1.5 × 105 with the mean of 1.2 × 105±0.18, and hydrocarbon utilizing fungi (cfu/ml) ranged between 1.4 × 105 and 1.8 × 105 with the mean of 1.6 × 105±0.15.

4.9.5 Sediment Microbiology

Sediments share some properties with soils and yet are distinct from soil environments for a variety of reasons, many of which are of great importance to the populations of microbes that reside there. Sediments are, in general, overlain by a permanent water body, be it an ocean, ford, lake, river, or reservoir. Thus, although the chemistry of the water may vary substantially, as may the level of primary productivity (autochthonous input) and contribution from runoff or rivers (allochthonous input), sediments share the property of being continuously wet. Microbes in sediment ecosystems are known to play important roles in the transformation of organic matter and in biogeochemical cycling of primary elements such as nitrogen, sulfur, phosphorus, and iron (Zhang et al., 2014).

The summary of microbial organisms of the sediment samples is presented in Table 4.19. In sediment samples, total heterotrophic bacteria (cfu/g) ranged between 3.5 × 105 and 4.4 × 105; total heterotrophic fungi (cfu/g) ranged between 3.7 × 105 and 4.7 × 105; hydrocarbon utilizing bacteria (cfu/g) ranged between 1.5 × 105 and 2.4 × 105, and hydrocarbon utilizing fungi (cfu/g) ranged between 1.8 × 105 and 2.6 × 105. A total of 17 bacterial genera were isolated and 14 fungal genera. This sums up to 31 genera isolated from the sediment samples.

4.9.6 Conclusion

Tables 4.20 indicated the bacteria and fungi genera isolated from the soil. The soil organisms were abundant in number and types. In the soil environment, bacteria and fungi are useful for the purpose of biodegradation and soil fertility. Fungi are active in decomposing major constituents of plant tissues, namely cellulose, lignin and pectin and their mycelia are useful for the crumble structure of good agricultural soil (Gaikwad and Sonawane, 2012).

Some bacteria genera known to be useful in non-symbiotic nitrogen fixation such as Escherichia coli, Enterobacter aerogenes as well as Bacillus and Clostridium spp. were among those identified. Many of the actinomycetes and fungi genera isolated such as Streptomycetes and Penicillium are known to have the ability to synthesize and excrete antibiotics (Bredholt et al., 2008). Most of the bacteria identified are commensal, but there are a few genera which are of public health significance such as Staphylococcus aureus, Streptococcus faecalis, Aspergillus niger, Corynebacterium sp. and Candida sp. in the soil and water.

The information on microbial number and types here documented will be useful for monitoring and assessment throughout the construction and operation phases of the project. It will also be useful to the proponents for the purpose of environmental management and protection and also in policy formulation and development concerns; taking into consideration the needs and priorities of all stakeholder

4.10 Terrestrial Biodiversity -Ecology

Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity, which defines biodiversity as “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems." Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types:

- Provisioning services, which are the products people obtain from ecosystems (e. as shown in plate 4.3)
- Regulating services, which are the benefits people obtain from the regulation of ecosystem processes
- Cultural services, which are the nonmaterial benefits people obtain from ecosystems; and
- Supporting services, which are the natural processes that maintain the other services.


Plate 4.3: Benefits of the ecosystem services been witnessed by Resourcefield personnel

Ecosystem services valued by humans are often underpinned by biodiversity. Impacts on biodiversity can therefore often adversely affect the delivery of ecosystem services. This Performance Standard addresses how clients can sustainably manage and mitigate impacts on biodiversity and ecosystem services throughout the project's lifecycle. The objectives of this biodiversity study is to

- To protect and conserve biodiversity.
- To maintain the benefits from ecosystem services.
- To promote the sustainable management of living natural resources through the adoption of practices that integrates conservation needs and development priorities.

4.10.1 Flora wildlife

4.10.1.1 Vegetation Sampling

Vegetation studies were carried out to determine the baseline status of the study area vis-à-vis the species composition, diversity, and population of the plant species as well as their medicinal and economical uses. The density and percentage of the key tree species and the herbaceous layers were determined while rare and endangered plant species and all those of special significance to the ecosystem and the local economy were categorized. The species diversity of the plants was calculated as the ratio between the number of species and importance value which for the purpose of this study was taken as numbers of individual per quadrat. Both the generic and specific characteristics of the vegetation were assessed by determining their floristic composition, life form and biological spectra.

Three station point of the study area was established (300m x 600m). Each sampling station was further divided into sampling points. A sampling point was established as a five line transect of 200m apart over a 300m length. An average of 2 hectares was adopted as sampling size per sampling point. This resulted in a total sampled area of 6 hectares.

4.10.1.2 Methodology (Wildlife)

The wildlife study cuts across the entire ecosystem. Methodologies of sample collection and identification include;

- Visual observations and documentation of droppings.
- Oral discussion with natives of the study area.
- Tree beating, shaking, purpose mark, feathers, shells, sounds, foot prints, information on the available species and relative abundance was obtained through oral interviews and discussions with artisanal hunters and indigenes.

4.10.1.3 Flora Habitats

The existing vegetation is composed of the rainforest and a derived savannah with abundance of grasses, herbs and shrubs with scattered trees. The vegetative distribution and types in the study area include; the rainforest, Freshwater forest and the anthropogenic vegetation effect due to construction activities. However, there is a mix of habitats in the study area.

- Rainforest
- Freshwater forest
- Anthropogenic vegetation due to construction activities
- Cultivated areas
- Plantations

- **Vegetation of the Rain Forest**

The Rain Forest area occupies significant area of the study area. Vegetation in most of the study area would be classified as the oil palm variant. This is indicative of (dry-land) lowland rain forest that is

Plate 4.4a: Typical Rainforest in the study area

undergoing active regeneration. Such areas have been long under cultivation with the oil palm (*Elaeis guineensis*) being the dominant emergent canopy species. The soil here is sometimes swampy especially at the peak of the rainy seasons and an evidence of being water logged is seen as the herbaceous species are pneumatophores in nature. This vegetation type contains significant leaf litter on the forest floor.

- **Freshwater Forest**

  The freshwater forest area has a high diversity of plant species. This vegetation type can be described as secondary rain forest, Tree and shrub species diversity. As the soil in these areas is often water-logged, poorly aerated and nutritionally poor, plant species that grow here are characterized by their development of pneumatophores (specialized aerial roots that serve respiratory functions in poorly aerated soils).

Plate 4.5: Freshwater (Orashi River) Vegetation type in the study area

- **Vegetation around the cultivated areas**

  These are areas used for agriculture but are devoid of "natural trees" which have been felled either for fuel or other purposes, as well as shrubs, due to continuous clearing of the land, filling and cultivation of agricultural crops. Species diversity in this area is quite low. Plants occurring here are mainly foods crop such *Manihot esculenta, Musa sapientum.*

Plate 4.6: Cultivation of Cassava and Plantain in the study area

- **Vegetation around the Plantations**

The vegetation in the plantation is largely dominated with stands of *Elaeis guineensis* which is predominantly the major tree in the study area. The stands provide a definite canopy for the area.

Plate 4.7: Oil palm Plantation in the study area

- **Anthropogenic Vegetation**

This is referring to the whole body of plant affected as a result of the on-going construction proposed farm camp in the study area as shown in Plate 4.8.

Plate 4.8: Disturbed vegetation in the Parcel II

4.10.1.4 Biomass Analysis in Ebocha Farmland

Description

Thick Vegetation: This area represents dense vegetation (forest or fallowed bush) dominated by trees.

Mixed Vegetation: This area represents places with low vegetation cover, mostly occupied by shrubs, grasses, and sometimes cultivated farmland.

Built Up: This represent area occupied by buildings, road, foot-path as well as bare surfaces.

Table 4.22: Showing Biomass of Farm 1

Vegetation Class	Counts	Coverage (hectares)	% Coverage
Thick vegetation	268	24.12	37.22
Mixed vegetation	299	26.91	41.53
Built up	153	13.77	21.25
TOTAL	720	64.80	100

Source: Resourcefield 2020

Table 4.23: Showing Biomass of Farm 11

Vegetation Class	Counts	Coverage (hectares)	% coverage
Thick vegetation	292	26.28	20.83
Mixed vegetation	365	32.85	26.03
Built up	745	67.05	53.14
Total	1402	126.18	100

Source: Resourcefield 2020

Table 4.24: Showing Total Biomass of the Farm

Vegetation Class	Counts	Coverage (hectares)	% coverage
Thick vegetation	560	50.4	26.39
Mixed vegetation	664	59.76	31.29
Built up	898	80.82	42.32
TOTAL	2122	190.98	100

Source: Resourcefield 2020

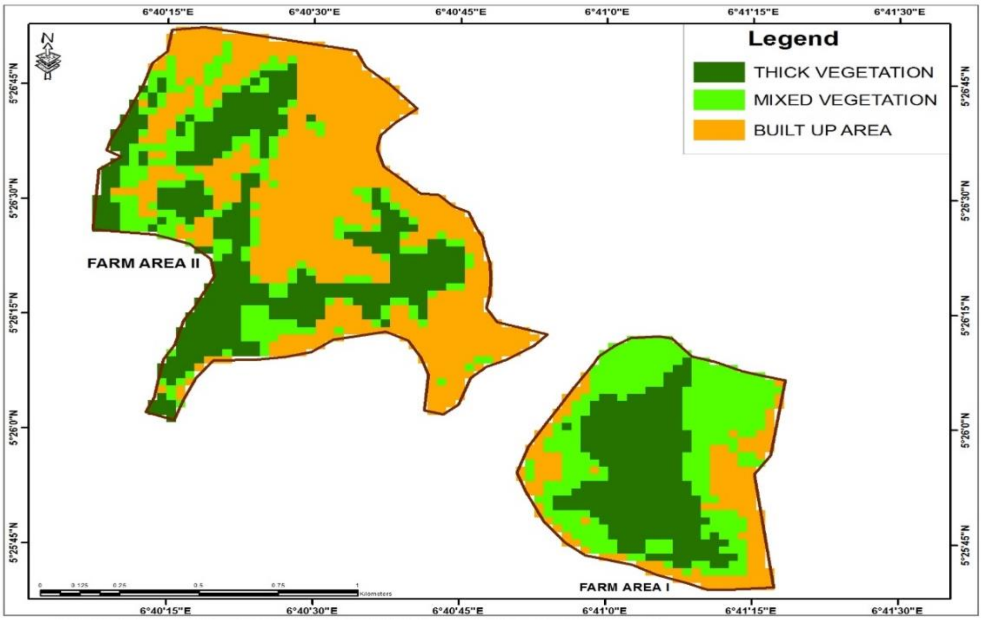


Figure 4.8: Showing Biomass cover of Ebocha farm yards

4.10.2 Flora

A total of twenty-eight (28) species were censored yielding 470 individuals (Abundance). About 56.5% were trees, 6% shrubs, 20.6% were herbs and about 16.9% were grasses.

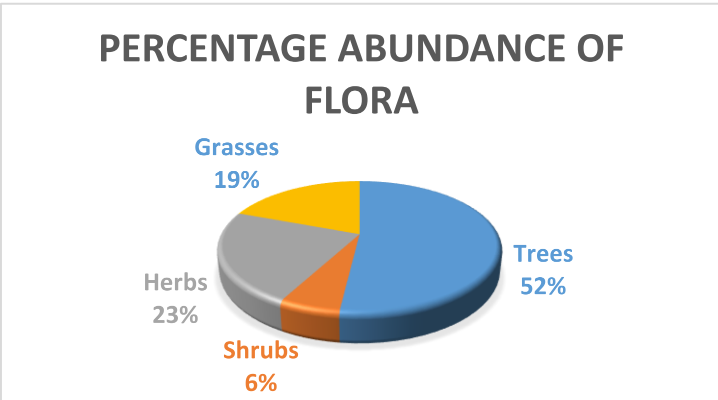


Figure 4.9: Showing percentage abundance of flora

Some of the tree species censored in these habitats include; *Elaeis guineensis, Parkia clappertononia, Hevea brasillesisi and Afzelia africana*. The Shannon index for the study area was 1.46. The vegetation structure for the study area was determined using Diameter at Breast Height (DBH). Vegetation structure for the study area revealed that a quarter of the species had DBH between 35cm and above.

This is suggestive of a relatively stable ecosystem. Of the twenty-four (24) species listed in the IUCN database as alien and invasive to Nigeria, only *Panicum lax and Mimosa pudica*were the invasive species captured in this study while *Etandrophragma angolense* was the only alien species (as shown in Table 4.25). With respect to the ecosystem services provided by the plant species, nine (9) of the species were reviewed to provide food/energy and medicinal services, while ten (10) species were used as raw materials.

The indigenous uses of each plant inventoried were assessed. The result showed that 21 species (representing 40.3%) had one indigenous uses or the other. Some of the indigenous uses include fuel wood, medicinal purposes, as fruits and seeds, as sundry products, as beverages and drinks, as fodder, as wattles, as nuts, as spice, as flavours and thickeners as chewing stick, as gum and adhesives, and some for prevention of soil erosion. Some species with numerous indigenous uses include *Elaeis guineensis, Raffia hookeri, and Azadirachta indica, Acacia senegalensis and Khaya ivorensis*.

The IUCN version of 2016 criteria was used to evaluate the conservation status of the species. The result indicated that some of the species were threatened or vulnerable.

Table 4.25: List of alien plant species in Nigeria

Alien Species	Invasive Species
Acalypha indica	*Bidens Pilosa*
Adeniacissampeloides	*Chromolaena odorata*
Ageratum conyzoides	*Cyperan rotundas*
Alternetherabrasicus	*Dalbergia sissoo*
Alternetherasessils	*Elchhhornia crasipies*
Antigoniumleptolus	*Imperata cylindrical*
Chromolaena odorata	*Leucaena leucocephala*
Cissus argute	*Mimosa diplotrichia*
Commenlina benghalensis	*Momomorium destractor*
Dissotis rotundifolia	*Momomorium floricola*
Euphorbia grammea	*Nypa fruticans*
Euphorbia heterophylla	*Psidum guajava*
Lantana camara	*Prosopis sp*
Leucaena leucocephala	*Adenanthera pavonine*
Merremia kentrocaulos	*Althermanthera sessilus*
Mucuna pruriens	*Mimosa pudica*
Passoflora foetida	*Oxycaryam cabense*
Plastosoma africanum	*Bacopa momieri*
Ruthalaciae glandulosa	*Cardiospermun grandiflorum*
Schriankia leptocarpa	*Cenchrus ciliaris*
Setaria barbata	*Commelina bengualensis*
Tithonia diversifolia	*Discorea bulbifera*
Truimfetta rhombusa	*Lygodium microphyllum*
Typha australis	*Panicum repens*
	Paspalum scrobiculatum

Alien Species	Invasive Species
	Rhizophora mangle
	Rottbiellia cocchinchnesis
	Ricinus cumunis
	Ziziphus Mauritania

Source: Borokini (2011)

4.10.2.1 Data Analysis

- **Species Richness/Compositio**n

The number of species present in each plot was evaluated using several multivariate data analysis packages that treated multivariate data summarizing the data and revealing the structure. It further gave detailed information about each plot and made it possible for plots to be weighed against each other. Plots were compared for the number of species in relation to the number of individuals.

- **Species Abundance**

Abundance of species was evaluated by counting the number of individuals of a species in the area census.

Relative abundance (Pi) of species was evaluated using the following formula:

$$Pi = \frac{Ni \times 100}{\text{Sum of all individuals recorded.}}$$

Where Ni is the sum or proportion of each individual species in the sample

- **Species Diversity**

In order not to miss an important aspect of the numerical structure of the community, diversity index was calculated for the different plot. Despite the several diversity indices available, Shannon's index was preferred as it is independent of area hence result can be compared with other sites. It was calculated by determining for each species the proportion of individuals that it contributed to the total in the sample. The following formula was used:

$H = -\Sigma Pi \ln Pi$,

Where H = Shannon's index, ln = log.

Equitability or evenness, which is the maximum possible value diversity, assumed that since individuals were completely evenly distributed (Begon, et al 1986) was also calculated using the following formula;

$= EQ = -\Sigma Pi \ln Pi / \ln S$

Where EQ = equitability, S = total number of species.

- **Family Abundance**

Family abundance was evaluated by counting the number of individuals of species belonging to a family. Relative abundance of family was evaluated by:

$$\frac{\text{The number of individuals in a family}}{\text{Sum of all individuals recorded.}} \times 100$$

- **Species Frequency**

Frequency is a simple measure calculated as the percentage of the plots set up, in which the species is present (Sutherland et al 1996).

$$\frac{\text{Number of plots in which species is recorded}}{\text{Total number of plots census}} \times 100$$

Relative frequency of species was evaluated by dividing the frequency of individual species by the sum of all frequencies.

$$\frac{\text{Frequency of a species} \times 100}{\text{Sum of all frequencies}}$$

Frequency analysis of families followed the same procedure.

- **Species Dominance**

For each plant species recorded, diameter at breast height (DBH) was also recorded. DBH was also used to calculate the basal area of each species and also for the total study area. Species dominance was then evaluated by summing for each species, the basal area. Relative dominance of each species was evaluated by dividing the sum of basal area of a species by the total basal area of all species, expressed in percentage.

$$\frac{\text{Combined basal area of a single species}}{\text{Total basal area of all species.}} \times 100$$

- **Family Dominance**

For each plant family that was recorded, dominance was evaluated by summing the basal area of all species belonging to the family. Relative dominance of each family was evaluated by dividing the sum of basal area of all species in a family by the total basal area of all species, expressed in percentage

$$\frac{\text{Combined basal area of species in a family}}{\text{Total basal area of all species.}} \times 100$$

- **Forest Structure**

Forest structure was evaluated in terms of stem densities, tree diameter and size class distribution and basal area.

Density

Tree density was evaluated by dividing the total number of trees recorded by the total area sampled. Relative densities were also evaluated where the following formula was used:

Number of individuals of a species X 100
Total area sampled

- **Size class Distribution**

Tree diameter recorded was arranged in diameter classes. The range of tree diameter found in the area was represented in a graphic way by displaying tree diameter in an orderly manner of 10m interval difference. Tree diameter recorded was arranged in diameter classes. The range of tree diameter found in the area was represented in a graphic way by displaying tree diameter in an orderly manner of 10 interval difference.

Basal Area

The basal area was calculated using Edward method, where tree diameter was divided by 2 to get the radius, secondly the radius was squared and thirdly, the number was multiplied by π, where π = 3.14.

Table 4.26: Showing Plant Diversity Index and Occurrence

Species	n_1	p_1	n p_1	$-(P_1.\ln p_1)$	Distribution %
Elaeis guineensis	338	0.3581	121.04	- 0.3677	35.81
Tectona grandis	190	0.2013	38.25	- 0.3227	20.12
Azadiractha indica	50	0.0529	2.65	- 0.1555	5.29
Raffia hookeri	134	0.1419	19.01	- 0.2771	14.19
Anachadium occidantele	148	0.1568	23.21	- 0.2905	15.68
Afzellia Africana	11	0.0117	0.13	-0.0520	1.17
Parkia clappertonania	29	0.0307	0.89	-0.1069	3.07
Hevea brasilensis	24	0.0254	0.61	- 0.0933	2.54
Cocus nucifera	20	0.0212	0.42	-0.0817	2.13
Total	944	1		1.46	100

Source: Resourcefield, 2020

4.10.3 Ecology of the study area

Nigeria has a rich variety of natural forest ranging from open vegetation and savanna forests of northern dry climate, to the tropical moist forest (TMF) of the south with riparian forest along the major rivers (Niger and Benue). Approximately eleven percent of the total land area of the country is covered by forest, comprising eighty percent savanna and twenty percent high forest.

Vegetation in most of the study area would be classified as the oil palm variant. This is indicative of (dry-land) lowland rain forest that is undergoing active regeneration. Such areas have been long under cultivation with the oil palm (*Elaeis guineensis*) being the dominant emergent canopy species.

The ground vegetation in the area was dominated by a variety of shrubs, herbs and weeds including *Nephrolepis biserata, Selaginella myosurus, Lycopodium cernuum, Chromolaena odorata, Ipomoea involucrate, Panicum maximum, Scleria vogelii, Dissotis rotundifolia, Dissotis erecta, Sporobolus* *pyramidalis, Aspilia africana, Sida acuta, Paspalum orbiculare, Stachytarpheta indica* and *Datura stramoniu.*

The general structure of the study area is derived savannah but dominated by the rainforest. However, the forest is not continuous. In most areas they are seen as a remnant of its own self or rainforest of several years. The stages of growth and maturity of the rain forest differs at different locations. To some extent human activities have transformed the structure as well as the species richness of this vegetation type. This is seen in the number of Oil palm bushes, and farmlands.

The boundaries between the rainforest and the derived savannah are often abrupt. Within the derived savannah, there are localized areas of rain forest vegetation, although they are frequently and very much reduced in diversity and canopy height and probably provide an intermediate between the derived savannah and the true forest. They take the forms of small patches of forest associated with shaded localities or narrow continuous belts of forest along the spring.

The result obtained from the flora field studies was discussed under habitat type, species richness, species diversity, species abundance, vegetation structure/canopy cover, alien/invasive species evaluation, indigenous uses and conservation status.

Species Abundance of the study area Species abundance is a record depicting the number of individuals of a species. It is an important concept in ecological study since it can be used to assess degree of impacts. The species abundance for the entire study area was calculated to be individuals. Table 4.27 Shows plant species with the most and least abundant individuals in the entire study area.

The major farm crop found in the project area was *Manihot esculenta* (cassava). Trees which offer non-timber forest products (barks, fruits, roots etc) that play roles in traditional medicine and nutrition included *Elaeis guineensis* (oil palm), *Raphia vinifera* (wine palm), *Musanga cercropioides, Costus afer, Alchornia cordifolia* and *Harungana madagascariensis*.

Plate 4.9: Showing Secondary rainforest and canopy height

Table 4.27: Checklist of plant abundance the study area.

Most abundant species	Abundance	Least abundant	Abundance
Elaeis guineensis	338	*Afzellia Africana*	11
Tectona grandis	190	*Parkia clappertonania*	29
Azadiractha indica	50	*Hevea brasilensis*	24
Raffia hookeri	134	*Cocus nucifera*	20
Anachadium occidantele	148		
Total	**860**		**84**

Source: Resourcefield, 2020

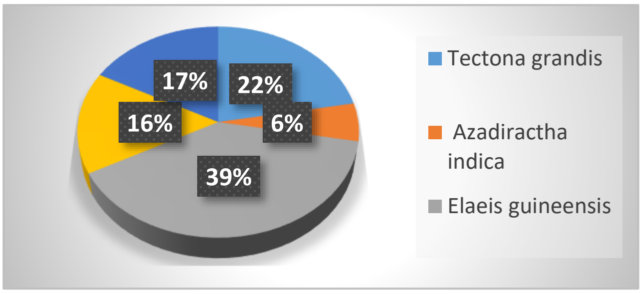


Figure 4.10: Tree species abundance in study area.

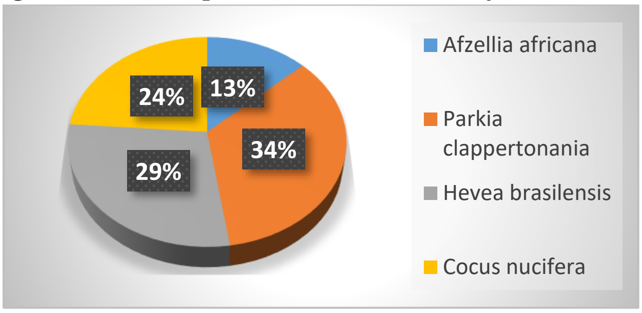


Figure 4.11: Showing less abundant tree species

4.10.3.1 Structure

Generally, the ecosystem in the study area is dominated by evergreen plants, tall shrubs which belong to several unrelated families that share common habitat preferences, physiognomy (that is the structural arrangement of the surface area of land and the vegetation cover), functional and structural adaptations. Vegetation is endowed with highest stratum, the upper canopy composed of emergent trees such as *Treculia africana, Berlinia auriculata*, *Chrysophylium albidum and Cynometra megtalophylla.* The prominent tree species are *Elaeis guineensis,* Landolphia *oweriensis, Glyphaea brevis, Cynometra megalophylla, Ceiba pentandra and Irvingia gabonensis*. The under-storey layer was dominated by *Napoloon vogelli, strychnos spinosa, Lindacleeria dentata* and *Diospyros* species, and the climbers include *Paulina pinnata* and *combretum smeathmannii*.

Vegetation Structure/Canopy Cover:
This is the Spatial orientation of species in space is the study area. It is one of the components of ecosystem restoration processes. An ecosystem with an excellent vegetation structure is a measure of a healthy ecosystem integrity and high productivity. Vegetation structure also called community structure was measured in this study using Diameter at Breast Height (DBH). Table 4.27 shows a diameter size class for the species.

Table 4.27: Showing Diametre at Breast Height

Diameter size class (cm)	No. of species	%	Notable taxa
0-9	9	17	*Afzellia africana*
10-19	19	25	*Elaeis guineensis, Rafia hookeri*
20-29	12	16	*Azadiractha indica*
30-39	8	13	*Tectona grandis*
40-49	12	16	*Azadiracthaindica, Magnifera indica*
50-59	7	12	*Hevea brasilensis, Azfellia Africana*

Source: Resourcefield, 2020

Table 4.28: Most Common Flora Families within the Project Area

S/N	Family Name	Common name	Specie name	Habit
1.	**Poaceae**	Abundant grass	*Acroceras amplectens*	Herb
		Arrocillo	*Acroceras amplectens*	
		Bamboo	*Bamboosa vulgaris*	
		Gamba grass	*Andropogon gayanus*	
		Giant bluestem		
		Carpet grass	*Axonopus compressus*	
2.	**Cyperaceae**	Small flower umbrella sedge	*Cyperus difformis*	
		Yellow nut sedge	*Cyperus esculentus*	
		Dwarf papyrus sedge	*Cyperus haspan*	
		Nutgrass purple sedge	*Cyperus rotundus*	
3.	**Euphorbiaceae**	Christmas bush	*Alchornea cordifolia*	Shrub
		Christmas bush	*Alchornea laxiflora*	
		Cassava	*Manihot esculenta*	
		Sand box tree	*Hura crepitans*	
		Spurge weed	*Euphorbia heterophyl*	
		Lobed croton	*Croton lobatus*	
		Tiger bush	*Croton zambesicus*	

Source: Resourcefield, 2020

Table 4.29 Flora species occurrence in the study area

Serial No.	Species	Life Form	IUCN STATUS
1.	*Acanthus montanus*	Herb	Threatened (Th.)
2.	*Adenia lobate*	Herb	Th
3.	*Aframomum daniellia*	Herb	Th.
4.	*Aframosia alata*	Herb	Th.
5.	*Alchomea cordifolia*	Shrub	Th.
6.	*A. laxiflora*	Shrub	Th.
7.	*Allophyllus africanus*	Herb	Th.
8.	*Anthocleisia nobilis*	Tree	R.
9.	*Anthonothat macrophylla*	Tree	Th.
10.	*Baphia nitida*	Tree	Dominant
11.	*Bermia grandiflora*	Tree	Th.
12.	*Bridelia micrantha*	Tree	R
13.	*Calamus derratus*	Shrub	D.
14.	*Carpolobia lutea*	Shrub	Th.
15.	*Chromolacna odorata*	Herb	Th.
16.	*Cissus polyantha*	Shrub	Th.
17.	*Cleistopholis pattens*	Tree	Th.
18.	*Combreum zenkeri*	Shrub	Th.
19.	*Commelina benghalensis*	Herb	Th.
20.	*Cosnis afer*	Herb	R.
21.	*Digitaria debilis*	Herb	Th.
22.	*Dimorphochlamys mannii*	Herb	Th.
23.	*Dossotis rotundifolia*	Herb	Th.
24.	*Elaeis guineensis*	Tree	D
25.	E vogeli	Tree	Th.
26.	*Harungana madagascariensis*	Shrub	Th.
27.	*Leptoderris branchyptera*	Herb	Th.
28.	*Macaranga barteri*	Herb	Th.
29.	*Manihot esculenta*	Shrub	Th.
30.	*Marantochloa cuspidate*	Climber	Th.
31.	*Napoleona vogelii*	Tree	D
32.	*Nauclea latifolia*	Tree	R.
33.	*Olax subscorptoides*	Climber	Th.
34.	*Oxyanthus tuboflorus*	Shrub	Th.
35.	*Paulina piñata*	Shrub	D
36.	*Phyilanthus discoideus*	Herb	Th.

Serial No.	Species	Life Form	IUCN STATUS
37.	*Picralima nitida*	Herb	Th.
38.	*Psidium guajava*	Tree	Th.
39.	*Pterocarpus santhozyloides*	Tree	Th.
40.	*Pycnanthus anagolensis*	Shrub	Th.
41.	*Scleria racemose*	Tree	Th.
42.	*Smilax kraussiana*	Climber	Th.

Source: Resourcefield, 2020

Keys

Th – Threatened

R - Rare

D- Domina

Table 4.30: Plant species and provisional services

Provisional services	Species	Common names
Food and energy	*Elaeis guineensis*	Oil palm
	Rafia hookeri	Raffia palm
	Anarchadium occidentele	Cashew
	Vachelliafortiila	Umbrella thorned acacia
	Cocos nucifera	Coconut
	Hageniaabyssinica	African redwood
	Magnifera indica	Mango
	Sacchariumofficinale	Sugarcane
	Lophiraalata	Ironwood
Medicine	*Azadiracthaindica*	Neem (dogoyaro)
	Acrocerus macrum	Nile grass
	Acaciaciasenegalensis	Gum Arabic tree
	Afzelia africana	Afican mahogany
	Lovoatrichiliodes	African walnut
	Phoenix dactilfera	Date palm
Raw material	*Elaeis guineensis*	Oil palm
	Raphia hoookeri	Raffia palm
	Parkia clappertononia	Locust bean
	Lophira alata	Iron wood
	Hageniaabyssinica	African redwood
	Milletiaconraui	Baobab tree
	Gmelina gmelina	Gmelina

Source: Resourcefield 2020

4.10.3.2 Protected areas

Protected Area Nigeria's protected area management system falls into 3 categories. Game Reserves and Forest Reserves are by statute managed by State Governments. The Federal Government of Nigeria oversees the management of the National Parks. Protected areas such as Forest Reserves were mostly creation of the colonial government in Nigeria. Most protected areas were thus established between the 1930's and 1960. For a variety of reasons mostly related to inadequate resources such as funding, skilled manpower and conflicting government policies, most protected areas at both state and federal level exist only on paper. A review of existing literature did indicate that in times past, the areas adjoining the proposed project area is reported to have harbored species of conservation importance.

According to the Nigerian Forestry Act (1958) during the colonial period, the closest forest reserve is the Upper Orashi Forest Reserve, south of the Project site. According to the Forestry Law 2002 (an amendment of the Forestry Law Cap 59 Vol. III) the destruction or modification of forest and protected areas is prohibited. There are no protected areas in close vicinity that will be directly affected with the development of the Project.

Upper Orashi Forest Reserve is a nature reserve in Rivers state, near the village of Ikodi in Ahoada west. The reserve covers an area of 25,165 ha (97.163 sq mi). It was designated a wetland of international importance under the Ramsar Convention on 30 April 2008.

4.10.4 Fauna Composition

A combination of sampling techniques was used which included identifications of major ecosystem types to identify associated fauna, collecting, preserving and representing fauna species such as foot prints analysis, faecal samples, nest type, feeding site, sounds, shell types and interviews with the indigenes.

Fauna Diversity had, a total of thirty-two (32) fauna resources were inventoried in the study. These 32 fauna species were obtained via indirect evidences. Twenty (26) mammalian fauna were recorded through indirect evidence. Ten avi fauna taxon was recorded of which six (6) species were sighted directly and 4 through indirect evidence. A breakdown of abundance for each fauna group revealed that the avifauna group recorded the highest abundance with 37 individuals, followed by the mammalian and amphibian groups with 26 and 10 individuals respectively.

The reptilian group recorded the least abundance with 5 individuals. Analysis for the conservation status of the species censored in the project area was conducted using the IUCN 2016 Red List of Threatened species. Results revealed that 5 of the censored species were classed in any of the three threatened categories. The species under the vulnerable class are *Pan troglodytes, Cephalous philatomba*, and *Silvacapra grimmia* are classed as endangered. Also, a total of 41 fauna species were reviewed as offering ecosystem services.

A breakdown revealed that the mammalian taxon with 10 species was the group with the highest number of species. This was closely followed by reptiles with 7 species, amphibians with 4 species while the avian group recorded the greatest number of species with ecosystem services.

The fauna diversity in the study area is very rich. This is due to the fact that some of the rain forest is still in its virgin state. A total of 47 species of birds, 23 of mammals and 7 species of reptiles were encountered. Some predominant invertebrate species recorded around the study area include termites, snails, worms, millipedes and ants. The termites and ants dominate especially the grasslands of the study area. Of all these, mammals occupy a higher position on the food chain and energy levels. The mammals especially the antelopes and deer are the only endangered species found in the study area.

Hunting of these animals is done in local and crude methods. Most times these animals are trapped or directly clubbed or macheted to death. Hunting is mostly done at night especially during the hunting seasons mostly by ensnarement at water holes. The most prevalent of the mammalian fauna are the grass cutters, rabbits, squirrel and the bush pig. The yellow Antelope is fast going into extinction.

The common birds are the Egret, Hawks, kites, Kestrels, guinea fowls, doves, pigeon, and Partridges. The reptiles will include the python, cobras, mambas and the viper. This gives a basis for the attacks and bites on the locals in the bush and on farm tracks. Smaller reptiles encountered in the course of study are; frogs, toads, lizards and monitor lizards. Also found in the study area are cattle herded by the Fulani herdsmen. These cattle are reared and fed in the grasslands which hold a definite seasonal cattle route. They cattle herds are made up of the Muturu, Zebu and Ndama breeds.

On the lower food chain are the Isopteran termites which dominate the soil fauna forming heaps occasionally. The Lady Beetle and the Spiders are part of the invertebrate fauna. There is a wide range of species habitats as some live on tree tops such as the Eagle (which is seen maybe once in a while), Kites, Hawks and vultures which are mostly scavengers feeding on dead and decomposing carcasses. The lower canopies of the trees are habitats for monkeys, bats, snakes and squirrels. According to the locals, wild felines such as Hyenas and Jackals are seen or heard occasionally and are known to rarely attack the residents.

The soil fauna also recorded black ants *(Monosium minium)* and termites which are the major invertebrate fauna in the study area forming huge colonies found in most quadrats in the study area.

The avian species recorded are of high economic importance as they feed on grains and seeds of crop plants in the fields.

4.10.4.1 Soil Fauna

Five species of termites were found in the grasslands. Their estimated total abundance and biomass were 485m^{2}and 1.0gm^{-2}respectively. The dominant trophic group was the soil feeders (460m^{2}and 0.4gm^{-2}) although the wood feeders (8m^{2}and 0.01gm^2) were underestimated due to exclusions of their arboreal nesting. Only two of the five species of the soil feeders constructed epigeal nests (mounds).

The presence of Tsetse fly in the grasslands indicates the reason for the neglect of the derived savannah area in livestock rearing and development. These biting flies are vectors of the disease *Trypanosomiasis* which is fatal to both man and grazing herds. The Tsetse flies live in trees and shrubs covers. Also abound in the study area are soldier ants which help in disposing of ground litter and debris and also in soil aeration by their burrowing activities.

Plate 4.10: Termite mould in the study area

Table 4.31: Distribution of Avifauna in the study area

Sn	Common Names	Scientific Name
1.	African Black kite	*Milvus migrans*
2.	Stand Night jar	*Macrodipteryx longipemix*
3.	Black-belied Coucal	*Centropus grillii.*
4.	Little African Swift	*Apus affinis*
5.	Yellow fronted canary	*Sevinus mozambicus*
6.	Yellow wagtail	*Motocilla flava*
7.	Collard sunbird	*Nectarinia cuprea*
8.	Pin tailed Whydah	*Vidua macroura*
9.	Bronze Mannikin	*Lunchura cucullata*
10.	Senegal coucal	*Centropus senegalensis*
11.	Tambourine Dove	*Turtur tympanistria*
12.	Laughing Dove	*Prinia subflava*

Sn	Common Names	Scientific Name
13.	West African Thrush	Corvus albus
14.	West African Prinia	*Pycronotus barbatus*
15.	African Pied crow	*Merops albecollis*
16.	Common bulbul	*Erycronotus barbatus*
17.	White throated Bee-eater	Merops albecollis
18.	Broad Bill Roller	*Erystomus glancurus*
19.	Cattle Egret	*Ardea alba*

Source: Resourcefield, 2020

Table 4.32 Inventory of Fauna Identified in the Study Area and their Biodiversity Status

SN	Scientific Name	Common Name	Biodiversity Status	Identification means
1.	*Xenopus tropicalis*	clawed frog	Least concerned	Sound / sighted
2.	*Crecetomys gambiaZnus*	African giant rat	Least concerned	Nests/ interview
3.	*Treton c alvus*	Green pigeon	Least concerned	Sighted/ sound
4.	*Scotophilus dinganii*	African yellow bat	Not evaluated	Sighted
5.	*Lasius niger*	Black ant	Not evaluated	Sighted
6.	*Muluus migrans*	Black kite	Not evaluated	Sighted
7.	*Crocodilus niloticus*	Nile crocodile	Least concerned	Interview
8.	*Strix nebolusa*	Owl	Not evaluated	Interview
9	*Potamochoerus lavartus*	Bush pig	Least concerned	Interview
10	*Necrosytes monachus*	Vulture	Not evaluated	Sighted
11	*Testudo graeca*	Tortoise	Least threatened	Eggs/ shells
12.	*Pan troglodytes*	Chimpanzee	Not threatened	Interview
13.	*Trimeresurus stejnegeris*	Green viper	Not threatened	Skin
14.	*Gorilla gorilla*	Gorilla	Threatened	Interview
15.		Rabbit	Not threatened	Nest
16.	*Xerus erythropus*	Squirrel	Not threatened	Interview
17.	*Agama agama*	Agama lizard	Not evaluated	Sighted

SN	Scientific Name	Common Name	Biodiversity Status	Identification means
18.	*Hippotragus equinus*	Yellow antelope	Threatened	Interview
19.	*Syncerus caffer*	Buffalo	Threatened	Interview
20.	*Psittacula krameri*	Parrot	Threatened	Interview/ feathers
21.	*Achatina maginata*	African garden snail	Least concerned	Sighted
22.	*Francolinus bilcarcaratus*	Bush fowl	Least concerned	Eggs shells
23.	*Python sebae*	Python	Not evaluated	Skin
24.	*Naja naja*	Cobra	Not evaluated	Interview
25.	*Boa constrieto*	Boa constrictor	Not evaluated	Interview
26.	*Hystrix cristata*	Porcupine	Threatened	Nests
27.	*Thryonomis swinderus*	Grass cutter	Not threatened	Sighted
28.	*Speothes venaticus*	Bush dog	Least concerned	Interview
29.	*Civettictis civetta*	African Civet	Not evaluated	Interview
30.	*Odocoilus virgianus*	Deer	Threatened	Foot prints
31.	*Eciton vagans*	Soldier ants	Least concerned	Sighted
32.	*Ardeola ibis*	Cattle egret	Least concerned	Sighted
33.	*Circaetus cinerascens*	Eagle	Threatened	Interview
34.	*Masotermes darwinensis*	Termites	Least concerned	Sighted
	Archispirostrepodus gigas	African millipede	Least concerned	Sighted

Source: Resourcefield, 2020

4.11 Aquatic Ecology /Hydrobiology

4.11.1 Overview

The productivity of any aquatic water body depends on the amount of plankton present in the said water body (Allen *et al* 2009). Four groups of hydrobiology parameters were evaluated. They are phytoplankton, zooplankton benthos and Fishes.

Ecosystem stability is a critical factor for aquatic lives. Since preconstruction and construction activities are likely to impact negatively on the water bodies, expected change in water quality would result in growth and count of opportunistic species. Therefore, a baseline study of the plankton population is imperative. Also, sediment deposition is also predicted to affect benthonic lives.

4.11.2 Sampling Methods

Sample for plankton analyses were collected by means of a 55 µm mesh tow net with diameter of 30 cm. The net was used to filter water scooped in a bucket (the content of the tube attached to the end of the plankton net was emptied into plastic bottles and made up to 100 ml mark) and preserved in buffered 10 % formalin.

Sediment samples were collected from sampling stations where surface water samples were taken. Bottom sediments were sampled using the Eckman Grab. Samples for macrobenthic fauna were sieved through a 0.5 mm mesh and transferred into 500 ml wide-mouthed plastic containers. Benthic organisms were preserved in 500 ml plastic containers using 40 ml of 10 % formalin. The organisms were identified and enumerated in the laboratory using identification tools and keys

4.11.3 Zooplankton

A checklist of the zooplankton in the aquatic systems around the proposed Life Camp is present in the table 1.11 below. A total of 16 species of zooplankton were recorded and. The total zooplankton counts ranged from 137-328 organisms per litre within under study.

The chart showing the contributions of the major families of zooplankton were recorded namely: Rotifera, Cladocera, Crustaceans (Copepoda) and Euphausiacea. Cladocera were the dominant family and constituted 41 % of the total number of zooplankton followed by crustacean (Copepoda) in the river Orashi.

Table 4.33: Diversity and Relative Abundance of Zooplankton

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Rotifera							
Brachiomus caliciflorus	10	2	5	8	12	0	**37**
Collotheca pelagic	3	1	6	4	0	0	**14**
Lecame bulla	8	4	0	0	2	1	**15**
Euchlanis sp.	7	5	10	0	0	0	**22**
Asplanchia prodonta	15	8	5	3	0	5	**36**
Sub-total	**43**	**20**	**26**	**15**	**14**	**6**	**124**
Cladocera							
Alona affinis	5	3	6	1	2	0	**17**
Bosmina sp.	21	17	0	0	14	19	**71**

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Daphnia carinata	3	41	26	13	40	32	**155**
Chydorus sp.	0	0	0	0	3	15	**18**
Plolyphemus pediculus	4	0	23	0	0	40	**67**
Sub-total	**33**	**61**	**55**	**14**	**59**	**106**	**328**
Crustaceans (Copepoda)							
Acartia longirenis	22	8	15	28	3	0	**76**
Anomaalocera patersoni	4	10	9	0	0	11	**34**
Calamus finmarchicus	3	8	1	2	14	1	**29**
Candacia speciosis	12	4	2	3	26	22	**69**
Sub-total	**41**	**30**	**27**	**33**	**43**	**34**	**208**
Euphausiacea							
Meganycliphanes norvegica	24	13	8	4	11	3	63
Meganycliphanes sp.	15	21	6	11	7	14	74
Sub-total	**39**	**34**	**14**	**15**	**18**	**17**	**137**

Source: Resourcefield 2020

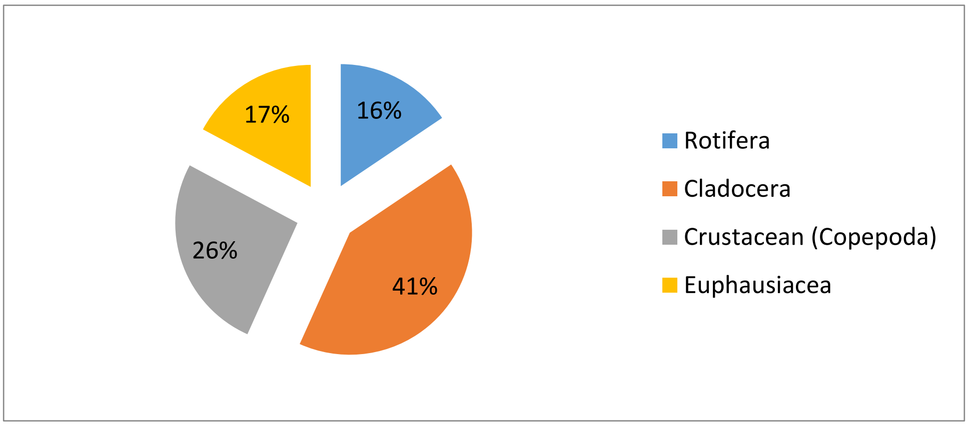


Figure 4.12: Relative Abundance of zooplankton (Source: Resourcefield, 2020)

4.11.4 Phytoplankton

A checklist of the phytoplankton in the aquatic systems around the proposed Life Camp is present in the table 4.34 below. The graphs showing the contributions of the major families of phytoplankton were recorded namely: Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae and Euglenophyceae and this composition is in conformity with observations made by Chowdhury (2007). Bacillariophyceae were the dominant family and constituted 35 % of the total number of phytoplankton in the river Orashi.

Table 4.34: Diversity and Relative Abundance of Phytoplankton

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Bacillariophyceae							
Achnanthes affinis	20	13	17	0	0	22	**72**
Biddulphia aurita	33	28	38	25	27	24	**175**
Chaetoceros mulleri	18	34	50	23	14	24	**163**
Chaetoceros didyma	50	58	49	28	40	45	**270**
Coscinodiscus centralis	48	75	8	45	12	34	**222**
Diatoma hiemale	0	80	0	0	24	50	**154**
Fragillriopsis oceanic	28	34	26	48	20	47	**203**
Leptocylindricus sp.	64	70	66	72	5	38	**315**
Sub-total	**261**	**392**	**254**	**241**	**142**	**284**	**1574**
Chlorophyceae							
Staurastrun seligerum	12	45	32	58	33	4	**184**
Eudorina sp.	10	6	8	3	7	15	**49**
Halosphaera viridis	28	33	40	8	29	44	**182**
Phacocystis globose	48	0	0	26	0	34	**108**
Pleudorina sp.	51	29	59	0	45	60	**244**
Micrasterias truncate	69	24	0	78	0	0	**171**
Sub-total	**218**	**137**	**139**	**173**	**114**	**157**	**938**
Cyanophyceae							
Anabaena flosaquae	15	18	0	24	12	0	**69**
Gleocapsa rupestris	17	90	4	25	73	0	**209**
Oscillatoria limosa	29	31	48	70	22	28	**228**
Phormedium uncinatum	82	49	26	0	53	0	**210**
Phormedium brevis	46	28	33	0	0	0	**107**
Sub-total	**189**	**216**	**111**	**119**	**160**	**28**	**823**
Dinophyceae							
Ceratium hirundinella	48	50	25	0	0	26	**149**
Ceratium tripos	21	13	10	5	0	0	**49**
Dinophysis caudate	0	0	10	3	6	0	**19**
Gonyaulax hurida	58	0	0	26	13	2	**99**
Pyrocystis sp.	0	0	0	33	15	10	**58**
Sub-total	**127**	**63**	**45**	**67**	**34**	**38**	**374**
Euglenophyceae							
Euglena acus	72	65	58	77	41	29	**342**
Euglena caudate	22	13	24	8	40	15	**122**
Euglena tripteris	8	15	0	30	11	2	**66**
Phacus caudatus	2	5	15	13	0	0	**35**
Trachelomonas sp.	65	41	68	74	0	29	**277**
Sub-total	**169**	**139**	**165**	**202**	**92**	**75**	**842**

Source: Resourcefield 2020

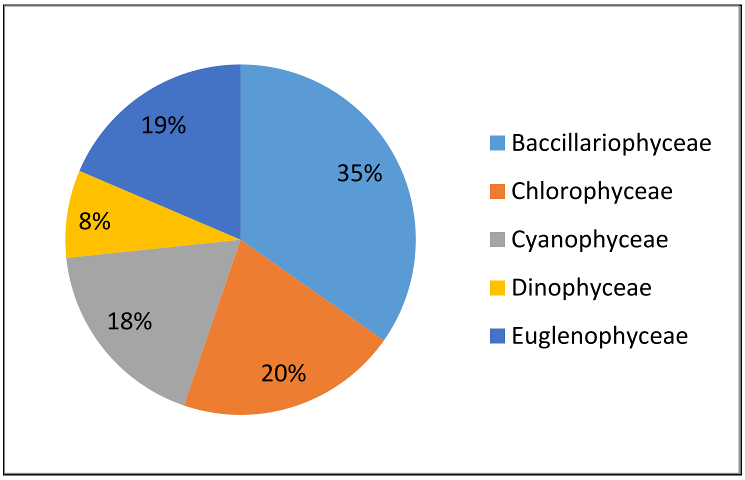


Figure 4.13: Relative Abundance of phytoplankton

The baccillariophyceae were represented by 8 species with numerical contribution ranging from 4.57 % (*Achnanthes affinis*) to 20.01 % (*Leptocylindricus* sp.). This baccillariophyceae abundance has been observed along Nigerian coastal waters (Ekwu and Sikoki, 2006). The second dominant family of phytoplankton was chlorophyceae which contributed 20 % of the total number of phytoplankton within Orashi River. Euglenophyceae contributed 19 % while cyanophyceae 18 % and dinophyceae contributed the least.

4.11.5 Benthic Macro-Invertebrate Fauna

A total of sixteen (16) benthic organisms were recorded in the study area. Benthic fauna encountered belong to four (4) major taxonomic groupings comprising Polychaete, Crustaceans, Bivalve Molluscs and Gastropods Molluscs. Gastropods Molluscs were the dominant benthos and they constituted 39 % of the macro-benthic organisms followed by Bivalves which constituted 25 % while Polychaete and Crustaceans constituted 18 % apiece of the number of benthos.

The population density in each station was relatively low. This may be primarily due to the study nature of the sediment. Another possible reason for the low-density benthos observed during the study is attributable to low level of organic material or detritus in the sediment (Olomukoro and Ezemonye, 2007).

Table 4.35: Diversity and Relative Abundance of Benthos

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Polychaete							
Arenicola marina	1	5	0	0	2	1	**9**
Capitella capitate	0	0	2	1	3	0	**6**
Eunice harassi	1	2	0	1	4	3	**11**

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Notomastus tenuis	3	1	0	0	1	1	**6**
Scolopsis uniramus	0	5	1	2	0	4	**12**
Sub-total	**5**	**13**	**3**	**4**	**10**	**9**	**44**
Crustaceans							
Alpheus monody	0	1	2	0	1	3	**7**
Cliberanus cooci	4	0	0	2	1	5	**12**
Iphinoe tripanosa	3	1	1	0	3	0	**8**
Isodus sp.	4	2	3	1	0	1	**11**
Nototropis swamidami	1	3	1	0	1	1	**7**
Sub-total	**12**	**7**	**7**	**3**	**6**	**10**	**45**
Bivalve							
Tellina nymphalis	3	0	5	2	1	1	**12**
Stylaria sp.	1	3	4	1	2	4	**15**
Nucula sp.	0	0	1	3	3	4	**11**
Sub-total	**4**	**3**	**10**	**6**	**6**	**9**	**38**
Gastropods Molluscs							
Littorina sp.	2	0	0	0	1	1	**4**
Neritina oweniana	6	3	7	1	4	8	**29**
Tympantonus fuscatus	2	5	1	3	7	7	**25**
Sub-total	**10**	**8**	**8**	**4**	**12**	**16**	**58**

Source: Resourcefield 2020

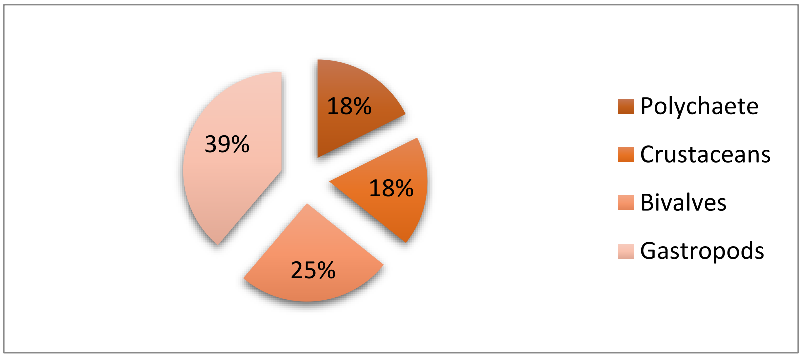


Figure 4.14: Relative Abundance of phytoplankton

4.11.6 Fisheries Studies

Fish from the study site were sampled using gill nets (mesh size: 9inches length: 6m), cast nets (mesh size: 9inches), hook (size: 2inches and lines by the local fishermen. The fish species were identified to the taxonomic level using Idodo-Umen (2003) andspecies were counted for number of individuals. The fish species were identified, sorted and frequency of occurrence were recorded in-situ. Further identification was completed in the laboratory using FAO literature (1988, 1994).

Plate 4.13: Fishing Activities in the study area

A total of twenty-six (26) countable individuals were recorded from 4 families during the fishing survey (**Table 4.36**). These include families: Cichlidae, Mugilidae, Sciaenidae and Ictaluridae.

Plate 4.14. A&B: A Catch of Cat fish and Mullet fish from the Study Area

Table 4.36. Fish Species Recorded in the Study Area

S/N	Family	Common Name	Local Name	IUCN Status	Scientific name	Abundance	%Abundance
1	Cichlidae	Tilapia	**Atabala**	**Least concern**	***OREOCHROMIS NILOTICOS***	3	11.5
2	Mugilidae	Mullet	**Asa**	**Least concern**	***Mugil cephalus***	4	15.3
3	Ictaluridae	Channel Catfish	Okpo	**Least concern**	*Ictalurus punctatus*	7	27
4	Sciaenidae	Croaker		**Least concern**	*Micropogonias undulatus*	12	46.2
					Total	26	100

Source: Resourcefield, 2020

4.11.7 Physical Deformities

Examination of the 14 fish samples collected showed some of the fishes had physical deformities. Ulceration and fin rots were prevalent possibly due to the activities of piscine predator. Examination of gut contents revealed traces of planktons and fish in the diet. The abnormality status of the fish samples is presented in Table 4.37. The table shows the number of occurrences of each disease type and the percentage prevalence in relation to the total fish samples studied.

Table 4.37 Abnormality Status of Fish Samples from the Study Area

Disease	No. of Occurrence	Prevalence (%)
Ulceration	5	35.8
Epithelial hypereplatia	1	7.1
Fused gill lamellae	1	7.1
Excessive mucus secretion	1	7.1
Fin rot/erosion	5	35.8
Chilodonelosis	1	7.1
Total	**14**	

Source: Resourcefield, 2020

4.12 Socio-Economics

4.12.1 Introduction

The socio-economic survey collated baseline socio-cultural, economic, and infrastructural indices of the study areas, while the consultation process elicited responses on stakeholders' concerns and expectations from the proposed project. This study is an integral part of the environmental and social impacts management and overall sustainable development arrangement.

Objectives of the socio-economic survey include:

- The study and documentation of the socio-economic and the cultural situation of the project area.
- determining the impacts of the project on settlements, cultural treasures, population, social and physical infrastructures, predominant economic structures, and the baseline health status of the people.
- documenting the views of the affected population, industries, and other relevant institutions/agencies in terms of environmental problems, perceived community problems and needs; and
- the engage stakeholders, with a view:

➢ to enabling the stakeholders, understand the project processes and cycle;

- to consider the views and opinions of stakeholders concerning the construction, operation, and decommissioning of the Life Camp.
- to developing and maintaining a robust relationship among the Government of Rivers State, EPC Contractor, and the project affected communities
- to prevent any form of social unrest among various levels of stakeholders that might arise from the development of the proposed project.

4.12.2 Scope of the Study

The study was conducted in the three host communities of Mgbede, Obrikom, and Omoku in Ogba–Egbema–Ndoni Local Government Area, Rivers State. It covered the socio-cultural resources of these communities, demographic issues including population and growth, age and sex distribution, and adult literacy.

Others were such indicators of the quality of life of the residents as the quality of housing, access to potable water, availability of functional infrastructural amenities, livelihood activities and patterns, and income levels. Health facilities and their patronage, disease prevalence and disease vectors, water and sanitation, and nutrition were also studied.

Additionally, the study discusses the perceptions, concerns, and expectations of members and residents of these communities, and establishes the proposed project's potential impacts, impact enhancement, and mitigation measures.

Table 4.38: Project-affected Communities

S/N	Community	Local Government Area
1	Mgbede	Ogba–Egbema–Ndoni Local Government Area
2	Obrikom	Ogba–Egbema–Ndoni Local Government Area
3	Omoku	Ogba–Egbema–Ndoni Local Government Area

Source: Resourcefield Fieldwork, 2020

4.12.3 Study Approach and Methodology

The EIA guideline has made it mandatory to consult communities on the possible impact of a proposed project. It is also binding to integrate community views at the project design stage. Socio-economic and community health impact assessment tools are designed to integrate the desires and aspirations of the community with those of the project proponent. In line with the EIA objectives, wide consultations were held and community aspirations were recorded.

Public forums were held to create more awareness of the proposed project and to prompt community support. The views expressed at the public forums are also an integral part of this report. The photographs were taken at the forums and the attendance list is attached to this report as Appendix.

This phase of the study consisted of data collation on the baseline social and economic indices of the study area. Relevant data were presented under various subheadings, including social environment (Socio-cultural/psychological environment, demography, education, and literacy, quality of life, poverty and inequality, human development indices); economic survey (production factors, labour force participation, employment/unemployment, and market survey).

4.12.3.1 Sampling Procedure and Data Collection Techniques

In obtaining socio-economic data of the project host community, the exploratory survey method was adopted. This involved key informant interviews and village-level group interviews using structured questionnaires. A "key informant" is generally a person adjudged to have good knowledge of the community under study such as a CLO, community leader, youth leader, a traditional ruler, an opinion leader, etc. the questionnaire used in obtaining socio-economic data employed a combination of "open-ended" and "closed" questionnaire format.

Open-ended questions are more suitable for qualitative data while closed questions are more suitable for quantitative data. Simple random and purposive or sampling techniques were employed in the sampling of the population of the study area.

Qualitative data were generated through informed meetings and also observations in small groups of stakeholders in the various communities with diverse socio-economic backgrounds and interests. Such groups include; Age grade, Farmers group, Market women, and Youth Associations. Each group meeting focused first on the political/administrative structure of the community/population characteristics, ethnic composition, and existing infrastructural facilities, predominant occupation as well as cultural practice and treasures.

4.12.3.2 Sources of Data

Primary and secondary sources were used for the survey. The research instruments employed for the survey were basically:

i. Desk reviews of available secondary data

ii. Direct Observation

iii. Individual Interview

iv. Questionnaire Administration

v. Focus Group discussion and

vi. Maps and published works of literature (journals)

a. Primary Sources

The administered questionnaires were employed to gather quantitative information concerning household and communal characteristics; while the direct observation, individual interviews, and focus group discussions were employed to assess the concerns of the community inhabitants on matters bordering on the social, economic, and health implications of the proposed Life Camp project in their community as well as their collective expectations from the proponent and government.

b. Secondary Sources

In instances where primary sources could not provide the required data, secondary data sources were relied upon. At the community level, such secondary data was sought from desk reviews which provided official and published information on the community including population figures and records revealed by other existing structures such as local government records and hospitals for baseline records.

Information was also obtained from existing national data sources including the National Population Commission (NPC), National Bureau of Statistics (NBS), Electronic maps, and the website of Rivers State Government. Some other data were collected from international sources such as the World Bank, the United Nations (UN), and the African Development Bank (AfDB).

4.12.3.3 Analytical Techniques

Descriptive statistics were utilized to analyze collated data. These included means, percentages, frequency tables, and charts. Data collected on various socio-economic parameters from all the communities were also analyzed using different tools as appropriate.

The questionnaire survey involved sampling households within the community using a set of questionnaires. Two hundred (200) Questionnaires were administered in the three project communities, 181 were returned for analysis.

4.12.3.4 Field Study Strategy

The field study comprised the following operations:

i. Pre-testing of questionnaires;

ii. Household listing;

iii. Field identification of households selected for interviews;

iv. Questionnaire administration and interview of key informants;

v. Focus group discussions; and

vi. Photography

4.12.4 Demographics

4.12.4.1 Population size, age Distribution and Growth

Rivers State is an *oil*-producing state of Nigeria, situated in the region known as the South-South geo-political zone with a population of 5,198,716, making it the sixth-most populous state in the country.

Ogba-Ndoni-Egbem Local Government Area is named after the three respective *Igboid* groups who inhabit this territory, the latter of whom is a pure stock of the *Ndokwa nationality*, who are located in *Delta State*. Ogba/Ndoni/Egbema Local Government Area (ONELGA) is bounded on the North by Ogbaru LGA of Anambra State; on the North-East by Oguta and Ohaji/Egbema LGAs of Imo State; on the west by Sagbama/Yenegoa LGAs of Bayelsa State and Ndokwa-East LGA of Delta State; on the South by Ahoada-West LGA and Emohua LGA of Rivers State on the East, and located on the Eastern bank of the River Niger. ONELGA has three (3) major ethnic/culture groups (Ogba, Egbema, and Ndoni) speaking distinct but familiar languages with their unique and peculiar self-sustaining cultures.

The three communities that make up the study area is also referred to Ali-Ogba, and it is located in the central Orashi-Sombreiro plains of Rivers State, Nigeria. The area is one of the major producers of the oil that fuels Nigeria’s economic development in recent decades. In his book, Ali-Ogba, Ellah posits that “according to current oil company records, no local government in Nigeria produces as much crude oil and gas as the Ogba/Ndoni/Egbema (ONELGA) local government (Ellah, 1995).

As a result of the activities of the oil industry in the area, Ali-Ogba has undergone significant political, social, economic, and environmental changes during the past several decades. Ali-Ogba stretches from about 4 50 N to 5 30’N and extends from about 6 25 E to about 6 40’ E. Spatially, it covers an area of 920 sq. km in the northern part of the Niger Delta region located within the River Niger flood plains.

It is bordered on the west by the Orashi river and the east by the Sombreiro river. In addition to the main drainage systems, there are the Omoku river and many back swamps, cut-offs, and interconnecting streams that form a maze of drainage channels superimposed on the area. At the peak of the rainy season, these interconnected waterways are a prominent feature of the landscape.

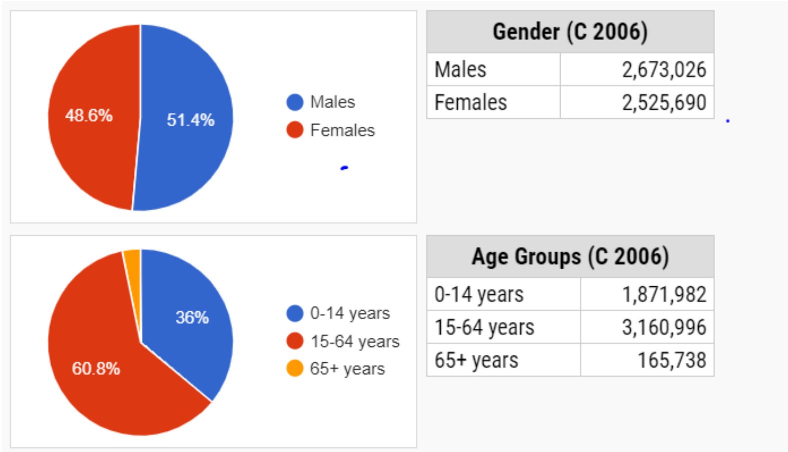
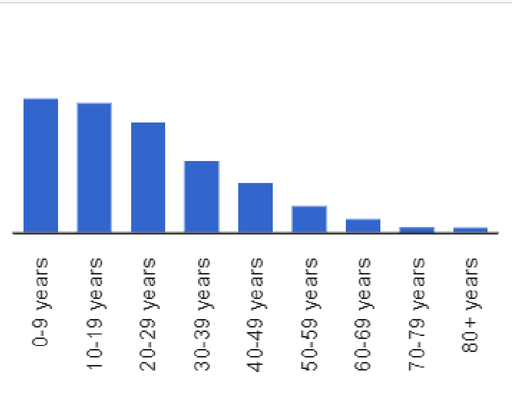


Figure 4.15: Population Structure of Rivers State (NPC: 2006)

Table 4.39: Projected population of the project affected LGA (using 2006 NPC population figure and 3.0% population growth)

Year	Ogba–Egbema–Ndoni Local Government Area
2006	283,294
2007	291,792
2008	300,545
2009	309,561
2010	318,847
2011	328,412
2012	338,264
2013	348,411
2014	358,863
2015	369,628
2016	380,716
2017	392,137
2018	403,901
2019	416,018
2020	428,498



Age Distribution (C 2006)	
0-9 years	1,262,446
10-19 years	1,214,221
20-29 years	1,036,110
30-39 years	681,847
40-49 years	472,846
50-59 years	265,117
60-69 years	149,058
70-79 years	67,059
80+ years	50,012

Figure 4.16: Age Distribution of Rivers State (NPC: 2006)

4.12.4.2 Household Composition, Structure and Size

The size of families differs from community to community, influenced in large measure by the cultural attitude of the people, the economy of the settlement, and educational status/awareness of the resident population amongst other factors. A total of 3,919,364 households were enumerated during the preparation of the Niger Delta Regional Master Plan Development with an average household size of 7.46, but with more than 70% of them having an average of 8 occupants. Large households were found more prevalent in rural areas (NDDC 2006).

The typical household unit in the study area has a head and several members. In many cases, the head is the father and members include his wife, children, and wards. The wards are often children of relations and, in some cases, friends. These are usually fed and generally catered for from the resources of the household. Members of the household are not necessarily related biologically. The household could also be composed of members who are not related but have agreed to live together under a common household head. This latter type of household group is not common in the study area.

From questionnaire responses, the mean household sizes obtained were 6.4 for the surveyed areas.

Dependency Ratio

The dependency ratio shows the proportion of the economically dependent segment of the population (children aged 0-14 years and the elderly, 65 years and above) to the economically active (those aged 15-64 years). It is an indication of the burden of providing for the dependent in the economy. It is assumed that the potential workforce (those aged 15-64 years) bears the economic burden of the dependent. The higher the dependency ratio, the lower the labour input per capita. In the LGA, the dependency ratio obtained is about 0.8.

The ratio obtained is indicative of a low economic burden and it implies that significant portions of the resources of communities are not dedicated to the care of children and the elderly. Typically, this would mean less investment in the provision of education, health, social welfare, and other services required by these two groups.

Fertility, Mortality and Life Expectancy

During FGDs in the project affected areas, groups interviewed indicated that factors that enhance fertility among them include general acceptance of the marriage institution, relatively early sexual activity and marriage, and polygamy. Fertility is best measured by the Total Fertility Rate (TFR) which is an indication of the total number of children a woman is estimated to have in her reproductive lifetime. The existence of precise estimates of the TFR values for this LGA could not be ascertained and no values were available, but the National Bureau of Statistics (NBS) estimates the value for South-South geo-political region is 4.1 while the national average is 5.7 (Annual Abstract of Statistics, 2016).

These values of TFR show that the rate of fertility in the South-South states is lower than the national average. Another measure of fertility is the Crude Birth Rate (CBR) which the NBS estimates at about 37.37 per 1000 in Rivers State and 42 per 1000 as the national CBR. (The Nigerian Statistical Fact Sheets on Economic and Social Development, 2016)

These rates indicate that, relatively, the region does not have high fertility.

Available mortality measures include the Neonatal Mortality Rate (NMR), Infant Mortality Rate (IMR), and Under Five Mortality Rate. The NMR, IMR, and Under Five Mortality Rate for the Niger Delta states are 53 per 1000, 120 per 1000, and 176 per 1000, respectively. The national averages are NMR 48 per 1000, IMR 100 per 1000 and Under Five Mortality Rate 201 per 1000 (Annual Abstract of Statistics, 2016). The NMR and IMR indicate that there are more deaths among neonates and infants in the Niger Delta states than what obtains generally in Nigeria. However, Under Five Mortality is lower in the Niger Delta region than the average in Nigeria.

Table 4.40: Under 5 Mortality and Maternal Mortality Ratio (MMR) per 100,000 in the various geopolitical zones of Nigeria

Geopolitical Zones	Number Under 5 Mortality per 1,000 children	Number Maternal Mortality Ratio (MMR) per 100,000 women
North West zone	269	1549
North East zone	260	1026
South West zone	176	286
South-South zone	103	165

Source: UNICEF Child Malnutrition and Mortality in Nigeria Report, 2013

Life Expectancy estimates for Rivers State is the same as the national estimates. The World Health Organization (WHO) in its World Health Statistics 2016 estimated that life expectancy for men in Nigeria is 42 years and 47 years for women.

4.12.4.3 Educational characteristics of Respondents

Education is a key determinant of the lifestyle and societal status an individual enjoys. Studies have consistently shown that educational attainment has a strong effect on health behaviours and attitudes. Education in Nigeria has evolved over a long time, with a series of policy changes. As a result, there have been increases in the enrolment of children and the number of educational institutions both in the public and private sectors.

The 1976 National Policy on UPE gives every child the right to free primary education. Later the 6-3-3-4 systems were introduced with 6 years for primary, 3 for junior secondary, another three years for senior, and 4 years for the university/polytechnic education respectively. Subsequently, the national literacy programme for adults was launched, followed by the establishment of nomadic education to address the needs of children of migrant cattle herders and fishing people in the riverine areas. With the inception of the present democratic dispensation in 1999, the Universal Basic Education (UBE) was again launched, making it compulsory for every child to be educated free up to the junior secondary school level.

A large proportion of the sampled population has received some formal educational training indicating a sufficiently literate society with minor variations between the three sampled communities. Almost an equal proportion (33.9% and 37.7%) of the sampled population reported possessing both the tertiary and post-primary (secondary) educational attainment. Some 11.5% have primary education, while approximately 3% have no formal education (NFE) while some 20.4% indicated having tertiary education. The proportion of the population that indicated possessing some technical/vocational educational training amounted to 14%, indicating the availability of some employable skills in the project affected communities. Respondents at Omoku were found to have a higher percentage of tertiary education (43.7%) and secondary education (55.6%).

A National Literacy Survey (2010) conducted by the National Bureau of Statistics in Nigeria estimates the adult literacy rate as 56.9 percent, with huge variations between states (Lagos 92.0 % and Borno only 14.5%), regions (urban 74.6 % and rural 48.7%,) and gender (male 65.1% and female 48.6%). More importantly, statistics from the Federal Ministry of Education indicate that only 500,000 of the 40 million adult illiterates are enrolled in adult learning classes.

There are also 3.5 million nomadic school-aged children with only 450,000 of them accessing any form of schooling. Nigeria is further saddled with the largest number of out-of-school-children estimated at over 7 million (10 percent of the global total). The Nigerian Government recognizes that literacy education will help equip individuals with the knowledge, skills, and attitudes needed for economic self-sufficiency, poverty reduction, and sustainable development, and is therefore making efforts to address the illiteracy challenge.

Rivers State has a higher *literacy rate* compared to most states in the *South-South* geopolitical zone. Its male literacy as of 2006 was 52.3% while the female literacy rate was 47.7%, putting the state above the national average. Approximately 18% of men and 26% of women over the age of six have no formal schooling; while approximately 15% and 14% of both men and women have finished nursery school and almost the same percentage (15.1% and 15.8%) have finished primary school (NPC, 2009).

Rivers State has been long recognized as an educationally advantaged State as was confirmed by the human development index (HDI) report of the UNDP (2006). The State's overall HDI of 0.615 was found highest in the Niger Delta and the educational index of 0.636 came second only after that of Akwa Ibom (UNDP 2006, The Guardian of September 2, 2006). Statistical estimates have put the proportion of children attending primary school in the Niger Delta region at 80 percent (which compares favourably with the estimated national average of 54 percent) (UNDP 2006). The adult literacy level of the population is 78.7%.

Table 4.41: Education-Current conditions in the Niger Delta states

STATE	Adult Literacy (%)	Attainment of Primary School (%)	Attainment of Secondary School (%)	Attainment of post-secondary education (%)	No. of Jobs in Sector 2000 (Teachers)
Abia	84.1	39.6	43.6	16.8	7276
Akwa Ibom	76.3	54.4	44.4	8.3	13,683
Bayelsa	78.7	38.8	49.3	11.9	3,515
Cross River	82.2	44.6	42.8	12.6	11,425
Delta	77.4	37.9	43.6	18.5	15720
Edo	69.7	49.3	38.8	11.9	10959
Imo	79.3	46.1	42.7	11.2	14,145
Ondo	78.8	45.0	44.2	10.8	12342
Rivers	79.9	33.3	49.5	17.1	4,011
The Region	78.7	43.3	43.2	13.5	95076

Source: Niger Delta Regional Development Master Plan (NDDC 2006)

4.12.4.4 Migration trend

There were no existing records and actual figures on migration in the communities, however, it was possible to examine and determine the trend and pattern. Many residents indicated they were born in the communities of their residence or had lived in them for more than ten years. Those who were born in or had lived in the communities for more than ten years were considered non-migrant while those who had lived for less than ten years were considered migrants.

The result shows that between 5% and 15% of respondents were migrants who came to the area after 2018 when relative peace returned to the area. This trend was not entirely unexpected given that the communities are rural areas. However, there were also indications that some household members had relocated over the years for various reasons. The most common reasons for relocation were marriage, school, and work, and the most affected age groups were those between 10 and 44 years.

Those who relocated went mostly to cities in Nigeria, like Port Harcourt, Asaba, Onitsha, Kaduna, Abuja, and Lagos.

4.12.4.5 Landuse

The land in the study area has been greatly affected mainly by the process of agricultural practices and development. A presentation of the land use in the study area (table 4.41a) and its environs as observed during the study shows that built up area accounts for 10.27%, fallowed bush 30.65%, Cultivated farmland 50.76%, and Swamp/wetland 1.76% and water body 6.56%.

Table 4.41a: Landuse Classification in the study area

Classes	Count	Coverage (Km^2)	Percentage
Built-Up Area	98211	88.39	10.27
Fallowed Bush	293078	263.77	30.65
Cultivated Farmland	485382	436.84	50.76
Swamp/Wetland	16878	15.19	1.76
Water Body	62760	56.48	6.56
TOTAL	956309	860.68	100.00

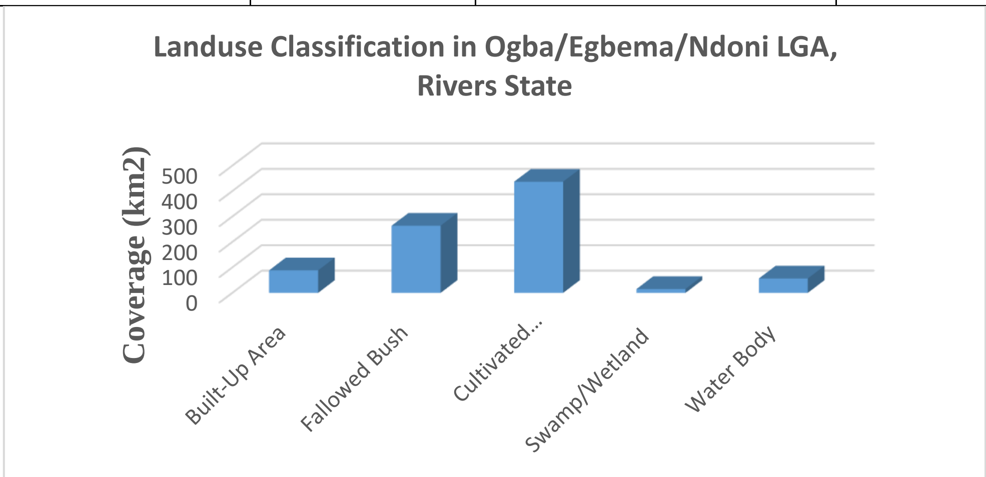


Table 4.16a: Landuse classification in the study area

4.12.5 Socio-Cultural Resources

4.12.5.1 Language, Marriage and Family

Available accounts of the origins of Ali-Ogba communities and their unique cultural characteristics and affinity lend credence to their common ancestry or 'brotherhood'. Based on common historical experiences and culture, especially language, Ali-Ogba people also exhibit some relationships with other communities in Rivers state and other parts of Nigeria. For example, based on culture and language, some linguists such as Professor Kay Williamson of the University of Port Harcourt posit that Ali-Ogba people belong to the Lower Niger (Igbo related group) among the six language units making up Rivers state. Ali-Ogba communities have a close linguistic relationship to Igbo spoken by people of present Abia, Imo, Anambra and Enugu and Ebonyi states who constitute the eastern and northern neighbors of Ali-Ogba people. Also, there is some evidence of language similarity between Ali-Ogba communities' dialects and those spoken by Agbor and Kwale communities in present-day Delta State.

Some people have postulated that Umudioga ancestors came from Ali-Ogba. So were ancestors of Rumuogba (sons of Ogba) communities and Rumuobrikom (sons of Obrikom the ancient capital of Usomini group of villages). Also, linguistically and culturally Ali-Ogba communities are related to other Nigerian people.

In the absence of valid historical records, historians accept oral tradition as a primary source of writing African history, the defects associated with this method notwithstanding. The history of the origin of the people is traceable to the waves of migrations from the lower Niger and delta regions.

The traditional marriage which follows is always elaborate and the traditional attires are elegant. Men adorn a loose-end wrapper on top of etibo (flowing shirt) with a hat to match. Hand staff/walking stick completes the men's attire while the females adorn wrapper with some traditional top. Beads are an essential part of the females' dressing. It is worn on the head, neck, and wrists. There are no known marriage restrictions based on religion or culture in any of the communities.

The family is recognized as a very important social unit and both nuclear and extended families exist in the communities. The typical nuclear family is headed by the father, with the mother and children. The extended family includes members who are not biological offspring of the same parents but relations. A nuclear family where the father was dead could be headed by the mother if the children are juveniles or by the eldest son if he is a grown man and able to bear the financial responsibility of taking care of the family. The extended family is always headed by a male member.

Considering that all the communities are used to non-indigenous residents, members can communicate in Pidgin English and the communities in some way have an accommodating social attitude. This attitude could be valuable for the proposed project, given that itinerant workers and camp followers would be attracted to the communities and this kind of social attitude would foster healthy cross-cultural exchanges. This can also help in some way to limit conflicts that arise when people of different cultural backgrounds live together, thereby reducing the potentials for tension and social upheavals during the project.

4.12.5.2 Social Structure and Organization

The studied communities share a lot in common concerning social structures and organizations. Membership of socio-cultural groups (CDCs, women's groups, youth groups, CBOs, cultural groups, and social welfare groups) by household members is quite common. The roles played by these groups are distinct and significant. A group like the Community Development Committee (CDC) is set up purely to perform local administrative roles and also to liaise between the communities and all external bodies, and other communities. Similarly, a lot of the social clubs and CBOs actively participate in improving the welfare conditions of their members. The cultural groups mainly performed at cultural festivals, thereby ensuring the preservation of their cultural heritage.

Every Ali-Ogba person belongs to a politico-cultural organization (Onuobdo) and every Onuobdo occupies a traditional position in the political organization of Ali-Ogba which has been preserved to this day. Every Onuobdo has its distinct titles that have political, social, and economic implications. The membership of Onuobdo and its associated title or "praise name" is expressed in one of the most important aspects of Ali-Ogba cultural and political legacies: the traditional greeting (Idu Isiali). When a member of an Onuobdo bow in the traditional greeting (Idu Isiali), he or she is praised with the appropriate title of his or her Onuobdo.

The 'Idu-Isiali' or traditional greeting is an important cultural obligation of a full-fledged indigene of Ali-Ogba. To perform the greeting properly, you must know the Onuobdo of the person you are about to greet as well as the appropriate praise name or title of distinction for his or her Onuobdo. Also, you must know the age-grade of the person to be greeted because a younger age-grade should initiate the greeting with the following exceptions:

- Whatever may be a person's age, he or she will initiate the greeting or "bow" to every member of his or her mother's Onuobdo, except the very young persons.
- A man and his agnatic relatives will initiate the greeting or "bow" to the agnatic relatives of his wife or wives.
- A man will "bow' to the wife or wives of an elder member of his own Onuobdo.
- All-female members of an Onuobdo should "bow" to all members of the same Onuobdo irrespective of age, except those from their own immediate extended family.
- Members of the same age-grade bow indiscriminately among themselves.

The elite council of Omoku (ECO) is an organization comprising intellectual gentlemen from Omoku and membership is open to only a few selected sons and daughters of the community. Apart from these socio-cultural groups, the communities are also made up of compounds. This structure that incorporates compounds allows the compounds some level of autonomy in their daily administration. The compounds are made up of extended families and their affairs are directly overseen by their appointed chiefs.

- **Traditional Governance**

The communities have distinct but similar traditional administrative structures. The structure comprises the traditional ruler assisted by chiefs and a Community Development Committee (CDC)with the youth and women groups.

The traditional heads are elected from eligible males. Eligibility is determined by age (minimum of 35 years) and standing/integrity. Occupants hold office for life except where they are deposed by the community. They could be deposed by the community or government if they are believed to be working against the communities' interests if they committed a heinous crime or became incapacitated by ill health.

The Chiefs are appointed by their respective compounds to oversee the affairs of the compounds and represent them in community matters. They also have the role of advising the traditional heads. Chiefs are also all adult males and they remained in office for life, except removed by the compound. Each council of chiefs has a Chairman.

The communities also have CDCs which are headed by a Chairman and assisted by a Secretary in the day to day running of the committee. They are often referred to as community Chairman and Secretary. Membership of the CDC executive is by election among adult males from the compounds. Members of the CDC serve a fixed term of four years. The CDC is the administrative organ that has responsibility for the day-to-day running of the communities, liaison with external bodies and agencies, and development planning. They report directly to the traditional head. Other groups that make up the traditional administrative structure include the women and youth and both report to the CDC. Both are also headed by executive committees which include the President, Vice President, Secretary, among others.

The executive committees are elected. Across the study area, while the youth executives serve for one or two years, the women leaders usually do not have a fixed term in office. All adult female members of each community are eligible for membership in the women's group in their respective communities. Membership of the youth groups is similarly open to adult community members of both gender who are between 18 and 40 years.

The roles of these organs of society are clearly defined and there were no indications of role conflicts. These organs could play significant roles in information dissemination and community mobilization before, during, and after the proposed project.

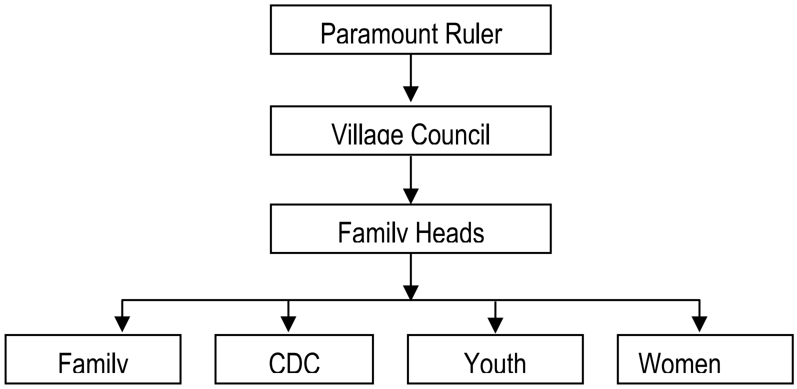


Figure 4.17: Hierarchy of Leadership/Governance in the Study Area

- **Roles of Women and Youth in Community Development**

The women and youth groups play important roles in the communities and serve to bring their members together as well as intervene in their welfare. The women's primary role is to advise the CDC and the council of Chiefs on matters concerning women in the communities. During the survey, it was noted that culturally women could not, lead the communities, head the key organs of traditional administration, seat, or participate with the men in making community decisions. They had their separate meetings and their decisions were transmitted to the CDCs and traditional councils. This cultural inhibition is a clear indication of gender inequality in the communities. Gender inequality across Rivers State was captured by the use of the Gender Empowerment Measure (GEM) which is an indicator of the opportunities women have in any socio-economic environment. GEM measures gender inequality in the three areas of political participation, economic participation, and control of economic resources. The GEM value for Rivers State is quite low at 0.25, higher than the Niger Delta regional average of 0.22, but at par with the national average (Delta Facts, 2016).

The youth, on the other hand, has become a strong force in the communities. Their roles include ensuring internal and external security, enforcing law and order, and development planning. Youth leadership, especially the President and Secretary are regularly invited to community meetings with the traditional councils and CDC, where decisions about development and security are taken. They are also responsible (with the CDC) for liaison with companies and other organizations that have any business in the communities.

4.12.5.3 Gender Issues

It is imperative to note that while sex recounts more to biological framework and differences among the two dominant sexes, gender relates more affirmatively to the social meanings given to each of the sexes not without significant implications for social relations as social stratification confers honour on some and dishonour on others. In general, field observation from this study revealed that social relations in the area are based on a patriarchal relationship in which authority is vested in the male head of the household.

Gender differences were found to manifest in the study area more clearly in terms of community and political participation, in that women are generally excluded from major decision-making processes. Moreover, women in the study area are frequently at a disadvantage in terms of inheritance and tenure rights.

Gender is a central organizing principle of societies and often governs the processes of security. Nigeria ranks 118 of 134 countries in the Gender Equality Index, Nigeria has one of the lowest rates of female entrepreneurship in sub-Saharan Africa. The majority of women are concentrated in casual, low-skilled, low paid informal sector employment and women represent over 70% of the World's poor due to unequal access to economic opportunities. Increasing female participation in the workforce and the development of the female human capital will not only help to reduce poverty at the household level, but it will also radically enhance national security.

Given the limited opportunities for local employment that will be created, it is not expected that the project will have a significant impact on the status quo of gender relations and gender equity in the project's social environment. However, gender mainstreaming remains a key principle that the project should apply when recruiting both temporary and permanent employment in the train stations in the area.

The socio-economic survey found that, in the local study area, gender differences in status manifest more clearly in terms of political participation and inheritance than in socio-economic attributes. The interaction during the fieldwork revealed the dominant position of men. During the Stakeholder Engagement process, there was also little participation from women.

Women do not have the same inheritance rights, nor could they directly access critical resources such as land or credit. Women are less mobile than men because of family responsibilities, and in particular, the need to care for children. Women hardly take part in the decision-making process at the community level. Women are never recognized as part of the ruling council. They are often allowed to socialize by forming their group, but could hardly influence the decisions of men. Women are usually treated as 'children'. At best women could become group leaders.

The global gulf between job creation and the growth in the numbers of job seekers has worsened the employment situation for women and men alike in Rivers State. But women face greater vulnerabilities in the labour market because of their relative lack of education and training, the tendency to channel women into certain occupations, and the continuous heavy burdens of unpaid domestic work, childbearing, and childcare, which restrict the time and energy available for income-earning activities.

Nigeria like other countries in the world is responding to the clear request calls made variously by the United Nations societies of all forms of discrimination, especially gender-based discrimination. Nigeria indeed has tried to respond to this development from the international arena by articulating policies and programmes that seek to reduce gender inequalities in socio-economic and political spheres, however, the success of bridging the gap between men and women is farfetched.

Results in the study area revealed that women in the area are a significant but undermined force. Economically, they constitute the majority of the peasant labour force in the agricultural sector, while most of the others occupy the bottom of the occupational ladder and continue to be channeled into service and domestic occupations.

The consequence of the unequal status between men and women is a high level of economics and political powerlessness among women and powerlessness in turn retards development of any level, politically, economically, and socially. FGD revealed gender inequality existed from the dawn of civilization and has continued over centuries in the study area. Gender discrimination has created wide gender gaps in the project-affected communities, with very devastating social, economic and, health consequences on the members of the female gender, who have been intensely marginalized, and subjugated to the background.

The culture of the people of the study area perceives and treats men as superior to women, this is well manifested in the "son preference syndrome" that is prevalent in Nigeria. Male children in the project-affected communities often enjoy preferential treatment, like exemption from house chores; they enjoy the unlimited right to education, while the girls are limited and often given out for marriage at an earlier age by some parents for economic gains especially in the Kogi State axis. The culture of the area strictly restricts women to the stereotyped role of home keeping, childbearing, and childrearing.

The negative outcomes outlined above are the result of systemic and deeply entrenched discrimination that not only undermines the life chances of millions of individual girls and women but adversely affects their future children and the whole community. Nigeria's 2006 National Gender Policy is consistent with the global consensus when it States that women's empowerment and gender equality underpin the achievement of all the other SDGs.

A well-established link exists between maternal education and child survival, for example, educated girls are more likely to avoid early marriage, plan their pregnancies, and have better maternal and child health outcomes. Nigeria's progress and national development will be constrained if women and girls continue to be disadvantaged and gender equity is ignored. Non-discrimination is enshrined in the Nigerian Constitution but in practice, the majority of Nigerian girls and women are unable to claim their constitutional entitlement as it is evident in the study area. If Nigeria is to maximize its "demographic dividend" as the population of working age increases and fertility declines, it must prioritize investment in women and girls to ensure that the next generation of all young adults are healthier, better educated and abler to contribute to economic growth and development. Investing in adolescent girls and women is not simply a question of human rights; it also makes economic sense.

- **Gender-Based Violence**

Domestic violence can be defined as physical abuse, sexual abuse, emotional and verbal abuse between people who have at some time had an intimate or family relationship. What constitutes physical, sexual, emotional, and verbal abuses against women often would be influenced by the socio-cultural norms of a particular society. Gender-based domestic violence against women is often maintained or perpetrated by unhealthy societal and cultural practices.

Physical violence based on WHO study [WHO, 2005], definition includes the women being;

- Slapped or thrown something at that could hurt her
- Pushed or shoved
- Hit with a fist or something else that could hurt.
- Kicked, dragged, or beaten up
- Choked or burnt on purpose
- Threatened with or used a gun, knife, or other weapons against her.
- Sexual violence as defined based on WHO study [WHO, 2005] include;
- Being physically forced to have sexual intercourse against her will

- Having sexual intercourse because she was afraid of what her partner will do.

FGD revealed cases of both domestic and sexual violence against women in the area, largely blamed on the customs of marriage in the study area which involves bride price and dowry usually paid on women, this they believe promote the values that give men proprietary rights over women and girls and encourage polygamy. The cultural practices of the people of the area as it is in most African societies, give women in the society a second fiddle role to play.

- **Occupation of the women in the area**

The contribution of women to the development of the various communities cannot be overemphasized. They are said to be very industrious and are majorly involved in agriculture and allied occupation. Focus Group Discussion also revealed that despite restriction placed on the women of the area by the culture; a lot of them have been able to grow their home-based business without support from their spouse. Results revealed 72% and 19% to be involved in farming and petty trading respectively, while 9% are into other businesses like artisanry, civil and public service, etc.

Investigations reveal that women as a body are fairly organized and may engage in any remarkable cohesive interaction. The project-affected communities have women associations that play a vital role in community organization. The women are more socially oriented than the male as can be inferred by their propensity to adorn identical apparel during festive occasions.

- **Lifestyle and Social Indulgent Practices**

Lifestyle and practices raised and discussed during FGDs and interviews included, drinking alcohol, cigarette smoking, and the use of hard drugs, prostitution, teenage pregnancy, and child labour. Residents confirmed that the use of spirits and alcoholic beverages is quite rampant among them. Most residents, of both genders, had been drinking since their teenage and several since they were children.

The local gin 'kai-kai' which is most popular is brewed in the communities, and therefore, is quite readily available. Cigarette smoking is also quite common among teenage and adult males. Most residents also believe that some of the youth smoke hemp.

Teenage pregnancies, on the other hand, are experienced quite commonly in all the communities. Child labour, another of the social vices, is not common. Children usually assist their parents in running their shops. This type of work does not attract any salaries or wages.

Residents expressed fears that the proposed project would further encourage some of these vices if construction workers and camp followers take up residence among them. Drinking, smoking, the use of hard drugs, teenage pregnancies, and prostitution were particularly mentioned by residents.

4.12.6 Belief System and Practices

Traditional celebration existed for a long time among groups of people in different communities within Africa and some continents. It is believed to be an integral part of the people's socio-cultural lifestyle.

Categorized under the intangible heritage, which is transferred from one generation to another, it is associated with totems, deities, coronation, burial and marriage rites, etc, due to the belief of the Africans, that there exist certain celestial spirits that mediate between man and the supernatural spirit. Such celebrations are in most cases accompanied by dances, music, incantations, libation, and proverbs, which have characterized most communities in Africa.

Rivers State, with its diverse ethnic and linguistic groups, is also very rich in culture and the arts. Several cultural bonds exist among ethnic groups, particularly in music, dances, plays, and masquerades which are very dependent on socio-cultural and religious backgrounds.

Christianity with the long historical origin is predominant among the Delta Igbos, herein includes the Ogba ethnic group as in other parts of Rivers State, although there are strong influences from traditional religious beliefs. It is safer to say that the religious persuasions of the majority of the population are ‘’ mixed’’. For the practicing Christians, religious houses, i.e., churches of various denominations and sects of Christendom abound in the area, including those of the orthodox and Pentecostal denominations, dominated by the Pentecostal Church with gigantic structures as is seen in almost all the streets of the study area.

The most cultural heritage of the people remains their festivals, which are tied to their way of life and livelihood, i.e. the seasons. Culturally, therefore, the subsisting festivals relate to either the fertility of the land and waters or the blessings of the ‘’gods’’. The strong influence of Christianity has eroded some of these trado-cultural celebrations, but there still exist some communities, which have not only found delight in such traditional celebrations but develop efforts to protect and preserve them from going into extinction, and Ogba communities are one of them.

Some of the festivals in the area include; Egwu Ogba or Nchaka. Egwu Ogba or Nchaka is a 4-day festival within Omoku and its environs, which seeks to achieve amongst all, the cleansing of the entire Omoku town from both evil spirits and evil mortals, who reside in the town, unification of family members from both far and near, appreciation of the gods for the planting and harvesting seasons, display of mystical powers, skills and strength by participants, an exhibition of supreme rulership of the Oba of Ogba land over his subject, through his significant role, as well as the transformation of Omoku town into a tourism destination, where tourists from all walks of life visit on annual basis.

The Egwu Oba or Nchaka festival just like most African festivals, gives room for consultation, proclamation, and preparation, where it is expected that elders and chiefs from Umu-ebe, descendants of the first Oba, as well as Umu-Eze-Ogba royal kindred, from all towns and villages in Ogba, will converge at the hall of the Oba’s palace to fix a date for the Nchaka festival, which is normally the last week of November.

Such a fixed date will be passed to the Oba divisional Council of Chiefs and traditional rulers for ratification before a proclamation by the Oba of Ogba land through his town criers, who uses a metal gong (i.e ukela), to intimate the public on the forthcoming festival. It comes during the notable market days of Orie (small market) and Nkwo (big market day). This act of intimation affords all expected participants, including those residents in the plantation, the opportunity to prepare for the d-day. After the intimation comes the four days of the Egwu Ogba festival.

On the first day, during the afternoon hours, women from each family, adorned with casual wrappers and simple blouse and on barefoot, are led by the eldest woman in each family. She dresses in Akwete cloth from her shoulders to her waist as a mark of seniority and leadership role and holding burning firewood in her right hand as they embark on a procession to the Arena or square of the four quarters in Omoku. The procession is marked with enhancement, incantation, dancing, clapping of hands, and striking of metal gongs (ukela), without other traditional musical instruments set up at the arenas. The women in turn invoke their ancestral spirits that are identified with the festival, to cleanse the town and do away with evildoers.

This cleansing process prohibits the torch bearers light from going off, because it signals a bad omen, with the bearer considered as an evil person and stigmatized for life. The spiritual cleansing, which is characterized by prolonged enchantment and rebuking of unwanted captains of the evil world, thereafter terminates at “Mini Omoku” (Omoku Rivers), a tributary of Orashi River. Here, each of the four quarters takes possession of a separate major river point that will accommodate them, where they carry out the final incantations, to send out the evil spirit from the land, after which each oldest woman from each family, throws the burning firewood into the river, which signifies a send forth or passing away of all perpetrators of evil in Ogba town.

The prepared food is thereafter taken to the house of the eldest male of each family, here all the family members gather to eat, with the women separated from the men. After eating and drinking, all family members retire to their various homes, paving the way for another two elaborate days of merriment, which calls for eating of special dishes such as pounded yam and native soup. Climaxing into the morning of the fourth day, the men and youth after the night celebration, converge at the four squares, with women, children, and tourists as spectators.

Their assembling provokes a lot of attention, where on individual or group bases, men and youths possessing the ogy, at various interval strike it on the ground, saying tua njoli (evil leave the land), as well as a display with metal gongs, ornaments, rattle nuts, without any central traditional musical instrument for formal display. This captivating day which marks the end of the festival is also characterized by those who possess spiritual powers and magical skill, who use such avenues to test their mystical powers while challenging those with the same.

This show of power continues until the arrival of the Oba of Ogba land, in the early hours of the morning, to perform the spiritual blessing of his subjects at ahia Orie square, situated in Obieti quarter (big quarter), resulting into a mass exodus from the other three quarters, to catch a glimpse of the Oba of Ogba land, as well as to share in the blessing.

This exercise of oral proclamations is aimed at, eradicating all associates of evil in Ogba land, which is synonymous with the actions and oral expressions of the participating men and women of Ogba origin.

This then marks the end of the Nchaka festival. Despite the poor participation experienced these days due to modernization, Christianity, and youth restiveness, the festival still subsists.

Celebrations in the study area, coincide mostly with the beginning of the farming/planting and harvest seasons. As Christian communities, Easter and Christmas celebrations are part of their cultural heritage. There is a wide variety but the same commonality of festivals still celebrated by the PACs, with marked periods of celebrations and some, have serious strictures attached to them.

These annual festivals are considered important for warding off evil, promoting fertility in marriages, and profitable enterprise with farming and other activities. The reality on the ground, however, is that traditional worship is rooted in the culture of the communities and even acclaimed Christians participate in the festivals at different levels of commitment.

Other belief systems revolve around the communal social life of the inhabitants in the affected communities. Social maladies such as incest, adultery, stealing fighting with cutlass, bottles, or guns and in the bush or mating with a woman in the bush are amongst the customs and beliefs, which are seriously frowned at. Violators are dealt with by either being physically beaten up and subjected to some punishment or asked to pay some fine, including the appeasement of the offended deity and/or ancestors.

FGDs revealed that 95% of the people are adherents to the Christian faith, while 4% and 1% are traditional worshippers and Muslims respectively.

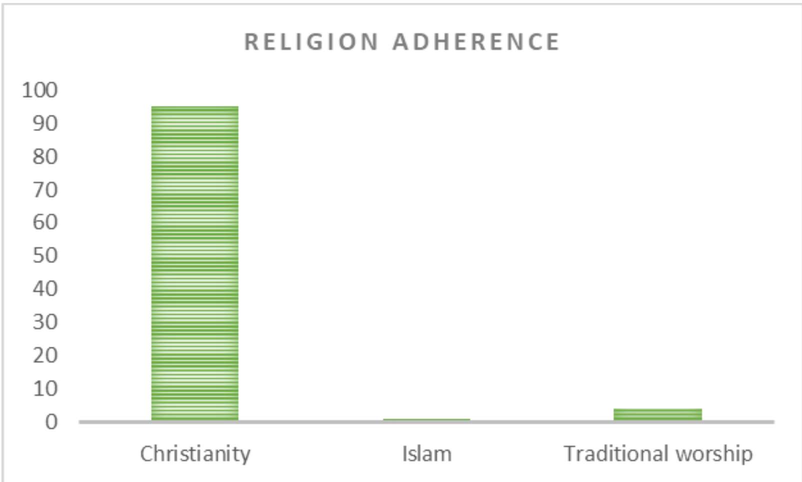


Figure 4.18: Religion adherence in the study area.

There are no communal restrictions on religious beliefs and worship. Residents are at liberty to pursue their religious beliefs and interests.

4.12.7 Conflict Management and Security

Throughout the world, dispute is a common phenomenon in human relations. Covertly or overtly, humans tend vested interest. Therefore, at any point one individual or group crosses the prescribed boundaries of the accepted cordial relationship, dispute ensues. Without overstating the obvious, the concept of dispute resolution is predicated on the assumption that an equitable society can only be brought about by an equitable decision. Conflict is one of the inevitable phenomena of every human society. However, what exemplifies the greatness or quality of life in any society is how much society can administer their affairs.

The study area is part of the Niger Delta region which has experienced several conflicts with violent outcomes. In particular, there was the issue of militancy and cultism in the region. The conflicts that gave rise to militancy involved the youth more than any other group. Many of them have become violence-prone and even social misfits.

Conflicts do not always have violent outcomes; in fact, many conflict situations are resolved daily. In the study area, such non-violent conflicts also arise and there are traditional ways of resolving them. These communities have various organs of society traditionally involved in resolving conflicts. These organs include the social organizations to which household members belong to, like the women organizations, the compound chiefs, and the CDC.

However, at the apex of the traditional conflict resolution process in each community are the traditional leadership. Their decisions on intra communal conflict issues are usually binding on all parties. Family crises are first reported to the most elderly person in the family who settles them, but should he fail to achieve the needed peace, the case is referred to the members of the traditional council. The traditional council invites all the parties involved, listens to them, and passes judgment. People found guilty are punished with penalties ranging from payment of fine and public apology, depending on the gravity of the crime committed. Formal law enforcement agencies are rarely contacted to adjudicate on contentious communal issues. They are only called in when traditional conflict resolution mechanisms do not achieve desired effects.

Cultism is one of the major sources of violence and causes of death among youths in the Niger Delta region, Nigeria. Youths join different cult groups to have more influence and power than their peers. The supremacy of a particular cult group in a community gives its members an edge to take control of proceeds and royalties accruing from crude oil production in the area. As a result, many cult groups are at conflict to assume dominance and control. This rivalry among them triggered inter and intra cult violence such as assassination, abduction, and violent fights.

The disastrous impact of cult-related violence was witnessed in the study area and claimed a number of lives and properties worth billions of naira between 2008 and 2018. Though not given wide publicity the level of devastation done to the area has remained evident in the number of banks and other businesses that left the area. Within the time under review, the study area witnesses a mass exodus as people and businesses as inhabitants fled to different places for safety. The result was the rural-urban migration and massive displacement of residents from their homes, with farmers abandoning their farms.

FGD participants were of the opinion that the increasing exposure of youths to delinquent behaviour and the lack of adequate parental care due to a high rate of poverty, unemployment, and bad governance have no doubt enhanced their susceptibility to joining cult groups and cumulatively increasing the vulnerability of the communities to cult conflict/war.

As pointed by Nnodim and Ochogba in their study, they showed that the menace has affected negatively the social and economic activities of residents and thereby threatened their wellbeing. This is because the cult-related activities have caused the displacement of many from their homes due to fear of being killed. Birabil and Okanezi also pointed out that violence resulting from cult attacks had taken an alarming dimension that posed threats to residents.

Because they were perpetrated by the community youths and took the people by surprise, they became difficult to control and by consequence caused destruction equivalent to man-made disasters.

Table 4.42: Distribution of frequency of cult killings (number of deaths) in LGAs with amnesty program (2009-2018)

S/N	LGAs	Year										Total frequency	Percentage (%)
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
1	Abua/Odua	1	1	1	0	1	2	2	1	2	3	14	3.07
2	Ahoada East	0	0	0	0	0	0	1	4	16	4	25	5.48
3	Ahoada West	0	0	0	0	1	0	1	2	7	1	12	2.63
4	Akuku-Toru	2	2	1	1	1	1	1	1	0	2	12	2.63
5	Andoni	1	1	1	2	1	3	2	2	4	2	19	4.17
6	Asari-Toru	1	2	1	1	1	1	1	1	1	1	11	2.41
7	Bonny	1	1	1	1	0	0	1	1	0	1	7	1.54
8	Degema	2	1	0	2	1	1	0	0	1	2	10	2.19
9	Eleme	1	2	1	1	1	1	2	2	1	2	14	3.07
10	Emuoha	1	0	1	1	3	14	6	18	14	3	61	13.38
11	Etche	1	1	1	2	1	2	2	3	6	2	21	4.61
12	Gokana	0	0	0	0	0	0	1	2	1	1	5	1.10
13	Ikwerre	0	0	1	1	0	11	3	2	3	13	34	7.46
14	Khana	0	0	0	2	0	0	9	1	3	2	17	3.73
15	Obio/Akpor	2	1	1	2	0	5	3	5	7	8	34	7.46
16	Ogba/Egbema/Ndoni	0	0	0	0	0	1	8	4	6	4	23	5.04
17	Oguta	0	0	4	6	4	5	4	7	6	10	46	10.09
18	Ohaji/Egbema	0	0	4	5	12	3	6	5	5	7	47	10.31
19	Port Harcourt City	2	1	1	2	0	5	3	5	7	8	34	7.46
20	Tai	1	0	1	1	1	0	1	2	2	1	10	2.19
Total		16	13	20	30	28	55	57	68	92	77	456	100

Source: Nigerian Police and Researcher's Field Work, 2019

Plate 4.15: Closed and abandoned banks, and destroyed properties in Omoku

4.12.8 Quality of Life

4.12.8.1 Settlement Pattern and Housing Conditions

In general, communities in the study area are relatively large to medium-sized. Going by NPC's definition of a town as a settlement with a population of 20,000 or more, all three are qualify as a town.

All the communities have the characteristics of both linear and nuclear settlements. The linear characteristics derive from the concentration of houses along the main streets and lanes in the settlements. Their nuclear characteristics derive from the clustering of houses. Houses are built in clusters which in some cases may identify family lineages and kindred groups.

Development and limited access to land have generally encouraged this clustering of houses. Spacing between houses is not definite and could range from one or two meters to about six meters.

The houses are quite diverse in their design and construction materials. Some houses have modern designs and they are built with utilities like kitchen, toilet, and bath, in-house. These modern houses are also constructed with stable and permanent materials like cement blocks and roofed with corrugated iron and aluminum sheets. A majority of the houses in the communities are family bungalows and tenement (rooming) houses. Housing attributes in the study area are presented in Table 4.43

Table 4.43: Housing Attributes

Housing Attributes	Mgbede **(%)**	Obrikom **(%)**	Omoku **(%)**
Type of House			
Family bungalow	27.0	4.0	27.0
Tenement house	37.0	52.0	12.0
Storey building	33.0	41.0	60.0
Flats	3.0	3.0	2.0
	100.0	100.0	100.0
Construction Material (Roofing)			
Thatch	0.0	0.0	0.0
Corrugated iron sheets (zinc)	15.0	40.0	46.0
Asbestos	5.0	8.0	9.0
Aluminum	80.0	52.0	45.0
	100.0	100.0	100.0

Housing Attributes	Mgbede **(%)**	Obrikom **(%)**	Omoku **(%)**
Waste Disposal (Refuse)			
Dumping in open space	15.0	20.0	18.0
Dumping in the bush	85.0	80.0	82.0
	100.0	100.0	100.0
Waste Disposal (Sewage)			
Water closet	77.0	85.0	87.0
Pier Toilet	23.0	15.0	13.0
	100.0	100.0	100.0
Sources of Water for Domestic Use			
River/Creek	0.0	0.0	0.0
Rain	5.0	4.0	3.0
Borehole	95.0	86.0	97.0
	100.0	100.0	100.0
Energy Source for Household Cooking			
Firewood	2.0	1.0	6.0
Kerosene	33.0	28.0	35.0
Cooking gas	65	71	59
	100.0	100.0	100.0
Energy Source for Household Lighting			
Kerosene	55.0	50.0	40.0
Public electricity	20.0	25.0	18.0
Private electricity generator	25.0	25.0	42.0
	100.0	100.0	100.0

Source: Resourcefield fieldwork, 2020

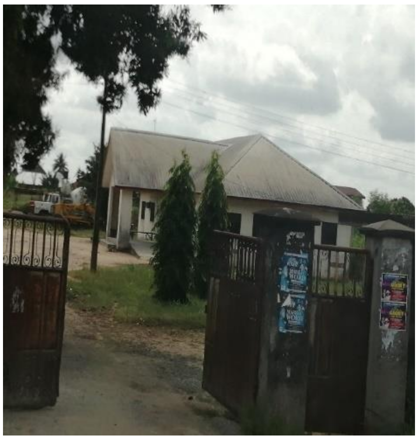



Plate 4.16 (A)- Housing type in Obrikom community (B)- Housing type in Omoku community

4.12.8.2 Livelihood Activities

The physical landscape of Ali-Ogba presents a variety of natural resources: relatively well-drained land and rich soils in many areas, freshwater rivers, creeks and wetlands, secondary forests, and abundant sunshine and rainfall all year round. Underneath the earth's surface are pools of natural gas and oil. As a result of these endowments, the natural environment supports an agricultural economy based on fishing and farming for the production of a wide variety of crops such as cassava, yam, maize, coco-yam, plantain, and banana, including many vegetables such as okra, pepper, and different types of melon. Also, fruit trees such as paw-paw (papaya) oranges, guava, mango, and pineapples are widely grown in gardens around buildings in the communities.

Livelihood activities across the surveyed communities are similar. The identified activities are mainly commerce and provision of services like petty trading, artisanship practices, and employment in the civil/public services. The largest proportion of household members in all the communities are engaged in trading. Artisanship practices inclusive of electrical repairs, boat building, tailoring, etc are significant in the study area.

Civil/public service employees in the communities are limited mostly to Local Government workers, teachers, and health workers. Others are inclusive of a few residents who are employed in oil companies and those involved in contracting.

There are small household-based shops for the sale of groceries, and supermarkets, where durable and non-durable consumer items are sold and bought. Consumer services like barbing and hairdressing salons, motor vehicle and bicycle repairing, laundries, etc, are also present in the area. Many restaurants cater to the needs of the area. Small grocery stores are a ubiquitous feature of the main streets of the area.

The violent outcome of cult activities in the area led to the closure of First and Zenith banks in the area with only UBA and unity banks serving the entire Local Government area. The meet the banking needs of the populace people open Point-of-sale (PoS) centers on major streets in the area. With the presence of PoS, people can make cash deposits, transfers, and withdrawers without having to visit the bank at a fee. The PoS operators charge N300 for withdrawer and deposit of N1,000-10,000, N500 for withdrawer, and deposit of N11,000-20,000.

Plate 4.17: (A)- A fuel Station in Obrikom (B)- Ebocha-Obrikom-Omoku road

4.12.8.3 Employment Situation in Households

Unemployment was experienced in several households in the communities. Results obtained from the discussion and interview sessions indicated that 72% of households across the communities had one or two unemployed members. Unemployment was determined as being ready and looking for work but unable to secure one in the last 6 months preceding this study and only household members who were 15-64 years and not full-time students were considered.

Plate 4.18: A- Fishing activities in Arashi River. B- Sand mining activities in Mgbede Community

4.12.8.4 Household Expenditure Patterns

The major items of expenditure in the households are food, health care, purchase of household items including utilities (kerosene, petrol, etc), transportation, and clothing.

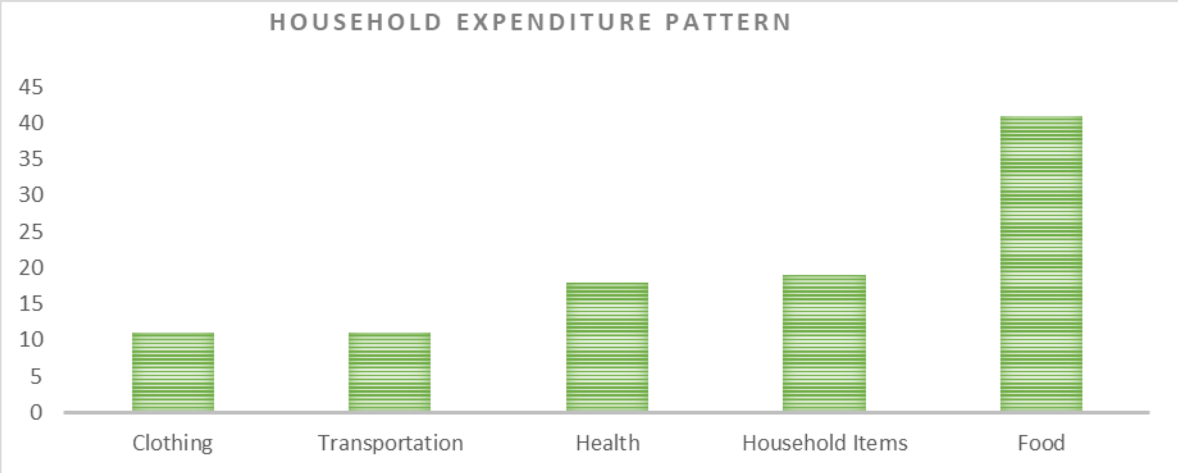


Figure 4.19: Household Expenditure Pattern (Source: Resourcefield fieldwork, 2020)

The major food items are mainly those that are not grown locally, beef, and also beverages. Expenditure on health care by households is quite significant because most households take their sick members to expensive hospitals to access functional orthodox health care facilities. Apart from these household members also spend considerable sums of money on drug purchases from drug stores ('chemists') in their communities.

Households also spend considerably on the purchase of kerosene for their lanterns and cooking stoves, and petrol for their private electricity generators. Expenditure on food and health accounts for 58% of total household expenditure. Community sources across the study area generally affirmed that for most households, expenditure on food, accessing higher education services, obtaining health care, purchase of household items, transportation, and clothing account for between 70% and 80% of their monthly earnings.

4.12.8.5 Health Facilities and Services

The survey area has both conventional and non-orthodox health care providers and facilities. Distribution of these facilities and services including the status of general basic infrastructures across the study area is presented in Table 4. 44.

The General Hospital in the area provides first aid, serves as an HIV/AIDS counseling center and treatment for minor ailments, as well as immunization services for children and women of childbearing age. The antigens they give include BCG, OPV, DPT, Measles, TT, YF, and HBV.

Apart from the orthodox facility, there are drug stores (chemists) located in all 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 the quality of drugs being distributed could not determine during the study.

In all the study communities, there are Traditional Birth Attendants and those who provide herbal remedies. In most cases, these groups do not offer their services on a full-time basis. Those who practice treatment with herbs, in particular, offer advice on herbs and roots within the environment which they believe bring relief to certain ailments.

Table 4.44: State of Infrastructural Facilities in the Study Area

Communities	Infrastructural Facilities							
	Roads	Telecoms	Water	Education	Health	Electricity	Market	Police
Mgbede	Connected to Port Harcourt Metropolis by an asphalt road network	GSM services by all major service providers.	Borehole	1 public primary school; 1 public secondary school.	PHC and multiple private clinics	Connected to PHEDC	Daily market	Police Post
Obrikom	Connected to Port Harcourt Metropolis by an asphalt road network	GSM services by all major service providers.	Borehole	1 public primary school; 2 public secondary school, and River State College of Education.	PHC, multiple private clinics	Connected to PHEDC	Daily market	Police Post
Omoku	Connected to Port Harcourt Metropolis by an asphalt road network	GSM services by all major service providers.	Borehole	2 public primary schools; 1 public secondary school, and River State College of Education.	General Hospital with multiple private clinics	Connected to PHEDC	Daily market	Divisional Police station

Source: Resourcefield fieldwork 2020

4.12.8.6 Utilization of Health Services

The patronage of available orthodox and non-orthodox health care service providers across the three communities is presented in Figure 4.22

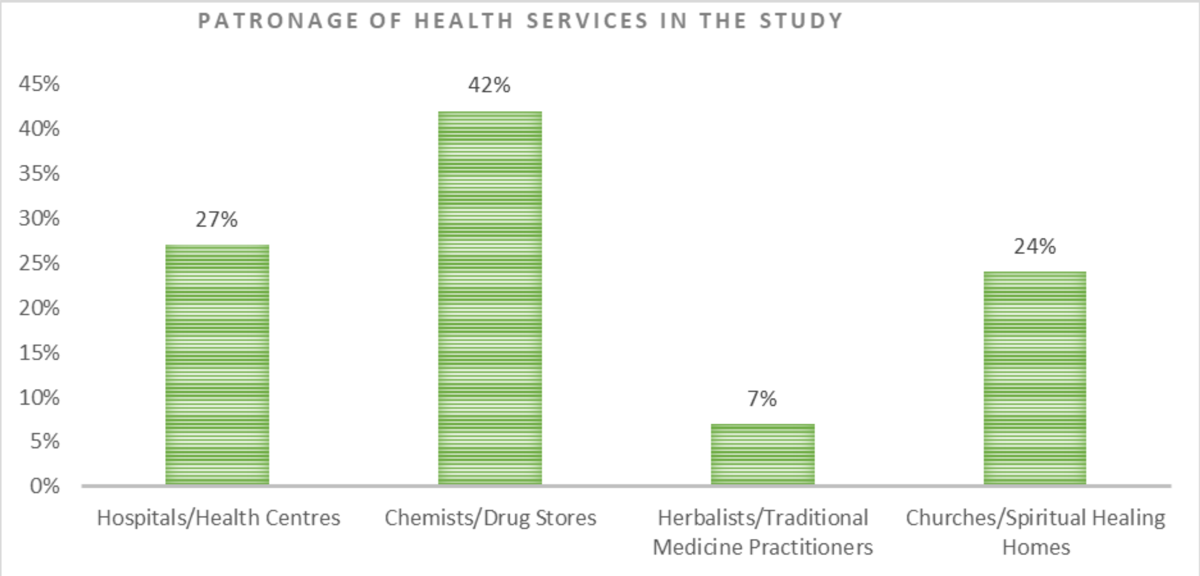


Figure 4.20: Patronage of Health Services in the Study area (Source: Resourcefield Fieldwork)

Traditional Birth Attendants (TBAs) are very popular with women of childbearing age. The staff of the General Hospital in the Omoku noted that even when some of the women attend an antenatal clinic in the orthodox facility, they prefer to give birth with TBAs, and they attribute this to the preference for the traditional body massage given by TBAs after child delivery.

The utilization rate of the General Hospital is relatively low at 30% by respondents. The services of herbalists and spiritual healing homes are not common among the residents of the communities. Given these conditions and the level of patronage of drug stores, it is possible to deduce that many residents indulge in self-medication.

4.12.8.7 Water and Sanitation

The sources of water used in households in the study area include water from rainwater, well and water from public and private boreholes.

In the surveyed area many households avoid the use of rainwater as a result of their belief that rainwater is being polluted by gaseous emissions from flares from oil and gas activities in and around their communities. For this reason, also, the use of rainwater is mostly limited to the washing of clothes and other things and not for cooking.

4.12.8.8 Waste Management Practices

Waste disposal practices in the project-affected communities are quite similar. Refuse is, unfortunately, mostly deposited by the roadside and medians by households, for eventual collection and disposal by Rivers State Waste Management Agency, instead of the waste holding facility provided by RIMAWA. Similarly, two methods of sewage disposal practices are the use of pier system toilets and water closet toilets. About 89% of households in the study communities dump their refuse in open space awaiting the government to evacuate, while 29% use the pit toilets.

The common refuse and sewage disposal practices in communities across the study area are not modern, hygienic, or safe. Considering the terrain of the communities, most of these wastes eventually end up in the water bodies around the area or are carried downstream and deposited in other communities. Although those that are easily biodegradable (including sewage), decompose and also provide nutrients for plants and fishes, they are still sources of pollution and constitute a health hazard. Those that are not easily degradable (especially metals and plastics) are always visible and obvious pollutants and litter around the environment.

Plate 4.19: RIMAWA officials evacuating waste from streets of Omoku

4.12.8.9 Nutrition

The average household in the study area can provide two meals daily for its members. The meals consist predominantly of carbohydrate and protein. Commonly available sources of protein are fish and seafood, especially periwinkles, oysters, prawns, and crayfish. These proteins are always available in the soups with which garri (the staple and most common food) is eaten. Other foods eaten include yam, rice, cocoa yam, sweet potato, and beans.

Although during interviews several residents complained about the nutritional value of the meals, they can provide for their households, medical records from the visited health centers did not collaborate that malnutrition was a common ailment in the communities.

4.12.9 Prevalent Diseases and Disease Vectors

Interviews in households and with health workers in the proposed project communities revealed that the most frequently reported diseases are malaria, diarrhoeal diseases, and respiratory tract infections (RTI).

Disease vectors identified in the area are presented in Table 4.45 The commonest is the mosquito which transmits Plasmodium which causes malaria in humans. Others are house flies and rodents. The environment around the project communities provides the necessary breeding grounds for these disease vectors.

Table 4.45: Common Disease Vectors in the Study Area

Disease Vector(s)	Common Habitat	Parasite(s) Transmitted and Disease(s) Caused
Mosquito (Anopheles and Culex).	Stagnant water	Plasmodium causes malaria.
Housefly and Latrine fly (Musca domestica and Fannia canicularis).	Toilets, refuse heaps, and dumps	Diarrhoeal diseases.
Tsetse fly (Glossina sp).	Toilets, refuse heaps, and dumps	Trypanosoma causes sleeping sickness.
Rats	A variety of places including houses drains, Toilets, refuse heaps, and dumps	A variety of diseases including laser fever, although there was no report of laser fever in the period before and after the study.

Source: Resourcefield fieldwork 2020

4.12.9.1 HIV/AIDS Prevalence and Awareness

Sub-Saharan Africa is one of the hardest-hit regions by the HIV/AIDS pandemic. Presently, it is hosting about 24.5 million people living with the virus. The medico-social consequences of this high HIV/AIDS prevalence in the region cannot be overemphasized. It has contributed to high orphan rates, high numbers of HIV positive infants, high rates of opportunistic infections, high school drop-out rates, societal discrimination, and stigmatization.

Nigeria with over 160million people is the most populous country in Africa and ranked fourth-worst affected by HIV/AIDS in the world based on the total number of cases reported (NACA, 2011). The HIV prevalence in Nigeria indicates a fluctuating trend from 1.8% in 1991 to 5.8% in 2001, before a decline to 5% in 2003 to 4.4% in 2005, 4.6%, and 4.1 as at 2010 end. (NACA, 2011).

There is a low prevalence of HIV/AIDS among the population. According to the national sentinel study on HIV/AIDs (2011), Rivers state where the project is situated has a prevalence of 4.1-6.0%. This figure is not too far from the national average (4.4%) and corresponds to the lower tier of prevalence in Nigeria. It is noted however that a good amount of awareness education and advocacy on the disease and its prevention is ongoing and from interviews, these are beginning to yield the desired results.

The federal and state governments spend billions of naira yearly to create awareness on the grave negative effects of the scourge. This awareness seems to be yielding positive results in the area as over 99% of the respondents claim to know about HIV/AIDS and its means of transmission and prevention. Collaborating this, drug vendors locally referred to as chemists in the area said there is an increase in the number of condoms sold daily. However, the FGD revealed that a quarter of respondents acknowledged that they often had unsafe sex with high-risk partners.

Knowledge, Practices, and Behaviour on Sexually Transmitted Infections (STIs) and General Health

Previously called venereal diseases (VDs), sexually transmitted infections (STIs) or Sexually Transmitted Diseases (STDs) are diseases primarily transmitted by sexual contact. They can be classified according to the causative agents (bacteria, viruses, chlamydia, parasites, fungi). Its incidence is increasing globally with both poor socio-economic and socio-cultural factors playing significant roles besides other factors such as industrialization and urbanization, labour migration, ignorance, and contraception.

4.12.10 Physically and Mentally Challenged Persons

Some surveyed households (1%) in the area have cases of physically/mentally challenged individuals, the majority of whom do not attend schools. No government or non-governmental organization (NGO) assistance has ever been offered to them, and their families/kindred who do not have enough to cater for them.

This group of persons is however not discriminated against since they are familiar faces who reside with their kith and kin who largely understand them. They are however cautioned and restricted when they get out of hand occasionally.

4.12.11 Commercial Sex Trade

Questionnaire analysis, FGD, and informal interaction in the area revealed that commercial sex trade is practiced. Without a doubt, the trade would boom especially during the construction phase of the project given that the workforce is usually predominantly male who work away from home and their women.

4.12.12 Land Ownership and Tenure

Land in all the project communities is primarily owned by families. Ownership rights over lands are handed down from one generation to another within the extended family. Such inherited land is put to any use as desired by the owner(s). These are the lands on which family members build their houses and are allocated for businesses. Land could be bought from owners who were willing to sell. Apart from the family, individuals and organisations also owned some land.

Any intentions to obtain land for corporate or industrial use are initiated through the CDCs and various councils of chiefs which are in the best position to offer proper guidance concerning ownership. This condition is important whether the required land is owned by a family, individuals, and organisations. This approach to obtaining land helps avoid intra/ inter-communal conflicts over ownership of any land that may be required for any project.

4.12.13 Infrastructural Base

4.12.13.1 Classification of Infrastructure

Infrastructure is classified as physical, social, and institutional. Physical forms include; transportation facilities (roads, railways, bridges, ferry services, canals, and foot-paths); storage facilities (silos), warehouses, cribs, open-air facilities, etc); processing facilities (machinery, equipment, building, etc.); irrigation, flood control, and water resources development facilities; and soil conservation facilities.

Social infrastructure comprises housing, leisure and recreational facilities, health facilities (hospitals, dispensaries, maternities, and health centres, etc); educational facilities (primary schools, teacher training colleges, secondary schools, technical schools, vocational schools, adult educational facilities, etc); and utilities (electricity, water supply, sanitation facilities, etc.). The main components of the institutional infrastructure are co-operative societies; farmer's unions/groups, community development projects, financial institutions; agricultural extension, research and training facilities; and post and telecommunications facilities (post offices, postal agencies, telephones, etc.).

It has been reported by the UNDP (2015) that infrastructural and social services in the Niger Delta are generally deplorable and grossly inadequate for an estimated regional population of about 30 million people. The case is not different for many parts of the study area. The Rivers State Government, the project affected Local Government authorities, and some industrial and multinational companies and international agencies have been contributing different quota to the development of the social infrastructures in the study area. The state government, over the last four years, has embarked on a lot of developmental projects bothering on roads/bridges/culverts rehabilitation and/or construction; provision and rehabilitation of educational and health facilities; and provision of electricity and potable water sources.

4.12.13.2 Available Infrastructure and their Functional Status

Public access to the project-affected communities is by **roads** with most of the communities having paved internal link streets and lanes. Additionally, telecommunication services from GSM service providers are received in all parts of the communities.

Education facilities in the LGA consist mainly of public primary, junior and senior secondary schools and an array of private schools. The infrastructures in many of the schools are inadequate. The students' desks and chairs are broken and insufficient, classrooms are also insufficient, and some of their ceilings, windows, doors, and floors are broken. Most of the schools do not have decent utilities like toilets and they also do not have equipped libraries and laboratories. The student to teacher ratio in the public primary schools is high, as much as 50:1. Teachers in secondary schools are not enough to cover all the subject areas, and subjects like Mathematics, Physics, Introductory Technology, Agricultural Science, English Language, and Home Economics are often taught by teachers who did not study these core subjects in the universities.

The cumulative effect of these inadequacies is a lack of interest in schooling among many children in the area despite the free education policy of the state government. Parents who are interested in their children being properly educated and who can afford the cost send their children and wards to private schools in the area. Local sources estimate that 1% to 3% of children of school age are not in school because of truancy or have dropped out.

There is generally a dearth of functional orthodox **health facilities** in the entire study area. The basic problems of government hospitals and PHC are inadequate staffing, broken down and unmaintained equipment, and lack of drugs. The situation is such that households generally do not have confidence in them and would rather 'consult' drug stores or take their members requiring medical attention to a private hospital.

Public water and electrification are very much dysfunctional in the communities. Several water boreholes have been constructed in the communities but most of them are not working largely because the water produced is deemed unfit for consumption by community residents, usually because of colouration. Similarly, **electricity** in the area is generally characterized by a frequent blackout and poor voltage.

In terms of trading opportunities, all the surveyed communities can boast of small, functional but poorly infrastructures a makeshift marketing facility that deals with foodstuff basically from which the people may procure their essential needs.

Plate 4.20: A- PHEDC electricty facility in Obrikom B- Rivers State College of Education Obrikom

4.12.14 Vulnerable Groups

Some groups in the communities have been identified as potentially vulnerable to the likely impacts of the proposed project. Their vulnerability derives from several different factors, including the inability to cope with certain envisaged changes in the society and economy. A key vulnerable group is adolescent youths.

Within this group, it is also possible to differentiate between the adolescent male and the adolescent female. For the male adolescent, there is a tendency to abscond or drop out of school to seek casual employment at the project site. This temptation to drop out of school is re-enforced by the state of educational institutions, particularly the poor staffing which makes schooling uninteresting.

The adolescent male will be faced with a situation of giving in to peer pressure and groups that encourage truancy and school dropout if these groups come into the communities as itinerant workers or camp followers.

The teenage girl on the other hand is faced with managing her sexuality in an environment where there will be considerable exposure to sexual excesses and the continuous advances by older and more experienced working-class males whose income would be an effective instrument to lure the girls. Again, with this group, there will be the likelihood of school dropout and teenage pregnancy. Teenage pregnancy had in some societies led to the stigmatization of the girls. Many of the teenage mothers may not be able to return to complete their schooling or embark on any academic pursuits, even after they would have given birth to their babies.

Another vulnerable group is the elderly. In any economy, the elderly usually requires special attention which includes health care and welfare, but the required facilities for the provision of these social services are not available across the study communities.

Additionally, widows and single mothers will have an uphill task providing for their households in an environment where there are construction workers who earn salaries higher than what generally obtains in the community.

4.12.15 Socio-economic Indices Interrelationships

Socio-economic baseline situations in the communities have significant multispectral links. In Table 4.46, key socio-economic conditions, their sectoral links, and implications, as identified in the study, are summarized.

Table 4.46: Socio-Economic and Health Indices Linkages

Key Environmental Factors.	Associated Sectors and Conditions.	Socio-economic and Health Outcome.	Required Intervention.	Monitoring Indicators.
Poor Infrastructural Framework.	**Water**-lack/limited access to safe potable water. **Education**-lack of facilities and materials. Inadequate staffing. **Health**-lack of access and equipment. Inadequate staffing.	Incidence of diarrheal diseases and other forms of water-borne diseases; Poor diagnoses and inadequate health intervention; Incidence of avoidable deaths. Poor academic performance; lack of interest in schooling; low student enrolment; poor school attendance; increased unemployment and miscreant behaviour. Lack of access to functional facilities for residents.	Provision of safe potable water in all settlements; rehabilitation of existing water facilities. Improved staffing and regular training of education and health staff and provision of equipment (laboratories, libraries, diagnostic equipment) in education and health facilities.	The number of treated boreholes provided in the communities. The number of subject areas for which there are adequately trained teachers in public schools. Increased school enrolment. Functional laboratories. Functional public library. The number of essential medical equipment (eg X-ray and ECG) and Personnel to man them in the hospitals and health centers.

Key Environmental Factors.	Associated Sectors and Conditions.	Socio-economic and Health Outcome.	Required Intervention.	Monitoring Indicators.
Domestic Waste and Sewage Management; and Indoor Air Pollution.	**Housing**-Poor design (no provisions for utilities). Poor construction materials (use of non-durable walling materials).	Pollution of the rivers and physical environment as sewage and waste is discharged into the environment; harm to aquatic life; health problems for humans. Indoor pollution from smoke (stoves and lamps); spread of respiratory problems.	Regulate and enforce the use of water closets or covered pit toilets in houses, by LGA. Regular sanitary inspection by LGA health inspection staff. LGA approval by of only properly designed houses with durable construction materials and with the proper and adequate location of utilities like toilet, bath, and kitchen.	The number of properly designed houses approved and construction monitored by LGA.
Gender Equality	**Public Administration**-traditional practices that limit women's participation in communal decision making.	Limited opportunities for women.	Without requiring a change in the composition of traditional decision-making bodies, certain offices in the CDU can be reserved for women like those of CDU Vice-Chairman or Secretary. This will facilitate their	The number of women playing prominent roles in CBOs, and the number of women in the CDU.

Key Environmental Factors.	Associated Sectors and Conditions.	Socio-economic and Health Outcome.	Required Intervention.	Monitoring Indicators.
			participation in communal decision making.	
Human Capital Development.	**Technical Education**-lack of facilities. **Micro Finance**- Poor access to credit; nonavailability of venture capital. **Employment**-existence of high unemployment rates in the communities.	Inadequate technical manpower and limitations on the economy (very few skilled workers); limited employment opportunities; low investments; stifling of entrepreneurial ability; low living standards.	Introduce, equip, and staff technical education units within existing schools. Enlighten business persons about the importance of financial services in growing their business. Identify and eliminate bottlenecks in the lending process.	Number and utilization of credit for start-up ventures, and to grow existing investments.

Source: Resourcefield 2019

CHAPTER 5

STAKEHOLDERS ENGAGEMENT

5.1 Introduction

Principle 10 of the Declaration of the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (Brazil, 1992) emphasizes that environmental issues are best handled with the participation of all concerned citizens, at the relevant level. Agenda 21 adopted by United Nations Conference on Environment and Development (UNCED) recognized the important role of public participation in environmental impact assessment (EIA) in achieving sustainable development (item 23.2 of Agenda 21).

The World Summit on Sustainable Development in Johannesburg (South Africa, 2002) developed further these provisions. The principles promoted by these conferences are fully integrated into the provisions of the UNECE Convention on Environmental Impact Assessment in a Transboundary Context, which came into force in 1997 (hereinafter referred to as the Convention). When project proponents enable the public to participate in decision-making, they help meet society's goal of sustainable and environmentally sound development.

Public participation in environmental decision-making and, in particular, in EIA, may lead to some benefits in these processes. As a result of public participation, the process of decision-making, up to and including the final decision, becomes more transparent and legitimate. Public debate on proposed activities among all interested groups at an early stage of decision-making may prevent or mitigate conflicts and adverse environmental consequences of the decisions with impacts.

The proponent considers consultation as a major feature of its operations; the thrust of the consultation programme for the Life Camp project is to promote mutually beneficial relationships with all the stakeholders through close contacts and regular consultations and also to notify the stakeholders of the nature, scale, and timing of the proposed project, thereby eliminating any fears or apprehension.

The process was also used to facilitate information gathering between the EIA consulting team/proponent and the other stakeholders. The consultation exercise commenced at the very early stage of the environmental impact process and it is planned to continue throughout the project duration.

The Stakeholders Engagement process has been designed to comply with regulatory requirements set out in Nigerian environmental legislation and, where possible, implement international good practice guidelines, for example, those of the IFC. The process provides stakeholders with an opportunity to evaluate the proposed project and to submit comments for enhancing project benefits while minimizing the project's adverse effects.

The Stakeholder Engagement process aims to achieve the following:

- To ensure that stakeholders are well informed about the proposed project;
- To provide stakeholders with sufficient opportunity to engage and provide input and suggestions on the proposed project;
- To verify that stakeholder comments have been considered and addressed;
- To draw on local knowledge in the process of identifying environmental and social concerns associated with the proposed project, and to involve stakeholders in identifying ways in which these can be addressed;
- To comply with the local legislative requirements; and
- To incorporate international good practice.

5.2 Public Consultation Process

The methodology employed for the public consultation process considered the following aspects:

- The Nigerian legislative requirements;
- International Stakeholder Engagement practice guidelines;
- Local cultural requirements such as language proficiencies;
- Social sensitivities associated with the proposed project; and
- The geographical location of communities.

The consultation team has sought to ensure that all identified stakeholders, including the project impacted communities, are aware of the proposed Project and the EIA process through extensive community consultation. The stakeholder engagement strategy was designed to attain meaningful participation and involvement that enabled stakeholders and the community to actively contribute to the development of new ideas and options as the Project is planned and developed.

The Stakeholder/Public Engagement methodology is summarised and depicted graphically in Figure 5.1; the same approach was used during the Scoping and ESIA phases.

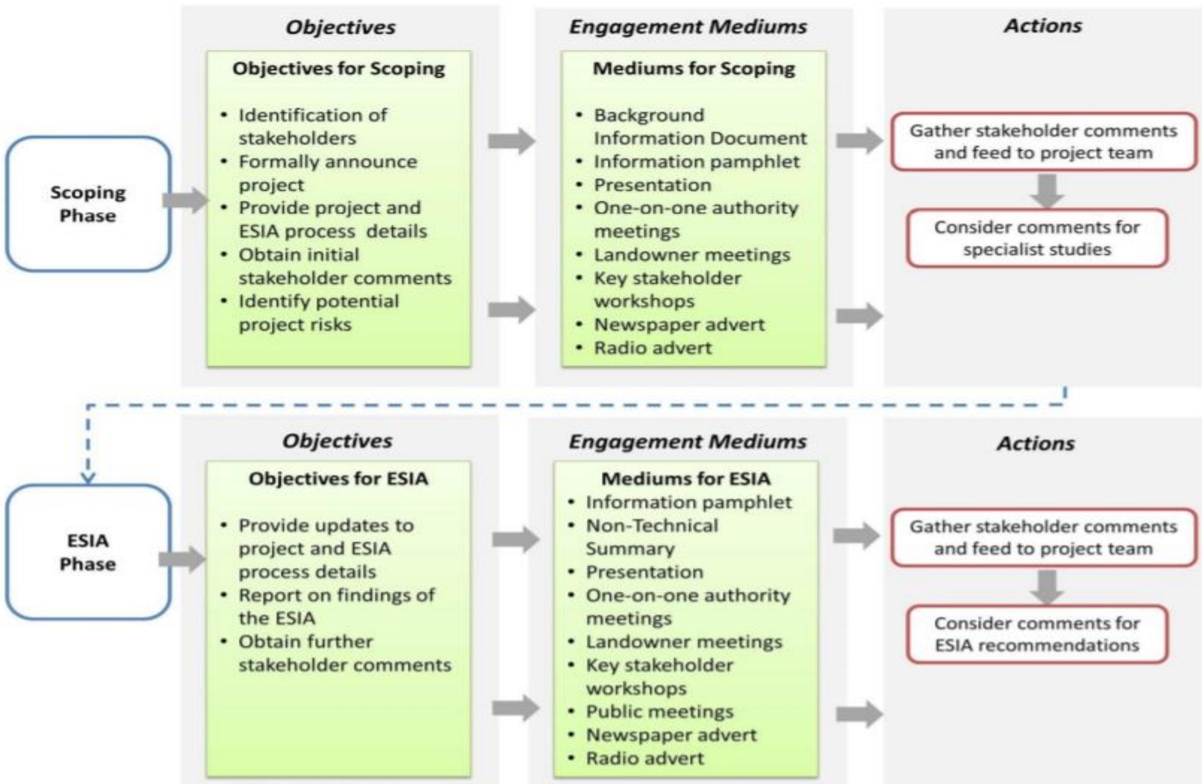


Figure 5.1: Stakeholders engagement methodology

5.3 Levels of Consultation

Two levels of consultations, as are generally recognized in the ESIA process, were held. These are institutional and Project affected communities (PACs) involvement. The subject of this section relied heavily on both, though with emphasis on PACs involvement, ie. getting the public, host communities, all other stakeholders that may be directly or indirectly affected by the project to participate in assessing the project.

The public forum with Project Affected Communities, NGOs, and CBOs, youth groups, Women organizations, religious organizations, and traditional bodies held between 24-29 August 2020 in the project-affected communities with the various village heads and traditional rulers in attendance and also with major institutional stakeholders on 27 August 2020 in Port Harcourt.

In all the consultation meetings, a brief on the project concerning the following was given by the ESIA consultant.

- Purpose of the Public Fora

- Background to the project
- Project description
- Benefit description
- The benefits of the project
- Environmental Management
- Community Affairs and relations.

At the end of the presentation, participants were given ample opportunity to ask questions and/or make comments on the project. They were unanimous in praising the proponent for considering them suitable to host the project and promised to accord the proponent all the needed support.

5.4 Identification of Stakeholders

The proponent's policy makes it mandatory to consult with stakeholders and relevant authorities in all activities. In preparing this ESIA report the consultation process is implanted at three (3) levels: The first level of consultation identifies the social and economic issues in the project area and ensures visible management commitment to addressing them. This level starts with the project conception.

The second level streamlines the issues and makes plans for specific actions. This level recognizes various phases of engagements among project proponent, host communities, village council, women/men's groups, and youth organization. The third level ensures regular communication with stakeholders throughout the project's life; the second and third levels of consultation commence at project inception and continue through the life span of the project.

The key stakeholders identified and consulted for the proposed construction of a Life Camp and Infrastructure at Polo-Cico farms and Estate at Ebocha are:

i. Federal Ministry of Environment
ii. Federal Ministry of Works and Housing (Controller)
iii. State Coordinator, National Environmental Standard Regulation Enforcement Agency (NESREA), Rivers State Office
iv. Nigerian Civil Aviation Authority (NCAA)
v. Nigerian Airspace Management Agency (NAMA)
vi. Transmission Company of Nigeria (TCN)
vii. Port Harcourt Electricity Distribution Company (PHEDC)
viii. GOC, 6 Division, Nigerian Army, Port Harcourt
ix. Sector Commander, Federal Road Safety Corps (FRSC), Rivers State Command

x. Commandant, Nigeria Security and Civil Defense Corps (NSCDC), Rivers State Command
xi. Commissioner of Police, Nigeria Police Force (NP), Rivers State Command
xii. The Director, Directorate of State Service (DSS), Rivers State Command
xiii. Rivers State Ministry of Works
xiv. Rivers State Ministry of Environment
xv. Rivers State Ministry of Lands & Physical Planning
xvi. Rivers State Ministry of Women Affairs
xvii. Rivers State Ministry of Urban Development
xviii. Rivers State Ministry of Employment and Empowerment
xix. Rivers State Ministry of Health
xx. Rivers State Ministry of Transport
xxi. Rivers State Waste Management Agency (RIWAMA)
xxii. The Director, Vehicle Inspection Office, VIO, Port Harcourt
xxiii. The Chairman, Ogba/Ndoni/Egbema Local Government Council
xxiv. Mgbede Community
xxv. Obrikom Community
xxvi. Omoku Community
xxvii. The Chairman of Nigeria Society of Engineers (Rivers State Chapter)
xxviii. The Chairman, Nigeria Union of Road Transport Workers (Port Harcourt branch)
xxix. The Chairman, Road Transport Employers Association (Rivers State Chapter)
xxx. The Association of Environmental Impact Assessment of Nigeria (AEIAN)
xxxi. Institute of Natural Resources and Environmental Studies (INRES), University of Port Harcourt
xxxii. Institute of Natural Resources and Environmental Studies (INRES), University of Port Harcourt
xxxiii. National Inland Waterways Authority (NIWA), HQ, Lokoja
xxxiv. The Commanding Officer, NAF Base, Port Harcourt

In the course of planning, the project proponent has established a close working relationship and a sense of partnership with those key stakeholders and the host communities and shall maintain these throughout the project life.

Table 5.1: List of project stakeholders and Engagement Activities

Stakeholder Group and interest in the project	Stakeholder Name	Stakeholder Level				Engagement Activity	
		International	National	Regional	Local	Meeting	Letter
Government Authorities: National, the regional, and local government of primary political importance to the Project with permitting requirements that must be met by the Project.	Federal Ministry of Environment (FMEnv)		X			X	X
	Ministry of Niger Delta Affairs		X			X	X
	Federal Ministry of Lands and Survey		X			X	X
	Federal Ministry of Works and Housing		X			X	X
	Rivers State Ministry of Environment			X		X	X
	Ogba/Ndoni/Egbema LGA				X	X	X
	Federal Ministry of Environment				X	X	X
	Rivers State Ministry of Rural Development		X			X	X
	Office of the Surveyor-General of the state			X		X	X
	Nigeria Police, Rivers State Command			X		X	X
	NCDSC, Rivers State Command			X		X	X
	Rivers State Ministry of Health, Rivers State			X		X	X
	FRSC, Rivers State Command		X			X	X
	Rivers State Ministry of Works			X		X	X
	Rivers State Office of the Secretary to the State Government			X		X	X
	Rivers State Government		X			X	X

Stakeholder Group and interest in the project	Stakeholder Name	Stakeholder Level				Engagement Activity	
		International	National	Regional	Local	Meeting	Letter
	Department of State Services (DSS)		X			X	X
Local Community(ies) and Neighbouring Land Users	Mgbede				X	X	X
	Omoku				X	X	X
	Ebocha				x	X	X
Non-Government and Community Based Organisations (NGOs and CBOs)	NSE		X			X	X
	AEIAN		X			X	X

Source: Resourcefield 2020

Table 5.2: Schedule of Meetings and Interview

Groups Met	Date	Issues Discussed
Members of Mgbede community leaders	28/08/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
Obrikom Chief	29/08/2020	Traditional governance, belief systems, conflict management procedures, social structures infrastructural network, livelihoods, perceptions, and concerns about the proposed project, community's needs, and development prospects.

Groups Met	Date	Issues Discussed
Youths Omoku community	29/08/2020	Developmental roles of women and the youth, conflict management procedures, infrastructural network, livelihoods, income levels, and expenditure patterns, employment situations in households, perceptions, and concerns about the proposed project, community needs, and expectations, and development prospects.
Rivers State Ministry of Environment	27/08/2020	Regulatory requirements and involvement
Federal Ministry of Environment, Port Harcourt	27/08/2020	Regulatory requirements and involvement

Source: Resourcefield 2020

Plate 5.1: Consultation with Rivers State Authorities and FMEnv Teams in the Office of the FMEnv Controller in Port Harcourt

Table 5.3: Schedule of Meetings and Interview

Stakeholder Group	Stakeholder Name			
		Done	Ongoing	To be consulted
Government Authorities: National, the regional, and local government of primary political importance to the Project with permitting requirements that must be met by the Project.	Federal Ministry of Environment (FMEnv)	X	X	X
	Ministry of Niger Delta Affairs	X		
	Federal Ministry of Lands and Survey	X	X	
	Federal Ministry of Works and Housing	X	X	
	Rivers State Ministry of Environment	X	X	
	Ogba/Egbema/Ndoni LGA	X	X	X
	Rivers State Ministry of Rural Development	X	X	
	Office of the Surveyor-General of the state	X		X
	Nigeria Police, Rivers State Command	X		X
	NCDSC, Rivers State Command	X		X
	Rivers State Ministry of Health, Rivers State	X		X
	FRSC, Rivers State Command	X	X	
	Rivers State Ministry of Works	X		X
	Rivers State Office of the Secretary to the State Government	X		X
	Rivers State Government	X	X	X
	Department of State Services (DSS)	X	X	
Local Community(ies) and Neighbouring Land Users	Mgbede	X		X
	Omoku	X		X
	Obrikom	X		X
Non-Government and Community Based Organisations (NGOs and CBOs)	NSE	X		
	AEIAN	X		

Source: Resourcefield 2020

5.5 Public Disclosure

As part of the formal regulatory and consultation process, when the draft EIA report is submitted to FMEnv, FMEnv will make a public notice of the opportunity for information and comment on the draft EIA report for the project. This notification is typically done through a newspaper and radio announcement.

The notification will provide:

- a brief description of the project;
- a list of venues where the EIA report is on display and available for viewing;
- duration of the display period; and
- contact information for comments.

The FMEnv generally requires a twenty-one (21) working day display period. Display venues will be decided by FMEnv but could be expected to include:

- FMEnv offices in Abuja;
- Rivers State Environmental Protection Agency (or the Rivers State Ministry of Environment) in Port Harcourt; and
- ONELGA Local Government headquarters.

Once the draft EIA report has been submitted to the FMEnv, it will likely be subjected to a review by a panel of experts constituted by FMEnv. The panel would likely comprise experts from within FMEnv as well as external specialists included for their expertise on the specific environmental or social topic. Following the review period, the findings will be presented to the panel, likely to be in the form of a public hearing.

The project will then need to take appropriate actions to address these findings and comments received from the panel members on the EIA report. This may include additional studies; revision to the EIA report text to correct or clarify content; or development of additional mitigation measures or management actions.

Upon satisfactory completion of the actions required to address the findings, the draft EIA report will be finalized and the FMEnv will issue the EIA certification/authorization.

5.6 Outcomes of communities Consultation

The concerns expressed by the host communities are listed below, evidence of consultation with host communities and other stakeholders are also presented in appendix 1 in form of attendance. Some of the photographs taken during socio-economic and community consultation are presented in this section too. At the project consultation/field data gathering meetings with various community stakeholders, community leaders, and members and FGDs several questions, issues and concerns were raised and certain expectations were also discussed by community members across the project impact communities.

Communities' Concerns

- Environmental damage: Most communities fear that the construction activities will destroy the vegetation, cause turbidity in the rivers and affect the water that is used by households for drinking and other purposes.
- Loss of livelihoods: PACs also fear families in the communities will lose their farmlands, fish ponds, grazing area, economic trees, and, therefore, lose their livelihood activities.
- Social problems: Introduction and increase in vices like drug use and prostitution, teenage pregnancy, school dropout, and insecurity during project construction.
- Health problems: Increase in the occurrence of STDs and HIV/AIDs.
- Payment of compensation: All compensation due to families and communities for loss of property should be adequately paid before the commencement of the project.

Community Expectations

Expectations of the communities consist mainly of human capital development and the development of infrastructural facilities. They include the following:

- Creation of employment opportunities for residents of the communities.
- Empowerment of community members through skills acquisition, an award of contracts, and provision of scholarships.
- Infrastructural development in communities in terms of provision of potable water, electricity, functional orthodox health care facilities, renovation, and equipping schools, and erosion control projects.

Plate 5.2: consultation with community leaders in Mgbede. Plate 5.3: Group photograph with the Eze of Obrikom

Table 5.4: Specific Expectations from stakeholders elicted during consultations

Organisation/ Groups	Role In Project	Information got from the meeting
FMEnv, NESREA, RSMEnv, and Ogba/Ndoni/Egbema LGA	Regulators defined in the EIA Act	Adequacy of measures Commitment to support the project or otherwise Suggestions and recommendations
Rivers State Min of Lands Office of Surveyor-General, Rivers State Physical & Regional Planning	Acquisition of Land PAP Entitlements Approval of Building Plans	The land acquisition process for the public project Compensation Rates for Crops & Economic Trees in Rivers State Commitment to support the project or otherwise Suggestions and recommendations
Nigeria Police, DSS, and NSCDC	Security and intelligence	The process to ensure the security of personnel, equipment and materials are secured during project Implementation
Federal Road Safety Corps Rivers State Fire Service Vehicle Inspection Office	Ensure traffic flow during mobilization and construction Ensure adequacy of fire preventing and fighting resources	Required permits Transport management requirements etc Fire management requirements
Ebocha, Mgbede, and Omoku communities	Host Communities (Land, security, etc)	Concerns, fears, and expectations
Rivers State Environmental Protection Agency Rivers State Waste Management Agency	Infrastructure, amenities, and services upgrade and expansion	Adequacy of measures Commitment to support the project or otherwise Suggestions and recommendations

Organisation/ Groups	Role In Project	Information got from the meeting
Rivers State Ministry of Works	To determine the capacity of existing road networks	The design capacity of the road and bridges
NGOs, CBOs (NSE, AEIAN) Academia	Observance and EIA process witnessing	Adequacy of measures Commitment to support the project or otherwise Suggestions and recommendations

Source: Resourcefield 2020

Table 5.5: Initial Consultations findings

Stakeholder Group	Issues	Solutions
Government authorities	Employment and local benefits	The Project should provide employment opportunities for local communities who are willing and ready to work as construction workers. Encourage the communities to work together for long term benefits for all community members.
	Resettlement	There is a need to pay compensation to property owners who will be affected by the proposed Life Camp construction.
	Waste	Develop comprehensive plans for water use and wastewater discharge.
	Scope of the EIA	The EIA should address the potential health impacts of the project on local communities.
Local communities	Employment and local benefits	Opportunities in terms of employment and procurement, particularly for local communities and the appointment of CLOs from the project communities

Stakeholder Group	Issues	Solutions
	Community H&S	The Project will need to plan for the community health risks related to the construction and operation of Life Camp.
	Livelihoods and resettlement	The Project needs to thoroughly understand the livelihoods within the area of influence to understand the impacts of the project on local communities

Source: Resourcefield 2020

Plate 5.3: A cross section of stakeholders during community and institutional stakeholders consultation workshop in port harcourt

5.7 Grievance Mechanisms

5.7.1 Introduction

During the implementation of the project activities, disputes/disagreements between the project developer and the PAPs may occur especially in terms of compensation, boundaries, etc.

There are great challenges associated with grievance redress especially in a project of this magnitude. The practice of grievance arbitration over resettlement issues in Nigeria is conducted within the framework of the Land Use Act (LUA) of 1978, reviewed under Cap 202, 1990. Two stages have been identified in the grievance procedure: customary mediation and judiciary hearings.

A grievance procedure based on community grievance committees, one per community, will be established for resolution of the disputes and complaints.

5.7.2 Customary Mediation

Procedures for grievances will be clearly explained during community meetings. At the village levels, a series of customary avenues exist to deal with dispute resolutions. Those avenues should be employed, when and where it is relevant as a "court of first appeal". Such customary avenues will provide a first culturally and amicable grievance procedure that will facilitate formal and/or informal grievance resolution for grievances such as:

- Wrongly recorded personal or community details;
- Wrongly recorded assets including land details and/or affected acreage;
- Change of recipient due to recent death or disability;
- Recent change of asset ownership;
- Wrong computation of compensation;
- Name missed out of register, etc.

A Customary Grievance Redress Committee shall be set up by the project proponent in each community to address complaints from project implementation. This committee will be assisted by the project proponent.

PAPs' complaints should first be lodged verbally or in writing through this process. It is expected that the committee will deal with the grievances they receive within three days of receipt of the complaint. If the complaint cannot be resolved at this level, or if the plaintiff is not satisfied with the settlement proposed, the plaintiff will then be referred to the official legal procedures.

5.7.3 Court of Law

The judicial process under applicable laws will be followed and the law courts will pass binding judgment on the matter.

Figure 5.2 illustrates this grievance redress mechanism.

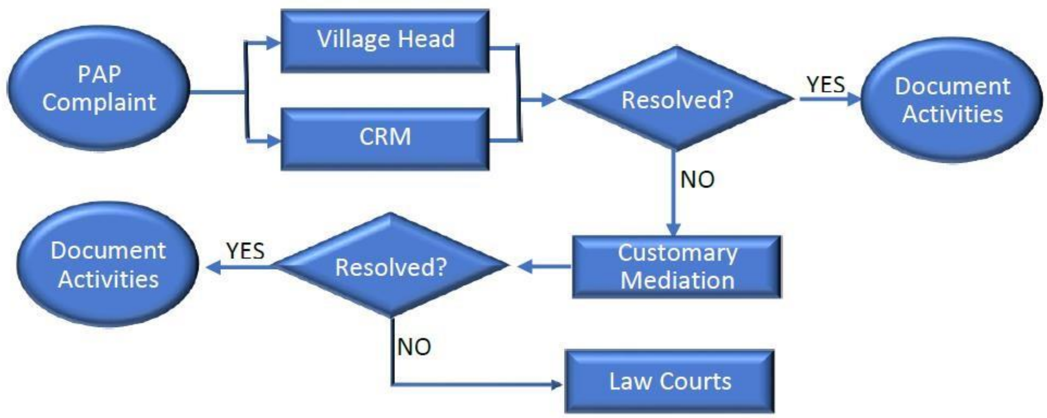


Figure 5.2 Grievance Resolution Procedure

5.7.4 Future Consultations

The proponent shall continue to consult with the regulatory agencies, the host communities, all stakeholders, and other relevant parties concerned with or are likely to be affected by the project at all stages of project development. At the approval of this ESIA to commence the construction activities, a detailed Memorandum of Understanding (MoU) shall be signed with the affected communities.

5.8 Conclusions

The community and stakeholder engagement undertaken by the Project fulfills the requirements of the Terms of Reference and is undertaken according to the strategy prepared by the Project. A variety of communication activities and tools were used to seek broad and informed communities and stakeholders' responses, and the issues and opportunities identified through stakeholders' engagement informed the development of the EIA. Specific communication activities undertaken to facilitate effective two-way communications included the Community Information Session, briefings of key stakeholders including government agencies and NGOs, and community-based groups.

Throughout the project design and data gathering process, multiple avenues were provided for stakeholders to access information and provide comments and/or ask questions and receive answers. The engagement program engaged the community by:

- attracting approximately major community members to the Community Information Session
- providing briefings to government agencies and Community-Based Organisations (CBOs) and NGOs
- generating feedback from community leaders and institutional stakeholders.

CHAPTER 6

IMPACTS AND MITIGATION MEASURES

6.1 Introduction

This Chapter will summarize the predicted positive and negative impacts of the project. Cumulative impacts of the project will be assessed as appropriate. Also, this Chapter will outline general and specific mitigation measures to reduce, remove or avoid negative impacts to environmental and social receptors. Any residual impacts (post mitigation) will be outlined.

6.2 Impact Assessment

6.2.1 Impact Prediction

The impact assessment process predicts and describes, qualitatively and quantitatively, impacts that are expected to occur for different phases of the proposed project.

The significance of each impact is evaluated by defining and evaluating two key aspects:

- The **magnitude** of the impact; and
- The **sensitivity** of the feature or receptor that will be impacted.

Impact Magnitude

Magnitude describes the degree of the change that is predicted to occur in the receptor/resource as a result of the impact. A magnitude rating reflects a combination of the size of an area that may be affected, the size, degree or scale of the impact, and the duration of the impact.

Magnitude of positive socio-economic impacts is usually categorized as **Positive** except there is enough information available to support a more robust qualification and quantification of magnitude as Small, Medium or Large. For instance, if the number and volume of contracts to be reserved for the local community members is confirmed or if the size or value of those contracts will contribute to the national, State or Local economy is known then a magnitude rating of Small, Medium or Large can be assigned. Otherwise, the significance rating will be based on the sensitivity of the feature impacted by a specific activity or change.

Magnitude encompasses all the characteristics of the predicted impact as defined and designated in Table 6.1.

Table 6.1 Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	The relationship of the impact with the Project (describes the cause and effect).	Direct Indirect Induced
Extent	The "spread" of the impact (e.g., a long distance of several kilometres or confined to a small space within the Project footprint, etc.).	Local Regional International
Duration	The time 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.).	a numerical value: no fixed designations
Frequency	A measure of the periodicity or constancy of the given impact.	a numerical value: no fixed designations

Source: Resourcefield, 2020

The evaluation of pre-mitigation impact significance considers control measures that have been built-in into the project design. This avoids the situation where an impact is assigned a magnitude based on a theoretical account of the project that considers none of the built-in controls that are defined as part of the project description.

These built-in controls could include sound lessening measures around noisy equipment or servitude and buffer requirements the development is obliged to implement and is part of the layout. Additional mitigation measures to further reduce the significance of 'residual' impacts are appropriately proposed where necessary.

In the case of **type**, the designations are defined generally (i.e., the same definitions apply to all receptors/resources and associated impacts) as provided in Table 6.2.

Table 6.2 Definitions of Designation

Designation	Definition
Type	
Direct	Impacts that result from a direct connection between the Project and a Receptor / resource (e.g., between land-take and the affected habitats).
Indirect	Impacts that trail the direct connections between the Project and its environment as a result of subsequent contacts within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a portion of land).
Induced	Impacts that result from other activities that occur as a result of the Project (e.g., influx of camp followers resulting from the mobilization of a large Project workforce).
Extent	
Local	Impacts that affect an area close to the development area within the area of influence of a receptor/resource.
Regional	Impacts occurring at a regional (interstate) scale as determined by political boundaries or which affect regionally important resources or ecosystems.
International	Impacts that transcend national boundaries or affect resources or areas protected by international treaties or conventions.
Duration	
Temporary	Impacts are predicted to be of short duration (in the order of days) and/or intermittent /occasional (e.g., traffic congestion during equipment haulage to site).
Short term	Impacts that are predicted to last only for the duration of the construction period (e.g., traffic diversions)- for about 8 years.
Medium term	Impacts that will continue for a period of 5 to 10 years following the commissioning of the project (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 cease when the Project either stops operating or is decommissioned, or where the impact may reverse or the affected resource / receptor recovers after 10 or within 20 years following the commissioning of the project.
Permanent	Impacts that cause a permanent change in the affected receptor / resource that lasts beyond 20 years following the commissioning of the project.

For **scale** and **frequency**, the features are not allotted standing descriptions, as they are typically numerical measurements (e.g., number of hectares affected, number of times per hour, day, week or month, etc.).

The terminology and descriptions are given for uniformity when these features are described in an impact assessment deliverable. However, it is not a requirement that each of these features be discussed for each identified impact.

To derive the magnitude rating of unintended events (e.g., accidental release of hazardous materials), the **likelihood** of the occurrence of an impact is considered and it is expressed as a probability and is designated using a qualitative scale (or semi-quantitative, where appropriate data are available), following the qualities described in Table 6.3.

Table 6.3 Likelihood Designations for unplanned events

Likelihood	Definition
Likely	The event will inevitably occur during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.

Likelihood is projected on the basis of experience and/or evidence that such an outcome has previously occurred under similar condition or situation.

Likelihood is a measure of the degree to which the unplanned event is expected to occur, not the degree to which an impact or effect is expected to occur as a result of the unplanned event, and therefore is qualitative and not quantitative.

For impacts from unplanned events, the same receptor/resource-specific approach to arriving at magnitude description is adopted, but the 'likelihood' factor is considered, alongside the other impact features, when assigning a magnitude description.

It is quite tasking to discuss impacts resulting from Project activities and those resulting from unplanned events. This methodology, based on professional judgment, and assisted by quantitative data, incorporates likelihood into the magnitude description (i.e., in parallel with consideration of the other impact characteristics), so that the likelihood-factored magnitude can then be considered with the receptor/resource sensitivity/susceptibility /importance in order to assign impact significance.

Once the impact characteristics are understood, they are used to allot each impact a magnitude. Magnitude is a function of the following impact features:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the receptor/resource. As in the case of extent and duration, the magnitude descriptions themselves (i.e., negligible, small, medium, large) are universally used and across receptors/resources, but the definitions for these descriptions will vary on a receptor/resource basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

The magnitude of impacts considers all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the range (in the case of adverse impacts) from negligible to large. Some impacts cause inestimable or imperceptible alterations to the environment or remain within the range of normal natural variations. Such changes can be regarded as having no impact, and are be characterized as having a negligible magnitude.

Sensitivity

The other principal step necessary to allot significance for a given impact is to define the importance/ susceptibility/sensitivity of the impacted receptor/resource to the type of proposed activity (e.g., habitat clearance, topsoil removal, etc.) or the consequences of a Project activity (e.g., dust, noise, water pollution, or induced population influx). This requires a range of biophysical, social factors to be considered and may also include other factors such as legal protection, government policy, public perception and economic value.

Classification of sensitivity for a biophysical resource or receptor (e.g., air quality or parameter) considers importance (on a local, national and international scale), its susceptibility to disturbance, and its resilience to recover or withstand a specific impact or type of impact. Where the receptor is social or cultural, the value of that social and cultural heritage receptor/s and its susceptibility to the impact is considered, taking into account the receptor's resilience, including ability to adapt to alteration or employ alternatives where available.

As in the case of magnitude, the sensitivity/susceptibility/importance designations themselves are universally consistent, but the definitions for these designations will vary on a receptor/resource basis. The universal sensitivity/susceptibility/importance designations are:

- Low;
- Medium; and
- High.

Assessing Significance

When the magnitude of impact and sensitivity/susceptibility/importance of receptor/resource has been characterized, the significance of the impact is assigned using the impact significance matrix shown in Table 5.4.

This methodology applies to impacts from unplanned events (e.g., a major oil spill or other event that cannot be reasonably predicted), but likelihood is also considered when assigning the magnitude designation, as classified in Table 6.4.

Table 6.4 Impact Significances

Assessment of Significance		**Sensitivity/Susceptibility/Importance of Receptor/resource**		
		Low	Medium	High
Magnitude of Impact	Negative Impacts			
	Negligible	Negligible	Negligible	Minor
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Critical
	Positive Impacts			
	Positive	Minor	Moderate	High

The matrix applies to all receptors/resources, and all impacts to these receptors/resources, as the receptor/resource or impact-specific considerations are factored into the description of magnitude and sensitivity descriptions that enter into the matrix. Box 5.1 provides a context for what the various impact significance ratings signify.

6.2.1.1 Residual Impacts Assessment

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

6.2.1.2 Cumulative Impacts/Effects

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The impact assessment process will predict cumulative impacts/effects to which the Project may contribute. The approach for assessing cumulative impacts and effects resulting from the Project and another activity affecting the same resource/receptor is based on a consideration of the approval/existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

Box 6.1 Context of Impact Significances

An impact of **negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude shall be well within applicable standards.

An impact of **Moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **Major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

An impact of **Critical** significance after all feasible mitigation measures have been identified and assessed warrants the highest level of attention and concern. As with residual impacts of major significance, the regulators and stakeholders will need to closely evaluate whether the positive impacts of the project outweigh residual negative impacts of critical significance. In many cases residual critical impacts can be considered as a potential fatal flaw of the project.

6.3 Results of impacts Assessment and Profferred Mitigation Measures for the proposed project

The identified and associated potential impacts of the proposed project have been evaluated. Table 6.5, presents the proffered mitigation measures for the significant and adverse impacts with the anticipated residual impact taking into account the effective implementation of the mitigation measures quantified.

Table 6.5: Mitigation measures for significant impacts of the proposed project

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
Pre-Construction Phase						
Land Acquisition	Socio-economic	Restriction on land available for farming and other land use activities	Indirect, adverse, normal, long term and reversible	High	Polo-Cico shall: Limit land acquisition to the minimum required for operational effectiveness and safety.	Low
Site Preparation Vegetation clearing	Flora & Fauna	Vegetation clearing exposes forest areas to increased human activities Loss of habitat for fauna leading to migration or death of species Loss of native species Loss of nesting grounds or homes for avifauna	Direct, abnormal, adverse, long term and residual	Medium	Polo-Cico shall: restrict access to work areas thereby discouraging increased human activities in the area. Create a gene bank to preserve genes of endangered and important native species	Negligible
	Socio-economic	Increased earnings to local labourers from vegetation clearing and site preparation	Impact is beneficial	High	To enhance this beneficial impact Polo-Cico shall: ensure that all contractors engage unskilled labour from the local area only.	Low

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
					encourage contractors to maintain a list of short-term employees for future call-ups when required	
	Socio-economic	Economic loss arising from clearing of farm lands and plantations	Direct, abnormal, adverse, short term, reversible and Residual	High	Polo-Cico shall: duly inform owner of such economic crops to harvest or remove them before commencing vegetation clearing. ensure vegetation clearing is limited to minimum area required for work. ensure adequate compensation is paid to owners of such economic crops	Low
	Geology & Soil	Erosion problems resulting from deforestation	Direct, abnormal, adverse, long term reversible and Residual	High	Polo-Cico shall: construct drainages to control runoffs. ensure vegetation clearing is limited to minimum area required for work	Low
	Noise	Increased noise level from machines used in site clearing and excavations	Direct, reversible, short term	Medium	Polo-Cico shall ensure Use of machines in optimal working conditions Arranging working times during the day to reduce noise levels at night	Negligible
Mobilisation of personnel,	Health and Safety	Increased traffic on local roads and water ways with risk of	Direct, abnormal, short term and reversible	Low	Polo-Cico shall:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
equipment and materials to project site and recruitment of workers		accidents during mobilisation of heavy equipment which may lead to injury/asset damage.			use competent drivers throughout the project. develop and maintain an effective journey management plan. ensure vehicles are periodically maintained and records kept. ensure pre-mobilization checks are carried out on vehicles before departure. Use out riders to warn other road/water way users. give prior notice to the communities on transport ways diversion and warning signs will be conspicuous.	
	Health	Increased rate of STDs and other communicable diseases in the locality.	Abnormal, indirect, Adverse	Medium	Polo-Cico shall: ensure all personnel are medically fit before mobilization to base camp. also subject all workers to periodic medical test. Periodically organize base health and safety awareness training for all its workers	Negligible
	Socio-economic	Socio-cultural conflicts due to difference in customs of migrant workers and residents	Indirect, abnormal, short term and reversible	Medium	Polo-Cico shall: sensitize the general public on the importance of the project so as to establish a	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
		of surrounding localities			co-operative and open working relations especially with residents within the immediate project area. educate workers on the culture and norms of the host communities. encourage mutual existence between the workers and the communities by appointing community liaison officers (CLO)	
	Socio-economic	Conflicts / community agitations over employment issues	Abnormal, indirect, Adverse	Medium	Polo-Cico shall: adopt procurement practices that favour skilled and semiskilled indigenes of the area. Liaise with the community leader to ensure all focus groups are represented in the employed workforce encouraging them to grow through additional trainings/qualifications	
	Noise	Increased noise levels, from machinery movement	Direct, short term, reversible	Medium	Polo-Cico shall: maintain all equipment at optimal working condition. adopt the use of low noise generating equipment in all its operations. enforce the use of ear muffles, where noise level exceeds the recommended FMEnv limit	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
Construction Phase						
Construction of access roads and work plateaus to projected locations, for performing investigative field work	Climate Geology & Soils	Change in climatic conditions leading to deflect of natural geological pattern of the area inducing flooding and compaction of soil due to use of heavy equipment	Direct, abnormal, adverse, short term and reversible	High	Polo-Cico shall: construct drainages to control runoffs. ensure compaction of soil is minimal as existing roads will be used	Low
	Air quality	Increased release of SOx, NOx, CxHx, COx (greenhouse gases) and SPM into the atmosphere from vehicular exhaust and heavy equipment	Direct, normal, adverse, long term and reversible	High	Polo-Cico shall: maintain all vehicles and internal combustion engines at optimal working conditions. ensure equipment/vehicles are periodically maintained and records kept. Carry out pre mobilization checks to ensure all vehicles/equipment designated for the job are at optimal working conditions. ensure an inventory of emissions is developed and maintained	Low
	Noise	Noise nuisance to human and wildlife by heavy machines	Direct, normal, adverse, short term and reversible	Medium	Polo-Cico shall:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
					maintain all equipment at optimal working condition. adopt the use of low noise generating equipment in all its operations. enforce the use of ear muffles, where noise level exceeds the recommended FMEnv limit. Use of noise barriers or noise canceling acoustic devices should be considered as necessary	
	Health and safety	Personnel injury/death from work place incidents/accidents	Direct, abnormal, adverse, long term and irreversible	High	Polo-Cico shall: Manage all associated constructional risks through the use of competent professionals/engineers or isolating the source of risk or use of acceptable administrative measures in the workplace. ensure all personnel wear appropriate personnel protective equipment (PPE). ensure only competent and well-trained personnel are used for the job. ensure safety awareness meetings are held prior to work each day. provide first aid facilities/administrators on work site.	Low

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
					ensure all incidents are reported and documented and corrective actions taken. employ the use of personnel and environmentally friendly construction techniques in its operations	
	Socio-economic	Engagement of indigenous labour and suppliers in different areas of construction activities with attendant economic empowerment	Direct, normal, beneficial, short term and irreversible	High	To enhance this beneficial impact Polo-Cico shall: ensure that local merchants are involved in supply of goods and services. ensure that all contractors engage unskilled labour from the local area only. encourage contractors to maintain a list of short-term employees for future call-ups when required. ensure that contractors do not unduly exploit the local workers through salary cuts and payment delay	Low
Excavation of foundations, construction of access tracks	Health and Safety	Personnel injury/death from work place incidents/accidents	Direct, abnormal, adverse, long term and irreversible	High	Polo-Cico shall: Manage all associated constructional risks through the use of competent professionals/engineers or isolating the source of risk or use of acceptable administrative measures in the workplace.	Low

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
					ensure all personnel wear appropriate personnel protective equipment (PPE). ensure only competent and well-trained personnel are used for the job. ensure safety awareness meetings are held prior to work each day. provide first aid facilities/administrators on work site. ensure all incidents are reported and documented and corrective actions taken. employ the use of personnel and environmentally friendly construction techniques in its operations	
		Respiratory tract infections (to onsite workers) due to inhalation of SPM	Direct, abnormal, adverse, short term and reversible	Medium	Polo-Cico shall: ensure all onsite welders wear appropriate PPE (nose mask, eye goggle etc.). provide first aid facilities on work site and also train personnel on first aid administration. Carryout daily safety briefings before commencement of work each day. ensure the best available welding techniques are used in its operations. ensure all electrical wires are insulated	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
	Fauna	Forced migration of fauna species due to vibrations from heavy machinery	Direct, abnormal, adverse, short term and reversible	Medium	Polo-Cico shall: Operate heavy machinery on bunded grounds to reduce felt vibrations As much as possible avoid thriving habitats	Negligible
	Socio-economic	Provision of social amenities Potable water supply	Impact is beneficial	-	Polo-Cico shall Ensure provision of amenities in close-by communities Ensure all roads in good condition to improve economic conditions of locals (through exchange of goods and services with other communities)	-
	Air Quality	Increased release of green house gases (GHG) and SPM into the atmosphere from vehicular exhaust and heavy equipment	Direct,normal, adverse, long term and reversible	Low	Polo-Cico shall: maintain all equipment at optimal working conditions. ensure all equipment are periodically maintained and records kept. Carry out pre mobilization checks to ensure equipment designated for the job are at optimal working conditions.	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
					enforce policies on efficient use of energy i.e., no equipment will be kept running when operation is down. ensure an inventory of emissions is developed and maintained	
	Health and safety	Respiratory tract infections (to onsite workers) due to inhalation of dusts and fumes from machines	Direct, abnormal, adverse, short term and reversible	Medium	Polo-Cico shall: Enforce the use of nose masks and other PPE by all personnel on site Ensure Concrete batching plants are located at least 300 m downwind or as far as practicable from the nearest dwellings in order to reduce the impact of fumes on humans and to be fitted with necessary ensure Stockpiles of materials such as sand are managed to reduce dust emissions, ensure before material is moved Stockpile covered with tarpaulins and fenced in to form a high barrier and prevent wind lifting and dispersing. Ensure water will be sprayed on construction sites and approach roads to suppress dust in dry weather	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
		Risk of electrocution and burns to onsite workers	Direct, abnormal, adverse, short term and reversible	Medium	Use of signs, barriers, Locks on doors, use of gates.	Negligible
	Socio-economic	Increase in economic activity around construction areas Influx of small-scale marketers to provide food and other essentials to on site workers Improved road infrastructure Employment creation for locals	Impact is beneficial	-	To enhance this beneficial impact Polo-Cico shall: Hold seminars for the petty traders on safe actions while on site Provide jobs for both the local/indigenous men and women during construction	-
		Capacity building, programmes for workers Health and safety awareness campaigns for locals and on-site workers	Beneficial long term	-	Polo-Cico shall: Schedule training programmes for workers Involve the community in awareness campaigns	-
	Air quality	Increased levels of SPM Cox. NOx (GHG)	Direct, normal,	Medium	Polo-Cico shall ensure:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
		from vehicular exhaust and heavy equipment	adverse, long term and reversible		Stockpiles of materials such as sand be managed to reduce dust emissions. before material is moved Stockpile be covered with tarpaulins and fenced in to form a high barrier and prevent wind lifting and dispersing. Water be sprayed on construction sites and access roads to suppress dust in dry weather	
Removal of vegetation for construction activities	Flora and fauna	Increased frequency of people and construction workers, particularly in the context of potential risk of disturbance to birds and other vertebrates, which prevents nesting and usual nourishment and rest of the autochthonous fauna, especially birds and mammals	Direct, Normal, Short term, reversible	Medium	Polo-Cico shall: Ensure construction workers are discouraged from engaging in the exploitation of natural resources such as hunting and collection of forest products such as wood. Consider establishing herbaceous species and shrubs or some low-growing trees that are considered desirable ground cover and valuable wildlife habitat along the right-of-way in the vegetation management and revegetation plan	Negligible
		Potential fires in the area of construction work, which could	Direct, Abnormal, long term,	Medium	Polo-Cico shall ensure:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
		have Irreversible consequences in terms of vegetation and biodiversity of flora	irreversible, Adverse		Planting and managing of fire-resistant species (e.g. hardwoods) within, and adjacent to, rights-of-way; Establishing a network of fuel breaks of less flammable materials or cleared land to slow progress of fires and allow firefighting access	
		Increased traffic frequency and vehicle movement which will result in increased levels of noise, which can cause disturbance, especially of birds and mammals in their usual activities for nourishment and rest. Obstruction of bird nesting and some mammals.	Direct, Normal, long term, irreversible, Adverse	Low	Polo-Cico shall: Prepare traffic management plan for safe access during construction. Use Clear signs to guide and advise road users. Where possible Road control staff should be deployed. In particular children should be warned not play near the access roads when vehicles are passing, especially if it is after dark.	Negligible
Eventual fuel leak and lubricants from construction machinery and vehicles for transport	Geology and Soil	Potential direct and indirect pollution of aquifer rock masses (hydro-geological collectors), through vertical infiltration (leakage) of fuel, oil,	Direct, Normal, short term, irreversible, adverse	Medium	Pico-Cico shall: bund storage rooms of lubricants and fuel. ensure compaction of soil is minimal as existing roads will be used	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
materials and equipment		or cement solution from vehicles and construction machinery				
Operation Phase						
Maintenance and servicing of Project, fuel storage, handling, and refuelling activities	Health and Safety	Workplace incident/accident leading to injury/death	Direct, abnormal, adverse, long term and irreversible	Medium	Pilo-Cico shall: ensure all personnel wear appropriate personnel protective equipment (PPE). ensure only competent and well-trained personnel are used for the job. ensure all incidents are reported and documented and corrective actions taken	Negligible
	Ground Water	Groundwater contamination due to large waste water Disposal	Direct, abnormal, adverse, long term and reversible	Medium	Polo-Cico shall: employ the best available Waste technology in its operations. put in place a dedicated waste management system to account for the waste (i.e. cuttings, chemicals will be evacuated). ensure an inventory of waste is developed and maintained	Negligible
	Geology & Soils Ground Water	Soil and groundwater contamination resulting from spillage	Direct, abnormal, adverse,	medium	Polo-Cico shall:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
			long term and reversible		put in place emergency response personnel and facilities and also make use of existing ones. enforce the use of safe fuel handling procedures. ensure workers undergo environmental awareness training in safe fuel handling and spill containment. enforce the use drip pans especially at transfer points to control spills	
	Health and Safety	Risk of fire / explosion due to improper fuel handling and storage	Direct, abnormal, adverse, short term, irreversible and residual	Medium	Polo-Cico shall: enforce the use of safe fuel storage and handling procedures. provide dedicated fire fighting personnel and equipment within the work area. prohibit fire/explosion escalation factors (cigarette lighters, smoking etc.) in work area.	Negligible
Operation of the Facility	Socio-economic	Provision of social amenities Potable water supply to host community	Impact is beneficial	-	No mitigation needed	-

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
	Health and safety	Risk of electrocution	Direct, abnormal, adverse, long term and irreversible	High	Polo-Cico shall: Ensure The use of trained personnel in handling electrical wires Clearly mark all potential hazardous materials on site Ensure all workers use appropriate PPE Train workers on safety measures to be applied during work hours	Low
	Socio-economic	Direct employment to qualified Nigerians and local inhabitants,	Impact is beneficial	-	This beneficial impact shall be enhanced by: Adopting procurement practices that favour skilled and semiskilled indigenes of the area. encouraging them to grow through additional trainings/qualifications. also employing qualified Nigerians in its work force.	-
	Air Quality	Degradation in air quality due to exhaust emissions (NOx, SOx, CxHx, etc.) by heavy equipment effecting change in climatic conditions	Direct, normal, adverse, short term and reversible	Medium	Polo-Cico shall: maintain all equipment at optimal working conditions. ensure all equipment are periodically maintained and records kept. Carry out pre mobilization checks to ensure equipment designated for the job are at optimal working conditions.	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
					enforce policies on efficient use of energy i.e., no equipment will be kept running when operation is down.	
	Socio-economic	Increased revenue to state and nation through payment of electricity bills	Impact is beneficial	-	This beneficial impact shall be enhanced by: encouraging diversification of national economic base) Prompt payment of all bills and fees to the appropriate government authorities. ensuring that tax deductions from employees get to the appropriate government agencies	-
Influx of workers and businesses	Socio-economic	Increased foreign and local investments in the area and in the country, leading to wealth creation, employment generation, infrastructural development and economic empowerment	Impact is beneficial	-	To enhance this beneficial impact Polo-Cico shall: employ and train resourceful Nigerians and expatriates in its work force. put in place a dedicated waste management system, in order not to impact negatively on the environment. assume it's cooperate responsibilities by assisting the host communities in their developmental drive, such as provision of infrastructures and social amenities where possible.	-
		Stimulation of local economy through	Impact is beneficial	-	This beneficial impact shall be enhanced by:	-

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
		increased earnings by the locals and other Inhabitants			- adopting procurement practices that favour skilled and semiskilled indigenes of the area. - encouraging them to grow through additional trainings/qualifications. - employing other resourceful Nigerians and expatriates who will be based in that locality.	
		Pressure on infrastructures (housing schools health centres etc.) and social amenities (potable water, electricity etc.) in the area	Direct, normal, adverse, short term and reversible	Low	Polo-Cico shall: assist the communities in provision of social amenities (potable water, electricity etc.) where possible. put adequate arrangement in place for housing of its workers. employ most unskilled workers from the host communities thereby eliminating the issue of housing them.	
		Risk of socio-cultural conflicts between the workers and Villagers	Risk of socio-cultural conflicts between the workers and villagers	Medium	Polo-Cico shall: educate the workforce on the culture and norms of the host communities. encourage mutual existence between the workers and the communities by appointing community liaison officers (CLO). sensitize the general public on the importance of the project so as to establish a	

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
					good working relation especially with residents within the immediate project area.	
		Increase rate of STDs and other communicable diseases in the locality	Direct, abnormal, adverse, long term and reversible	Medium	Polo-Cico shall: ensure all personnel are medically fit before mobilization to base camp. also subject all workers to periodic medical test. Periodically organize base health and safety awareness training for all its workers	
	Geology & Soils Ground Water	Change in climatic conditions and soil geology leading to increased risks of tremor, flooding, due to excavation, use of heavy equipment and pressures of heavy vehicles Risk of contamination of soil and groundwater due to solid waste and wastewater generation	Direct, abnormal, adverse, long term, reversible and residual	Medium	Polo-Cico shall: Reduction of use of heavy equipment on sites ensure that process wastewater is treated before discharging to nearby water bodies. ensure that treated waste water is reuse to minimize its discharge volume. put in place a dedicated waste management system to account for generated waste. ensure an inventory of waste is developed and maintained	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
	Socio economic	Provision of employment for locals	Impact is beneficial	-	To further enforce this impact Polo-Cico shall: Meet with community leaders to select suitable persons from their community for the jobs Maintain a good relationship with the communities to reduce cases of insecurity	-
Sewage and solid waste generation	Geology & Soils	Contamination of soil and groundwater from disposal of sewage and solid wastes	Direct, abnormal, adverse, short term and reversible	Medium	Polo-Cico shall: develop and maintain contingency procedures and measures to minimise the consequence of accidental leakages put in place a comprehensive and dedicated ESMP, to carter for all generated waste. ensure workers undergo environmental awareness training in waste handling and management	Negligible
Decommissioning/Abandonment						
Dismantling of transmission lines, site demolition and metals/cables	Socio-economic	Availability of land for alternative uses	Impact is beneficial	-	Polo-Cico shall consult with relevant stakeholders (FMEnv, Host communities etc.) to decide on the best option for landuse after abandonment.	-

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Rating	Mitigation Measures	Residual Impact
from towers dismantling					ensure re-vegetation is effected with local species	
	Flora and fauna	Invasive flora species could colonise former sites on decommissioning following removal of structures, buildings and hardcover.	Direct, abnormal, adverse, short term and reversible	Medium	To mitigate Polo-Cico shall: Introduce previous banked native species gene to decommissioned areas Where soil conditions can't support growth of native species appropriate herbicides shall be used to control and inhibit growth	Negligible
	Aesthetics	Solid wastes, e.g. brick/concrete rubble from demolition activities	Direct, short term and reversible	Low	Polo-Cico shall: Clear all concrete rubble or debris Sell reusable parts to locals at greatly reduced prices	Low
	Air quality/Noise	Local residents could be subject to noise and air impacts during demolition.	Direct, normal, shorter and reversible	Low	Polo-Cico Shall; Ensure decommissioning in the daytime to limit night time noise impact to locals Ensure all machines are well serviced and in optimal working conditions	Low

Source: Resourcefield 2020

CHAPTER 7

ENVIRONMENTAL MANAGEMENT PLAN

7.1 General

Environmental management is a planned, integrated programme aimed at ensuring that unforeseen and unidentified impacts of a proposed project are contained and brought to an acceptable minimum. In conducting its business activities, Ebocha Life Camp and Infrastructure Management places a strong emphasis on maintaining safe and healthy working conditions for its personnel and minimising the effect of its activities on the natural and human environments. These objectives are achieved through the implementation of an HSE policy that integrates environmental management approaches into its developmental and operational schemes, and which typically addresses a number of environmental issues including the following:

i. identification of environmental sensitivities;
ii. identification of potential significant impacts;
iii. adoption of design measures or operational procedures that eliminate or reduce impacts to acceptable levels;
iv. establishing emergency and contingency plans;
v. monitoring the effectiveness of environmental protection strategies; and
vi. auditing the success of the overall strategy.

The EMP has been designed within the framework of various Nigerian and International legislative and regulatory requirements on environmental and socio-economic aspects.

The Ebocha Life Camp and Infrastructure Management is fully aware of its responsibility to maintain clean and green environment in operating the facility. The Management will therefore, endeavour to incorporate appropriate environmental protection norms while working in the Facility.

This EMP consists of plans, procedures and programmes, covering areas such as the handling of hazardous materials and wastes, emission and discharge monitoring, site inspection, auditing and emergency response. It is formulated to ensure that the environmental mitigation requirements outlined in the EIA are central to the management and operation of the proposed project.

The EMP has been comprehensively developed by following international standards for (environmental) management such as the International Standards Organization (ISO 14001). It covers all the phases of the projects from project design to project decommissioning. The various responsibilities and tasks involved in implementing the EMP vary with the project stages and are summarized in Table 7.1.

Table 7.1: Summary of Environmental Management Responsibilities for Stages of the Project

Project Phase	Action
Project design	Review design in compliance with EMP and regulations
Project planning and Scheduling	Setting up of an environmental focal point
Contingency planning	Training, plan development and implementation
Project mobilization	Supervision of the process
Construction phase and Supervision	Supervision including inspection, monitoring, and auditing activities
Construction, demobilization	Supervision of the process
Operations and maintenance phase supervision	Supervision including inspection, monitoring and auditing of activities
Project Decommissioning	Post project monitoring and auditing

Source: Resourcefield 2020

7.2 Objectives of the EMP

The objectives of the EMP are to ensure that the impacts of the project on the environment are kept to the barest minimum or completely mitigated. This can be achieved by:

- Ensuring that all stipulated legislations and regulations on the protection of the environment are complied with;
- Ensuring that environmental concerns are fully integrated into project planning;
- Promoting adherence to the provisions of the HSE Policy of Ebocha Life Camp and Infrastructure Management;
- Promoting awareness of the importance of Environmental Management Planning among workers and other stakeholders;
- Encouraging adherence to the principles of good housekeeping and the use of best available technologies;
- Ensuring that the Project is successfully and safely implemented with minimal harm to both the environment and the health of workers and host communities.

In order to make the implementation of the proposed EMP worthwhile, a two-pronged environmental management framework has been developed for adoption. The framework consists of:

a. an Environmental Management System (EMS); and
b. an Environmental Monitoring Programme

7.2.1 Environmental Management Sysytem (EMS)

Environmental Management System (EMS) is that part of the overall management system which includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the Environmental Policy. This implies that for an EMS to be put in place in an organization, the organization shall have an environmental policy.

The relevance of an EMS is that it assists an organization in achieving excellence in sustainable environmental development. Ebocha Life Camp and Infrastructure Management shall develop and incorporate an EMS component into its operational procedures for the implementation of the proposed project.

7.2.2 Environmental Monitoring Plan

Environmental Monitoring Plan is the systematic schedule for collection of environmental data through a series of repetitive measurements. UNEP (1996) describes three known types of environmental monitoring within the conceptual EIA framework as follows:

- ***Baseline Monitoring*** – refers to the measurements of environmental parameters during the pre-project period

- ***Effects Monitoring*** – involves the measurements of environmental parameters during project construction and implementation so as to detect changes in these parameters which can be attributed to the project; and

- ***Compliance Monitoring*** – is the periodic or continuous measurement of environmental parameters of discharges to ensure that regulatory requirements and standards are met. Compliance monitoring can either be Mitigation Measures Monitoring which relates to the prescribed mitigation measures put in place by the pre-project EIA to the existing operational structure of the project, or Regulatory Compliance Monitoring, which compares the regulatory monitoring requirements to the existing operational, occupational and environmental parameters.

Ebocha Life Camp and Infrastructure Management shall adopt a systematic monitoring schedule that will comprise both effects and compliance monitoring plans for the implementation of the proposed project. environmental baseline data are already embodied in the Chapter 4 of this Report.

7.3 Site Design and Management

7.3.1 Construction Site Layout Plan

Once the design and positioning of the project has been finalised, Ebocha Life Camp and Infrastructure Management will provide detailed construction lay out areas that will accommodate the contractors, provide electricity take-off points, water supply system and sewage discharge system, treatment plants, road network and drainage network system.

Once this process is complete, the individual contractors will design their local layout and distribution of electrical network, water supply and sewage discharge within these allocated areas as proposed by Ebocha Life Camp and Infrastructure Management.

Layout and separation distances shall be done with care to prevent injuries and damage due to accidental fires. The following codes shall be used as the minimum specification in terms of plant layout, safety distances, secondary containment and related issues:

- SANS 10089 Part 1 (formally SABS 089-1) is specific to the storage of large volumes of petroleum products.
- SANS 10087 Part 3 (formally SABS 087-3) is specific to the storage of LPG products.

These codes shall be used as the minimum specification in terms of plant layout, safety distances, secondary containment and related issues.

The construction area shall be clearly demarcated on the site plan, and all other areas shall be considered no-go areas for the construction personnel. No construction shall take place within the 1:100-yard flood line or within 100 metres of a watercourse, whichever are the furthest as well as other areas identified as sensitive.

Only designated areas may be used for the storage of construction material such as topsoil, machinery, equipment and establishment of site offices. Throughout the period of construction, the Contractor will restrict all activities to within the approved areas on the construction layout plan. Management plans and control measures on site accessibility and clearing are listed in Tables 7.2 and 7.3.

Table 7.2: Controls and Management Plan on Site Accessibility

Element	Management Plan
Controls	Access in and out of the site shall be allowed only at one point to minimize impacts during construction.

Element	Management Plan
	- All areas of construction activities will be fenced by the Contractor prior to construction, unless authorization to the contrary is given by the Project Manager. Fencing will be done at individual areas of construction and around the full perimeter of the site. - Construction activities shall be limited to areas which are deemed to be safe, and deemed as the minimum area needed for the construction activities. All sites that are identified by the Project Manager as being unsafe or no-go areas will be indicated as such with warning signs in all relevant languages. - Livestock/domestic animals will not be permitted access to construction sites. - Site Access roads are to be designed, constructed and maintained by the contractor. The areas where these roads are constructed are to be reinstated after construction. - Temporary access roads will follow existing tracks as far as practically possible. - Permanent access roads will also follow existing tracks as far as practically possible and are to be constructed and maintained by Ebocha Life Camp and Infrastructure Management during construction and operation. - Adequate drainage shall be in place and where possible all the impacts

Table 7.3: Site Clearing

Element	Management Plan
Controls	- The maximum permissible time lapse between site clearing and initiation of Life Camp operation shall be reduced to the barest minimum necessary to permit safe operations. - Trees felled from site shall be re-utilized for the benefit of the host communities or as otherwise requested by Ebocha

Element	Management Plan
	Life Camp and Infrastructure Management in consultation with the host communities. • Areas cleared in excess of operational requirements shall be reinstated with indigenous topsoil and vegetation as soon as possible to assist in the checking of erosion. • During the operation of the project, acquired land not used for the project shall remain as unused land. As an additional measure to mitigate reduction in biodiversity, approved clearing of land for construction activities shall commence from the road into the bushes. • The size of areas subjected to clearing shall be progressive as the construction activities continues. • Only areas as instructed by the Project Manager shall be cleared and grubbed. • Cleared vegetation debris which has not been utilized or collected by local communities will be collected and disposed of to a suitable waste disposal site. It will not be burnt on site. • No vegetation will be cut or collected off construction sites for burning or for any other purpose without the prior permission of the Project Manager. • All vegetation not required to be removed will be protected against damage.

Source: Resourcefield 2020

7.4 Project Requirements

7.4.1 Project Proponent and Regulatory Agencies Requirements

As clearly indicated in some sections of the Report, the proposed project will no doubt have both positive and negative impacts on the biophysical, social environment and health conditions within and around the project area.

The onus of implementing the project EMP in the best environmentally friendly manner lies on Ebocha Life Camp and Infrastructure Management and the various institutions/agencies that shall be involved in the project development. The essence of this exercise is to apportion roles and responsibilities to all the various parties involved in the implementation of the project. The following roles shall be undertaken by Ebocha Life Camp and Infrastructure Management for the purpose of the project.

7.4.1.1 Staffing and Training

Ebocha Life Camp and Infrastructure Management shall ensure that every category of its operational staff is adequately trained on the various aspects of the job. Ebocha Life Camp and Infrastructure Management shall also reinforce staff training with regular induction courses and refresher courses/programmes.

Ebocha Life Camp and Infrastructure Management shall also ensure that personnel of its Health, Safety and Environment Department, saddled with the responsibility of coordinating periodic safety activities/ are effectively trained in handling safety equipment, firefighting and other contingencies.

7.4.1.2 Emergency Contingency Plan

Ebocha Life Camp and Infrastructure Management shall develop a sound emergency contingency plan for the entire project's lifespan. The contingency plan shall cover actual and potential incidents/accidents that might occur in the course of the operations. The development of the contingency plan will assist Ebocha Life Camp and Infrastructure Management in having a framework to handle emergency cases and the procedures on follow-ups.

7.4.1.3 Facilities Surveillance

This is a salient system maintenance requirement for the environmental sustainability of the proposed project. Ebocha Life Camp and Infrastructure Management shall carry out constant equipment and facilities surveillance to detect on time, the malfunctioning or deterioration of equipment/facilities. This surveillance shall aim at taking prompt corrective/repair measures on detected faults.

7.4.1.4 Project Planning and Implementation Strategy

Ebocha Life Camp and Infrastructure Management shall evolve various implementation strategies during the construction and operation of the project in such a way as to avoid injury to its employees, while preserving their health and safety as well as those of its contractors and other stakeholders. It shall also minimize to the barest minimum, the environmental impacts that are likely to result from the project facility operations. This will be achieved by:

- the integration of environmental management issues into the proposed project plan;
- the development of a waste management plan for the proposed project;
- the review of environmental issues during project review meetings; and
- the promotion of environmental management awareness among personnel.

7.5 Project Operations

Ebocha Life Camp and Infrastructure Management shall implement all inputs contributed by the regulatory agencies into the proposed project operations and shall also ensure that these agencies are carried along as the project advances. By statutory regulation, the Federal Ministry of Environment (FMEnv) and River State Ministry of Environment (RMEnv) are expected to play active roles in the implementation and approval of the proposed project design. Among the requirements that the regulators shall consider during the design phase of the project include:

- international standards and codes for the project design,
- technology which shall be simple but competent to ensure efficiency in project safety components,
- technology which shall be environmentally friendly and support a healthier environment, and
- adequacy of safety facilities to cover all units of operation.

The role of the regulators shall also be, among other things, to ensure that the highest level of safety and environmental awareness is brought to bear on project implementation and that mitigation measures recommended are appropriately implemented throughout the entire lifespan of the project operations.

The Contractor will be responsible for negotiating the site camp(s) and conditions under which the site may be established with the relevant landowner(s) (if required) before the main contracts are in place. This includes contracts for the accessibility and other associated infrastructure. Prior to the establishment of the site camp(s), the Contractor will produce a layout plan showing the positions of all buildings, parking lots, fuel and petroleum storage facilities and other infrastructure for the approval of the Project Manager. If possible, it is considered preferable to locate the site camp as close as possible to the construction site.

A signboard shall be placed at the construction site, informing the public of the construction activities taking place.

Construction staff shall be adequately educated by the Environmental Control Officer or the Project Manager as to the provisions included in the EMP and general environmentally friendly practice.

The conduct of on-site workers shall be specified to the Contractor by Ebocha Life Camp and Infrastructure Management. Specifications are to include sanitation, water and waste (litter), as well as informal trading and interfering in local community/cultural affairs. The following activities shall be prohibited at site camp(s), and by the construction staff in general:

- The irresponsible use of welding equipment, oxy-acetylene torches and other naked flames which could result in wild fires or constitute a hazard.
- Indiscriminate disposal of rubbish or rubble.

- Littering of the site.
- Spillage of potential pollutants, such as petroleum products.
- Collection of firewood.
- Lighting of fires for cooking, heating or other purposes outside designated areas, and failure to exterminate any fire.
- Burning of any type of waste material.
- Interference with any wildlife, fauna or flora.
- Poaching of any description.
- Resource harvesting.
- Use of any ablution facility other than those provided.
- Burning of wastes and cleared vegetation under any circumstances.
- The use of rivers, streams, dams or any watercourses/surface water for washing or recreational purposes.
- Entering areas outside of the demarcated construction area without relevant permissions.
- The presence of construction staff at the construction site outside the designated construction times (6:00hours to 18:00hours), i.e. no construction staff are allowed to work overnight on site, outside of the demarcated construction camp. The camp management strategy put in place by Ebocha Life Camp and Infrastructure Management is in table 7.4.

Table 7.4: Camp Construction and Sanitation Management

Element	Management Plan
Controls	✚ The Contractor shall take responsibility for the camp to conform to all contractual aspects and environmental standards applicable. This includes aspects related to storm water and waste management. ✚ The Contractor shall provide adequate refuse bins that shall be emptied/cleaned and the waste removed from site on a regular basis. ✚ The construction camp shall be kept neat and tidy at all times. ✚ Water sources/taps available for drinking water etc. shall be pointed out by the HSE Officer. The contractor may only abstract from Surface water Sources for which General Authorizations are in place. Daily water abstraction volumes shall be recorded on a tally sheet and provided to the HSE Officer on a weekly basis. ✚ Food preparation shall only be done in areas designated by the HSE Officer.
Controls	✚ A minimum of one chemical toilet wash shall be provided per 15 persons per shift. ✚ Toilets shall be strategically placed (easily accessible to workers) and will not be situated within 150m of any borehole, surface water source or drainage line.
	✚ They shall be secure, clean and functional throughout the construction

Element	Management Plan
	period. - All ablution activities shall take place in these facilities, and the waste material shall be stored and disposed of at the registered waste disposal site or collected by a suitable waste contractor on a regular basis. - The Contractor shall ensure that toilets are cleaned or emptied regularly and that no spillage occurs during routine maintenance. - The exact location of the toilets shall be approved by the HSE Officer prior to establishment. - A temporary/portable toilet shall be secured to the ground to prevent them from toppling due to wind or any other cause. - The Contractor will ensure that the entrances to toilets are adequately screened from public view. - Discharge of waste from toilets into the environment and burying of waste is strictly prohibited. - Suitable toilets will be provided for the staff at all points at which workmen are carrying out duties under the contract.
Monitoring	- The Contractor will monitor and ensure that toilet facilities are used by personnel and that use of non-designated areas is actively

Source: Resourcefield 2020

7.6 Land Management

Land degradation is one of the major adverse impacts of the project activities in the form of excavation, spillage and also in waste dumps. Land remediation measures shall, therefore, be implemented simultaneously with the project development.

7.6.1 Land Remediation

One of the requirements of the Regulators is to ensure simultaneous remediation of land in all the phases of the project development.

Any effort to control adverse impacts on land would be incomplete without an appropriate land remediation strategy. The first step in a successful remediation programme is to decide the post remediation land use. In this case, it is considered appropriate to cover the land with dense vegetation, keeping in view the following:

- Area is rich in vegetation and further tree planting would match with the existing environment;
- Trees absorb CO_2, contribute oxygen that purifies the air, conserve the soil and prevent erosion. Trees promote precipitation and add to stabilization of slopes;

Keeping the above in view, the land remediation shall be carried out with an emphasis on tree planting. At any point in time the area under disturbance shall be kept at minimum.

The degraded land including the area disturbed due to excavation, dumping, construction of haul roads, ramps, structures etc shall be fully cleaned up before finally abandoning the project site. The remediation process shall take:

- One year for cleanup processes and top soil spreading;
- Another four years for landscaping and stabilization of trees planted.

Thus the area shall be fully cleaned up within five years of completion of operations.

During post operation period, in the project area, all the disturbed areas will be Cleaned up before decommissioning/abandoning the project, excluding the buildings meant for garages, office, etc; which will be left as such to be later used as social infrastructures (school, health centre, etc) by the population in the vicinity.

7.7 Soil Conservation Measures

To prevent soil erosion and wash-off of dump-fines from freshly excavated benches and dumps, the following measures shall be adopted:

- Garland drains shall be provided around the project wherever required to arrest any soil from the project area being carried away by the rain water;

- Special local stone paved chutes and channels will be provided, wherever required, to allow controlled descent of water, especially from the top of the slope along to the foothills;

- Bench levels will be provided with water gradient against the general pit slope, to decrease the speed of storm water and prevent its uncontrolled descent.

- Gully formations, if any, on sides of the benches shall be provided with check dams of local stone or sand filled bags. The inactive slopes will be planted with bushes, grass, shrubs and trees after applying top soil to prevent soil erosion;

- Loose material slopes will be covered by trees by making contour trenches at 2m interval to check soil erosion both due to wind and rain;

- Retaining walls (concrete or local stone) will be provided, around the stockpile or wherever required, to support the benches or any loose material as well as to arrest sliding of loose debris.

7.8 Air Quality Management Plan

Air pollutants generated during project operations mainly include particulate matters due to excavation, loading, unloading and transportation in form of dust, smoke, organic gases, oxides of carbon, sulphur, nitrogen, fumes of petroleum products etc which adversely have effects on the human health conditions, depending upon the concentration, particle size and duration of the above pollutants.

The result of the air quality survey and parameters tested proves that the SPM concentration is within the permissible limit but with increasing project activities the SPM concentration may become high close to the source and at about 0.5 km. Beyond this the concentration will be well within the permissible limit.

7.8.1 Prevention and Control of Air Pollution

7.8.1.1 Air Quality and Noise Levels

The air quality of the area under study is predicted to be in good condition and therefore, it is necessary to retain it or at least reduce the rate of its deterioration. In this regard, the following air quality parameters shall be monitored:

- Total suspended particulates (TSP)
- Atmospheric deposition
- Noxious gases - SO_X, NO_x, CO, 03

Monitoring shall be carried out at least biannually and/or as specified by the regulators. The level of noise in the Project area and vicinity of the generating plant, factories and loading point during operation, and other installations shall be monitored monthly and/or as required by the regulators.

- **Noise Level**
  It is necessary to monitor the level of noise that workers are exposed to at the project area, especially during construction of the project, generating plant, all the neighbouring communities and staff residential estate. Noise monitoring shall be done quarterly.

7.8.1.2 Noise Abatement and Control

❖ Generation of noise due to Heavy Earth Moving Machines (HEMM) is confined to construction phase. The noise will be reduced by regular and proper maintenance of noise generating machinery including the transport vehicles, to maintain the noise levels.

- Innovative approaches of using improved plant and machinery designs, with in-built mechanism to reduce sound emissions like improved silencers, mufflers and closed noise generating parts.
- To keep noise generation in control, latest sophisticated technology and equipment have to be considered. The equipment systems will include cabins to ensure that the operators and other work persons, in and around the operating equipment, have comfortable work stations.
- In order to reduce effect of noise, earmuffs will be provided to operators and other employees working in higher noise zone as a safety measure.
- The noise pressure level and vibrations generated by Industrial Park construction activities will be of very short duration, generally less than 0.5 second. It shall not, therefore cause any adverse problem to the inhabitants in the surrounding area.
- Periodical monitoring of noise level of the project during construction period will be carried out with the help of noise level meter.

7.9 Water Management Plan

7.9.1 Water Quality

Presently, results of laboratory analysis on water quality in the study area are within acceptable limits, certain project operations eg. operational wastes (spent oil / grease, solid waste, domestic liquid wastes and sewage) could contribute to its degradation.

To this effect, certain water parameters that shall be monitored in order to keep record of any water quality changes, include:

- pH
- Conductivity
- Total Dissolved Solids (TDS)
- Dissolved Oxygen (DO)
- Biological Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Turbidity
- Total Hydrocarbon Content
- Phytoplankton and zooplankton
- Microbiology (bacteria and fungi)

These parameters shall be monitored as specified by the regulatory authorities.

7.9.1.2 Effluent Discharge

The liquid effluents can contaminate surface and ground water bodies, soil and biological environment, if proper care is not taken. During operational activities, groundwater pollution may occur from storage and handling of chemicals, fuels and materials used for production.

Potential sources of groundwater pollution include stockpiles of materials at factories and tanks for storage of chemicals. The following measures will be taken to minimize adverse impacts of effluents.

- Since the project is on a river bank, fast percolation of water is expected. Therefore, liquid waste shall be contained in storage tanks.
- The run-off water will be directed through pre designed courses to the lower course of Orashi River. A few pits will be dug at these courses to arrest silt, so that clean water flows in the Orashi River. The pits will be cleaned at regular intervals, particularly before start of the rainy season. (Table 7.5)
- Periodical water quality survey will be carried out.

Table 7.5:Groundwater Quality Associated with Waste Management

Element	**Management Plan**
Groundwater Quality Associated with Waste Water Treatment	
Controls	✚ Exclude soakaways and wastewater irrigation as methods of disposal. ✚ Install wastewater works as treatment method, ensure correct sized, designed and constructed facility. ✚ Design ponds (if any) in such a manner to ensure sufficient capacity prevent overflow / spillage. ✚ Install monitoring boreholes to monitor groundwater quality.
Groundwater Quality Associated with Seepage from Waste Disposal	
Controls	✚ Prevent ponding of poor quality water. ✚ Install a drainage system below the disposal facility. ✚ Line waste disposal facility to prevent leachate from entering the groundwater. ✚ Dispose of solid Waste at an alternative licensed disposal facility. ✚ Install groundwater monitoring boreholes to monitor groundwater quality down-gradient of disposal facility. ✚ Prevent further groundwater use until after remediation period.

Source: Resourcefield 2020

7.10 Environmental Monitoring Requirements

Environmental monitoring is essentially a process aimed at detecting negative impacts of a project on the environment early enough to take remedial actions.

Monitoring Objectives

In order to measure and quantify the impacts of the project development on the receiving environment, the following monitoring objectives have been established:

- Monitor alterations in existing physical, chemical, biological and social characteristics of the environment.
- Determine whether any detected changes in environmental components are caused by the project or natural occurrences.
- Determine the effectiveness of the ameliorating measures that have been put in place;
- Highlight areas of concern unforeseen in the EMP and provide a basis for recommending further amelioration measures.

Monitoring Impact Indicators

Impact indicators are defined in terms of carrying capacity, threshold levels and regulations/enforcement standards. In identifying impact indicators, priority is given to environmentally sensitive areas (discharging and loading points), and in this regard, it is noteworthy that the entire project area falls under this category. Based on the results of baseline studies and consideration of FMEnv limits, the following impact indicators (Table 7.6) are identified with the corresponding environmental components.

Table 7.6: Monitoring Impact Indicators

Environmental Components	Impact Indicators
Air Quality	• Particulates (TSP, $PM_{2.5}$, PM_{10}), volume • discharged, SO, NO, CO, 0_3, heavy and trace metals.
Soil	• Texture, pH, Total Organic Carbon, Nutrients, Heavy metals, oil & grease
Quality of effluent from site & receiving water	• DO, COD, BOD, pH, Nutrients, Turbidity, TDS, TSS, Heavy metals, Hardness, oil & grease
Aquatic ecology	• Diversity, Abundance, Benthic Fauna
Socio-Economics	• Social and Health status
Health Status	• Pulmonary symptoms, cough, sputum, breathlessness, chest pain, blood pressure, pulse rate, urine & blood analysis.

Source: Resourcefield 2020

Monitoring Programme

The monitoring programme that has been designed will meet the data needs of Ebocha Life Camp and Infrastructure Management for self-enforcement of corporate policy and compliance with national and international regulatory standards. The programme is based on the status of the existing environment and the assessed incremental impact of the additional facilities on areas designated as environmentally sensitive. The proposed monitoring parameters and programme is shown in Table 7.6.

Scope of Monitoring

The monitoring programme will be developed to verify the emissions and discharges based on existing national and international regulations on environmental pollution and on the findings in each monitoring campaign. The Environmental Guidelines and Standards for the Industry in Nigeria (FMEnv, 1991) defines a required monitoring programme. The quality of the environment in the project area can be verified by focusing on measuring specific indicators of environmental quality parameters that are representative for the overall environmental quality and at the same time relatively easy to measure.

Monitoring Methodology

The procedure employed for assessing the impacts of the project on the environment include:

- identifying the source and characteristics of all wastes generated;
- quantifying emissions and discharges to the environment; and
- quantifying and qualifying land-take and its direct effect on terrestrial ecology.

This environmental assessment will continue to evolve along with the project, and in the process of impact mitigation. Monitoring and audit will continue throughout the life of these projects. Monitoring may involve measuring specific indicators of environmental quality parameters and comparing with baseline levels.

The frequency of this depends on the results of the monitoring and inspections. If the results of the monitoring measurements give rise to concern about the environmental quality of water and sediment, for example, more detailed surveys will be performed which may include the sampling and analysis of organisms living within the habitats of the project area.

7.10.1 Measures for Minimizing Impact on Flora

However, all possible steps will be taken to prevent pollution of air, water and soil environment due to project activities in the area. Planting of trees will be carried out to develop green belt at and around the project site to arrest dust at source. Under green belt development programme, those botanical species, which are locally suitable, will be planted. This green belt adds to the faunal environment of the area too as better environment is created for them.

7.10.2 Measures for Minimizing Impact on Fauna

Although the project site comes under unclassified mixed degraded forestland, but as such, no adverse impact of the project activities on animals found beyond the project area is anticipated. The following measures will be taken to minimize the impact of project on fauna within the environment of the area.

i. Precautions will be taken to control pollution to Air, Water, Land and Noise environment to below permissible limits.
ii. Greenery development in the project area will help in creating a habitat for local fauna species and to attract birds, insects and reptiles from distant places.

7.11 Socio-Economic Mangement Plan

Socio-economic parameters depicting social economy and general well-being - population, income, settlement pattern, health, safety and security, level of development and quality of life shall be monitored through studies.

The host communities' feelings and relationship with Ebocha Life Camp and Infrastructure Management shall be gauged through regular meetings with the communities. Health parameters and facilities as detailed in Chapter four of this EIA shall continue to be monitored on workers in the different sections of the project with a view to taking corrective measures.

The Socioeconomic Environmental Management Plan (SEMP) is the essential and stand-alone component of an EIA that provides the assurance that the mitigation measures developed for reducing the adverse effects of associated and potential impacts to as low as reasonably practicable (ALARP) as well as those proposed for enhancing beneficial impacts are implemented and maintained throughout the project lifecycle.

Ebocha Life Camp and Infrastructure Management recognizes the development of an effective environmental management to facilitate better achievement and demonstration of sound environmental performance. Furthermore, environmental management is seen as the means to ensure that the commitments specified in this report are properly managed and that unforeseen or unidentified impacts of the proposed development are detected.

In accordance with Ebocha Life Camp and Infrastructure Management health, safety and environment policy of good environmental practice, the SEMP of the proposed Ebocha Life Camp and Infrastructure Management Project has been designed in accordance with regulatory specifications, and is presented in this section.

7.11.1 The Objectives of the SEMP for the Proposed Project

The long-term objectives of the programme on Socio economic management for Ebocha Life Camp and Infrastructure Management Project include:

- Integrate environmental issues fully into the project construction and project management;

- Demonstrate a systematic procedure ensuring that all project activities are executed in compliance with applicable legislations and Ebocha Life Camp and Infrastructure Management's policies on Health, Safety, Environment, Security and Community Relations have been established for the Project;
- Show that mitigation measures for all impacts and effects have been established and shall be maintained throughout the project life cycle.
- Achieve, enhance and demonstrate sound environmental performance built around the principle of continuous improvement;
- Demonstrate that emergency response measures will be in place. This will ensure that adequate responses in cases of emergency have been established for the project;
- Provide the standards for overall planning, operation, audit and review.

7.11.2 Uses and Maintenance of the SEMP

The SEMP shall remain a dynamic working tool and will be owned by the Ebocha Life Camp and Infrastructure Management Project team. The SEMP shall be reviewed with changes in regulatory regime and in the event of new policies or guidelines from governmental environmental agencies.

Periodic reviews and updating shall also be carried out throughout the project lifespan, to incorporate better environmental technologies, management systems and economic policies. Constructive suggestions by users (contractors, management, operating personnel and community members) shall be assessed and integrated into the SEMP.

7.11.3 Regulatory Compliance

All environment-related regulations as they apply to the Project have been documented and described in the EIA. The socioeconomic environmental management activities at each stage of this project have been guided by the environmental standards including national legislation, international conventions and agreements and Ebocha Life Camp and Infrastructure Management general practice.

The Federal and State Ministry of Environment have responsibilities for environmental protection and the enforcement of environmental standards. Where standards and regulations are not present in Nigeria, standards issued by international bodies such as the World Health Organization (WHO) and World Bank have been adopted. The Ebocha Life Camp and Infrastructure Management (and all her contractors/subcontractors) shall ensure compliance with these regulations throughout the project's lifecycle in line with measures inherent in the Engineering Project Management.

7.11.4 Implementation of Mitigation and Enhancement Measures

The mitigation measures proposed for the significant negative impacts and the measures proposed to enhance the significant positive impacts presented in the EIA have been developed into a SEMP that provides a detailed action plan with roles and responsibilities for their implementation. Ebocha Life Camp and Infrastructure Management and the project contractors shall ensure that these measures are complied with as indicated in the SEMP.

7.11.5 Maintenance Programme

The maintenance officer to be employed by the contractors for the project shall develop a comprehensive maintenance programme. The maintenance schedule contained in the programme shall be designed in line with specifications for the project facility to ensure that it functions properly all year round.

7.11.6 Archaeological/Heritage Sites Management

Contractors and all Ebocha Life Camp and Infrastructure Management personnel working at the sites shall preserve and respect the cultural heritage of the host communities as much as possible. Though the land has been acquired, the culture and norms of the host communities still have to be respected. The relevant control measures are recorded below in table 7.7

Table 7.7: Relevant control measures on cultural heritage

Element	Management Plan
Potential Impacts	Heritage objects or artefacts found on site and inappropriately managed.
Controls	• All relevant legislation regarding the conservation of national heritage sites shall be adhered to: • Excavation and mapping of sites before construction commences. • Shifting of development/infrastructure to avoid such sites. • Formalizing sites by fencing them in. • Under no circumstances shall the contractor, his employees, his sub-contractor's employees remove, destroy or interfere with archaeological artifacts.
Maintenance	Awareness of procedures for dealing with heritage objects shall be updated where necessary.

Element	Management Plan
Corrective Action	- In the event that any heritage sites are found within the footprint of the construction activity, all work will cease immediately, and the event reported. - The excavation shall be examined by an archaeologist as soon as possible. The HSE Officer will advise the Contractor of necessary actions to be taken after receiving advice from the archaeologist. All necessary actions to ensure that delays to construction is minimised shall be taken. - If any human remains are discovered they shall be treated with respect and SAHRA notified immediately. An archaeologist/palaeontologist shall be contracted to remove the remains at the expense of the developer. - Ebocha Life Camp and Infrastructure Management may need to apply for a permit from SAHRA to destroy the occurrences if they are to be affected by the proposed activities. The province archaeologist may at his or her discretion ask that mitigatory work in form of archaeological trial excavations and rescue of archaeological material be conducted by an accredited archaeologist as a condition of such a permit being issued.

Source: Resourcefield 2020

7.11.7 Health and Safety of Workers

Ebocha Life Camp and Infrastructure Management shall fully implement its HSE policy during the entire duration of this project and all safety protocols for this project shall be adequately communicated to Ebocha Life Camp and Infrastructure Management staff and contractors' personnel. The HSE Officer for the proposed project shall ensure strict compliance with the provisions of the HSE policy and recommendations in this EMP.

In addition, the HSE Officer shall ensure that contractor's HSE Officer conducts "Tools Box Talk" every day prior to the commencement of work and submits minutes of safety meetings and HSE monthly statistics records submitted to Ebocha Life Camp and Infrastructure Management. Other responsibilities of the HSE Officer shall include:

- review of all safety and environmental protection issues identified in the course of engineering design, HAZID, HAZOP and EMP studies with the purpose of fine-turning them for implementation;
- implementation of safety and environmental provisions of the Report by the officials of Ebocha Life Camp and Infrastructure Management and its contractors;
- implementation of the contingency plan of Ebocha Life Camp and Infrastructure Management and all legislative requirements mentioned in the Report;

- supervising all environmental matters arising in the course of project implementation as well as developing/implementing environmental audit programme as follow-up studies and
- keeping adequate records and making them available to regulators and interested third parties.

Ebocha Life Camp and Infrastructure Management shall equally ensure that contractor's personnel engaged on this project are adequately trained in safety, environmental management and emergency procedures. Ebocha Life Camp and Infrastructure Management through her HSE Officer shall monitor contractor's performance in complying with environmental guidelines and standards and mitigation measures mentioned in the report.

In particular, personnel shall have an understanding of the rationale for the recommended mitigation measures and monitoring. Such environmental monitoring shall cover material storage area, equipment repair yards, construction workers' camps and sites. This is essential to ensure compliance with good practices and other special requirements to mitigate adverse impacts and detect any impact, which may occur so that corrective actions can be initiated. Therefore, Ebocha Life Camp and Infrastructure Management HSE Officer shall focus on critical environmental issues, which shall include but not limited to:

- waste generation;
- environmentally sensitive locations such as swamps and other wetland
- actions that could lead to changes in water quality such as high turbidity etc.

Ebocha Life Camp and Infrastructure Management shall ensure that adequate warning signs are put in place to minimize or eliminate accidents throughout the duration of the construction period. Similarly, a buffer zone or safety zone shall be created to prevent unwarranted encroachment by unauthorized third party. All chemicals, paints, thinners and other hazardous materials shall be adequately stored and applied in a safe manner to prevent damage to the environment.

7.12 Health Management

7.12.1 Personal Medical Fitness

Ebocha Life Camp and Infrastructure Management shall ensure that a qualified medical doctor, registered by the Nigerian Medical Association, certifies all personnel employed for any company's work as medically fit for their job. The examining physician for each such personnel shall issue a certificate of medical fitness valid for one year.

7.12.2 Health Work Environment

Ebocha Life Camp and Infrastructure Management shall ensure that all personnel accommodation locations are regularly fumigated against mosquitoes and other vermins, and shall ensure that its personnel and those of its subcontractors (if any) maintain the highest standard of personal and environmental hygiene.

7.13 Waste Management

During discharge of products, transportation through pipes and loading of truck, it is inevitable that discharges of materials to the environment will occur. If these are not controlled, they may act as a source of environmental disturbance or nuisance. The level of discharge expected has been quantified in Chapter Four. All the wastes that cannot be re-used will be safely managed and disposed of in a manner that meets regulatory requirements. Below are the waste management guidelines and waste disposal systems that will be implemented in this project.

- **Waste Inventory**

The primary wastes include spills and fugitive dust particulate emissions from vehicular movement and from a variety of waste oil and lubricants. Waste generation would also arise as a result of transport of raw materials to the site, during construction period. Other wastes include solid wastes which are mainly papers, bottles, biodegradable waste, glasses and fuel/ gas, sulfur dioxide, carbon monoxide, construction materials, fuel storage containers, scrap metal, domestic and sewage wastes.

These wastes shall first be segregated, minimized and/or disposed of in the planned landfill in accordance with waste management standards. It is the responsibility of Ebocha Life Camp and Infrastructure Management, and its contractors to develop a comprehensive waste management plan for the proposed project.

The waste management plan shall be in compliance with international protocols, RMEnv and Ebocha Life Camp and Infrastructure Management waste management standards. The contractors shall keep waste tracking documentation and make it available on demand for inspection and verification of practice by Ebocha Life Camp and Infrastructure Management, regulators and interested stakeholders. The contractor's waste management protocol shall have the following minimum provisions:

- Waste reduction strategy,
- Classification and registration of all categories of wastes,
- The procedure for the segregation of wastes,
- The disposal of the following wastes: construction debris; scrap metals; handling of fuel, chemicals and other hazardous materials; biodegradable domestic wastes; etc
- All wastes shall be quantified and the inventory data recorded.

Adequate disposal of waste is vital to the implementation of any waste management system and, as such, all wastes as above shall be stored in designated storage areas, which shall be completely isolated from surface drains, and bounded to contain spillage. The transfer of garbage and special wastes for the disposal shall be accompanied by a waste consignment note from Ebocha Life Camp and Infrastructure Management. The waste shall be logged and reported on a weekly basis by the Environmental Officer in charge.

Ebocha Life Camp and Infrastructure Management shall also have in place an agreement with an accredited waste disposal third party that has the facilities to collect non-incinerated waste and dispose appropriately in an environmentally friendly manner or at recommended disposal sites.

The contractors shall provide adequate health services as well as site first aid services for its workforce. The first aid services shall be extended to all visiting personnel. All project activities shall be properly managed through careful planning and the application of relevant safety policies including the following:

- Job hazard analysis before embarking on a job,
- Use of appropriate personal protective equipment (PPE),
- Prohibition of alcohol in the project area,
- Prohibition of smoking in designated areas,
- Proper journey management

Operations at all work sites shall be subject to government, industry and Ebocha Life Camp and Infrastructure Management policies and guidelines.

All Ebocha Life Camp and Infrastructure Management and contractor staff shall be well informed and trained on the safety policies and guidelines.

All facilities shall also be designed to enhance safety planning and all activities shall be executed within the confines of relevant legislation and stakeholders' interests. Details of the Socioeconomic Impact Management and Monitoring Plan (SIMP) and a follow up process covering the project phases are presented in Table 7.8 below.

Table 7.8: Socioeconomic Impact Management and Monitoring Plan for the Ebocha Life Camp and Infrastructure Management Project.

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
Mobilization							
Movement of goods, workers, equipment etc.	Increase in road traffic volume and risk of accidents /injury	Place visible warning signs on roads and vehicles	Federal Traffic Regulations	Number, Adequacy of signs and speed breakers number	Quarterly	Quarterly	Ebocha Life Camp and Infrastructure Management and Contractor
		Install speed breakers at sections of the roads traversing communities	Ebocha Life Camp and Infrastructure Management Policy	No. of speed breakers	Once before road commissioning	Annually	Ebocha Life Camp and Infrastructure Management and Contractor
		Large and slow moving vehicles shall be scheduled during off-peak periods	Ebocha Life Camp and Infrastructure Management Policy	Records of schedule	Monthly	Quarterly	Ebocha Life Camp and Infrastructure Management and Contractor
		Raise community awareness of Unusual activity via the	Ebocha Life Camp and Infrastructure Management	Records of awareness sessions	Monthly	Quarterly	Ebocha Life Camp and Infrastructure Management

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		community relations team	Policy				and CLOs
		Emergency/First aid procedures as they apply in Ebocha Life Camp and Infrastructure Management shall be put in place	Ebocha Life Camp and Infrastructure Management Standard	Inventory of Required materials	6-monthly	When an Incident occurs	Ebocha Life Camp and Infrastructure Management medical team & contractor
		Contact traffic police to provide more traffic control on the relevant road(s) during periods of movement of heavy equipment, thus reducing danger to the general public	None	Records of such contact	Quarterly	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor
		Counseling for heavy tanker/truck drivers on need to be careful while in transit, to reduce danger to the general public	Ebocha Life Camp and Infrastructure Management Policy	Records of such counselling	Before employment /awareness campaigns	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor

Project Activity	Impact (positive or negative)	Mitigation/Enhancement	Compliance Requirement (if any)	Parameter For monitoring	Frequency of inspection/ monitoring	Frequency of formal reporting	Action party
		Transportation of heavy equipment to the site shall be accompanied by public warning and precautions such as labels; sirens etc.	Ebocha Life Camp and Infrastructure Management Policy	Labels on Heavy vehicles and outriders following	Before such journeys	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor
	Increase in community unrest	Ebocha Life Camp and Infrastructure Management shall maintain established channels of Communication with communities around the project area.	Ebocha Life Camp and Infrastructure Management Policy	Records of meetings	Quarterly and after any project related incident	Annually and after reported incidents	Ebocha Life Camp and Infrastructure Management & contractor
	Pressure on existing infrastructure, e.g., roads	Ebocha Life Camp and Infrastructure Management shall listen sympathetically to the needs of the host communities with a view to assisting, whenever possible.	Ebocha Life Camp and Infrastructure Management Policy None	Records of needs communicated to Ebocha Life Camp and Infrastructure Management Road Maintenance	Quarterly 6-monthly	6-mothly Annually	Ebocha Life Camp and Infrastructure Management & contractor Engr. Dept.

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		Ensure appropriate maintenance of the road to project site with a view to improving its functionality.					
Operations and Marketing							
All activities requiring workers	Increase in jobs in the local area	Use of local staff shall be maximised, in compliance with Ebocha Life Camp and Infrastructure Management policy on local content both for Ebocha Life Camp and Infrastructure Management and contractor staff	Ebocha Life Camp and Infrastructure Management Policy	Employment records	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management & contractor
	Training shall be provided to facilitate the use of local people	Ebocha Life Camp and Infrastructure Management Policy	Employment records	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management & contractor	Training shall be provided to facilitate the use of local people

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
	Economic enhancement	Where possible and agreed (as part of local content plan,) use and procurement of local facilities and resources shall be maximized	Ebocha Life Camp and Infrastructure Management Policy	Extent of compliance	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management & contractor
	Increase in local population	Advertise construction jobs that will be available. This will, hopefully, discourage unqualified persons from moving into the project area, thus reducing the rate at which population will grow	None	Records of Advertisements and applications at employment office	Once Prior to advert and once during advert period	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor
		Site job recruitment centres in The Metropolist to discourage influx of people	None	Documentary Evidence of implementation	Once prior to recruitment and once during recruitment	Annually	Ebocha Life Camp and Infrastructure Management & contractor
		Movement of unauthorized persons into construction areas	Ebocha Life Camp and	Records of access control	Monthly	Quarterly	Ebocha Life Camp and

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		and project site shall be strictly restricted	Infrastructure Management Policy				Infrastructure Management & contractor
	Alteration in age-sex distribution	Ebocha Life Camp and Infrastructure Management shall encourage Contractor to employ qualified females of working age	None	Records of Such employment	6-montly	Annually	Ebocha Life Camp and Infrastructure Management& contractor
	Increase in cost of living / Inflation	Ebocha Life Camp and Infrastructure Management shall support skill development & enhancement in the communities	None	Training, Micro-credit and Cooperatives statistics	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management & contractor
	Waste generation	Wastes shall be inventoried and segregated at source to enable effective handling and disposal Ebocha Life Camp and Infrastructure	Ebocha Life Camp and Infrastructure Management Policy	Physical assessment and records Physical Assessment	Monthly Quarterly	Quarterly 6-monthly	Ebocha Life Camp and Infrastructure Management & contractor

Project Activity	Impact (positive or negative)	Mitigation/Enhancement	Compliance Requirement (if any)	Parameter For monitoring	Frequency of inspection/ monitoring	Frequency of formal reporting	Action party
		Management shall ensure that contractor follows laid down regulations for waste disposal.					
		Ebocha Life Camp and Infrastructure Management waste management policy shall be enforced	Ebocha Life Camp and Infrastructure Management Policy	Waste collection records and chain of custody transfer	Quarterly	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor
	Soil Degradation And soil/Groundwater Contamination	Ensure controlled fuelling, Maintenance and servicing protocol for construction machinery at construction site.	Ebocha Life Camp and Infrastructure Management	Fuelling, maintenance and servicing protocol record	During refuelling activity	Quarterly	Ebocha Life Camp and Infrastructure Management & contractor
	Pollution of the Orashi River (and other surface waters)	Project waste water shall be channelled down-stream. Also bore holes will be provided to ease water problems in the project.	None	Bore hole site records	Annually	Annually	Ebocha Life Camp and Infrastructure Management & site engineers

Project Activity	Impact (positive or negative)	Mitigation/Enhancement	Compliance Requirement (if any)	Parameter For monitoring	Frequency of inspection/ monitoring	Frequency of formal reporting	Action party
		Ebocha Life Camp and Infrastructure Management waste management policy for this project shall be enforced	Ebocha Life Camp and Infrastructure Management Policy	Waste Collection records and chain of custody transfer	Quarterly	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor
		Ebocha Life Camp and Infrastructure Management shall ensure that containment for oil and chemical discharges are provided by contractor	Ebocha Life Camp and Infrastructure Management Policy	Physical Assessment	Quarterly or as required after an incident	6-monthly or As required After an Incident is reported	Ebocha Life Camp and Infrastructure Management & Contractor

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
	Increase in noise nuisance	Ebocha Life Camp and Infrastructure Management shall ensure that all construction equipment are in proper condition and fitted with project standard silencing features if available.	Ebocha Life Camp and Infrastructure Management Policy	Equipment specifications and maintenance records	Quarterly	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor
		Communities shall be consulted prior to periods of expected peak noise levels	Ebocha Life Camp and Infrastructure Management Policy	Records of consultation	As required	As reported	Ebocha Life Camp and Infrastructure Management, contractor
	Increase in social vices	Intensive enlightenment campaign and health education for the abatement of abuse of drugs, alcohol and tobacco in the communities and among workers throughout the life of the project	Law against smoking in public places and NDLEA Act	Enlightenment Campaign/Health education statistics Records of cases of abuse in the workforce.	At least three Months before commencement of activities then 6-monthly thereafter	Annually	Ebocha Life Camp and Infrastructure Management & Contractor

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		Ebocha Life Camp and Infrastructure Management shall ensure that contractor enforces alcohol & drug policy for staff	Ebocha Life Camp and Infrastructure Management Policy	Records of violation	As required	Quarterly	Ebocha Life Camp and Infrastructure Management & contractor
		Ebocha Life Camp and Infrastructure Management shall encourage contractor to support sporting activities	None	No. of Ebocha Life Camp and Infrastructure Management's Sponsored sporting Activities supported by contractor	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management & contractor
		Ebocha Life Camp and Infrastructure Management shall support public health lectures with emphasis on	None	Statistics of health awareness lectures	1-3 Months before mobilization and then quarterly	Annually	Ebocha Life Camp and Infrastructure Management & contractor

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		common and communicable diseases such as malaria, TB, STIs including HIV/AIDS					
		Ebocha Life Camp and Infrastructure Management shall engage and support local security systems	None	Records of Ebocha Life Camp and Infrastructure Management support	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management, contractor & security team
		Ebocha Life Camp and Infrastructure Management shall ensure that contractor implements social and health awareness programs for all workers at induction and on a continuous basis throughout the life of the project	None	Statistics of social & health awareness programmes	At induction and quarterly thereafter	Annually	Ebocha Life Camp and Infrastructure Management & contractor

Project Activity	Impact (positive or negative)	Mitigation/Enhancement	Compliance Requirement (if any)	Parameter For monitoring	Frequency of inspection/ monitoring	Frequency of formal reporting	Action party
	Increase in community impact	Hire local labour, where feasible, as required by law	Nigerian labour laws	Staff statistics	Quarterly	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor
	Support local capacity building	Ebocha Life Camp and Infrastructure Management shall undertake and agree on an MOU with the local communities. Ebocha Life Camp and Infrastructure Management shall honour this MOU.	None	Training records	Quarterly	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor
			Contractual	Compliance With MOU items	Quarterly	6-monthly	Ebocha Life Camp and Infrastructure Management team
	Potential for erosion on and off the site	Ebocha Life Camp and Infrastructure Management shall put in place appropriate erosion-control facilities before heavy rains begin. Grassing of areas prone	None	Records of compliance	Before construction commences	Before construction commences	Ebocha Life Camp and Infrastructure Management & contractor

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		to erosion shall be carried out.					
		Before construction activities begin, Ebocha Life Camp and Infrastructure Management shall ensure that a storm water pollution prevention plan for erosion control is put in place.	None	Record of such plan	Before construction commences	Before construction commences	Ebocha Life Camp and Infrastructure Management & Contractor
	Increase in communicable diseases (incl. STIs) Provide condoms for construction workers.	Support immunization in collaboration with Rivers state Municipality Council for workers and community members	National Health Policy	Immunization statistics	6-montly	Annually	Ebocha Life Camp and Infrastructure Management & contractor
		Assist in training traditional health practitioners and village health workers to strengthen primary	Ebocha Life Camp and Infrastructure Management policy	No of village health workers trained	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		health care in the project area					
		Support community based training on (i) the prevention of common communicable diseases; and (ii) water protection/ purification techniques and basic sanitation	Ebocha Life Camp and Infrastructure Management policy	Number of Commercial Sex workers (CSW) Statistics on AIDS Prevention session	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management & contractor
		Support activities of the State Action committee on Aids	Ebocha Life Camp and Infrastructure Management policy	Sex education programme conducted; Incidence of HIV/AIDS	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management, Contractor and State Min. of Health
		Ensure that insecticide treated nets (ITN) are given to workers as part of malaria control.	Ebocha Life Camp and Infrastructure Management policy	ITN uptake Statistics	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management & contractor

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		Enforce malaria policy and Immunization status.	Ebocha Life Camp and Infrastructure Management policy	Statistics of Compliance	Before the Expatriate is Deployed for work	Annually	Ebocha Life Camp and Infrastructure Management & contractor
		Ebocha Life Camp and Infrastructure Management Policy	Freely available condom for workers	Quarterly	Annually	Ebocha Life Camp and Infrastructure Management & contractor	Provide condoms for construction workers.
	Soft tissue Injury /fatalities in workforce communities	Enforce compulsory medical fitness test for all Ebocha Life Camp and Infrastructure Management and contractor personnel	Ebocha Life Camp and Infrastructure Management policy	Medical reports	Quarterly	6-monthly	Ebocha Life Camp and Infrastructure Management & contractor
		First Aid training of workforce (at least 1: 50)	Ebocha Life Camp and Infrastructure Management policy	Training records Records of Such procedures	Monthly	Quarterly	Ebocha Life Camp and Infrastructure Management &

Project Activity	Impact (positive or negative)	Mitigation/Enhancement	Compliance Requirement (if any)	Parameter For monitoring	Frequency of inspection/ monitoring	Frequency of formal reporting	Action party
							contractor
		Emergency response procedure shall be put inplace and administered	Ebocha Life Camp and Infrastructure Management Health standard	Training records Records of Such procedures	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management medical team & contractor
		Safety awareness training for workforce and nearby communities on the likelihood of exposure to poisonous wildlife. Polyvalent anti-venoms shall be provided on site.	Ebocha Life Camp and Infrastructure Management policy	Training records and statistics	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management & contractor
	Pressure on existing infrastructures	Existing infrastructure shall be maintained with a view to upgrading or improving their functionality	None	Maintenance records	6-montly	Annually	Ebocha Life Camp and Infrastructure Management Engr, Team
	Stress on existing security structures	Ensure that both contractor and Ebocha Life Camp and	None	Statistics of Security breaches	Quarterly and As required after an incident	6-monthly and as required after an incident	Ebocha Life Camp and Infrastructure

Project Activity	Impact (positive or negative)	Mitigation/Enhancement	Compliance Requirement (if any)	Parameter For monitoring	Frequency of inspection/ monitoring	Frequency of formal reporting	Action party
		Infrastructure Management personnel develop a high level of security consciousness both within and outside the work area					Management & contractor
		Security reports shall be reviewed by the Ebocha Life Camp and Infrastructure Management Project manager	Ebocha Life Camp and Infrastructure Management Policy	Security reports	Quarterly and As required after an incident	6-monthly and as required after an incident	Ebocha Life Camp and Infrastructure Management & contractor
		Ensure that a liaison is Established and sustained, to foster partnership with the community and guarantee security for the project	Ebocha Life Camp and Infrastructure Management Policy	Ebocha Life Camp and Infrastructure Management - Community Security Meetings	Quarterly and As required After an incident	6-monthly and as required after an incident	Ebocha Life Camp and Infrastructure Management, contractor & CLOs
	Increase in Respiratory diseases	Nose masks shall be worn by site workers during (dusty)operations	Ebocha Life Camp and	Records of respiratory diseases	Quarterly	6-monthly	Ebocha Life Camp and Infrastructure

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
			Infrastructure Management Policy				Management & health reports
		Water shall be sprayed on construction site to reduce dust levels especially during dry season	None	Inspection	Daily before Dusty operations	Monthly	Ebocha Life Camp and Infrastructure Management & contractor
		Construction workers shall be compelled to wear Personal Protective Equipment (PPE)	Ebocha Life Camp and Infrastructure Management Policy	Monitor compliance	Daily	Monthly	Ebocha Life Camp and Infrastructure Management
	Shift in traditional Occupation	Support traditional occupations through extension services	Ebocha Life Camp and Infrastructure Management Policy	No. of beneficiaries	6-monthly	Annually	Ebocha Life Camp and Infrastructure Management, and Min. of Agric. Rivers State

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		Loss of farmland and by land owners	Timely and adequate payment of compensation to affected Landowners	Ebocha Life Camp and Infrastructure Management Policy	Compensation records	6 months before construction	Ebocha Life Camp and Infrastructure Management
		Ensure that the contractor supports training schemes for skills acquisition	Ebocha Life Camp and Infrastructure Management Policy	Training records	6 monthly	Annually	Ebocha Life Camp and Infrastructure Management
Dismantling and decommissioning							
-Assessment of facility Dismantling and decommissioning -Staff movement	Loss of Employment	Ebocha Life Camp and Infrastructure Management to ensure that Contractor provides severance package in line with conditions of service and Nigerian labour laws	Nigerian labour laws	Records of Beneficiaries	As necessary before handover	As necessary before handover	Ebocha Life Camp and Infrastructure Management and Contractor
		Possibility of staff retentions in new contracts	None	None	As necessary during decommissioning discussions	Once agreement is reached	Ebocha Life Camp and Infrastructure Management

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		Ebocha Life Camp and Infrastructure Management to ensure that Contractor provides counseling for staff in preparation for Decommissioning	None	Records and Statistics of counseling sessions	As necessary during decommissioning	Once agreement is reached	Ebocha Life Camp and Infrastructure Management and Contractor
		Ebocha Life Camp and Infrastructure Management to ensure that Contractor adopts a transparent approach towards staff on all decommissioning matters	Ebocha Life Camp and Infrastructure Management Standards	Records of communication with staff	Monthly during decommissioning	Quarterly	Ebocha Life Camp and Infrastructure Management and Contractor
		Ensure that the contract for employment of staff shall include information on the date of disengagements	Contractual	Employment agreement	As necessary during employment discussions	Once agreement is reached	Ebocha Life Camp and Infrastructure Management and contractor
	Emotional disturbance	Encourage contractor(s) to provide psychological	None	Records of services	Quarterly	Annually	Ebocha Life Camp and

Project Activity	Impact (positive or negative)	Mitigation/Enhancement	Compliance Requirement (if any)	Parameter For monitoring	Frequency of inspection/ monitoring	Frequency of formal reporting	Action party
		services as part of occupational health Requirement					Infrastructure Management & contractor
		Encourage new operator to retain workers who have demonstrated competence on other jobs	None	Number of personnel retained	As necessary during discussions	Once agreement is reached	Ebocha Life Camp and Infrastructure Management and contractor
		Possibility of hospital services being available to disengaged staff	None	Records of Services	As necessary during dismantling	Once agreement is reached	Ebocha Life Camp and Infrastructure Management and contractor
	Stress on existing security structures	Ensure that both contractor and Ebocha Life Camp and Infrastructure Management personnel develop a high level of security consciousness	None	Statistics of security breaches	During decommissioning	During decommissioning	Ebocha Life Camp and Infrastructure Management and contractor

Project Activity	**Impact (positive or negative)**	**Mitigation/Enhancement**	**Compliance Requirement (if any)**	**Parameter For monitoring**	**Frequency of inspection/ monitoring**	**Frequency of formal reporting**	**Action party**
		both within and outside the work area					
		Security reports shall be Reviewed by the Ebocha Life Camp and Infrastructure Management Project manager	Ebocha Life Camp and Infrastructure Management Policy	Security reports	During decommissioning	During decommissioning	Ebocha Life Camp and Infrastructure Management and Contractor
	Community Unrest	Ebocha Life Camp and Infrastructure Management and contractor shall honour all obligations	Contractual	Compliance with MOU items	As necessary during dismantling	Once agreement is reached	Ebocha Life Camp and Infrastructure Management and contractor

Source: Resourcefield 2020

7.14 Managing Stakeholder perceptions

Public interest is expected to be high. The project will have impacts on the surrounding communities through disturbance during construction and operation (e.g. noise, traffic, dust, emissions etc) and through the influx of workforce. Effective and realistic measures have been put in place to mitigate these impacts. Nevertheless, stakeholder perceptions are bound to persist. This project shall manage these perceptions by employing and sustaining dialogue as well as involvement of the communities and other stakeholders in all phases of the project. In particular,

- Ebocha Life Camp and Infrastructure Management shall ensure that the Contractors fully involve stakeholder communities in the environmental monitoring and management plan for this project.
- Use available records on community development and other community-based activities as evidence of a good corporate neighbour.

7.14.1 Social Interaction

- All adjacent landowners shall be notified and advised of the timing of the intended construction activities.
- A community liaison officer/Communications Practitioner from Ebocha Life Camp and Infrastructure Management will deal with community needs and complaints. Any community complaints raised by I&AP's shall be addressed as a matter of urgency.
- Open liaison channels with nearby residents and Interested and Affected Parties (I&AP's) shall be developed in order to facilitate communication and field concerns or complaints about construction activities, working hour's etc. The construction camp shall be planned in detail, such that affected parties do -not feel threatened by the presence of construction workers.
- Contractors shall prevent and prohibit their employees from entering neighboring land and homes.
- The Contractor shall construct and maintain adequate perimeter fencing around the camp and ensure that materials used for construction on the site do not blow on or move outside the site and environs.
- All construction activities shall take place within the demarcated footprint. If it is necessary for activities to take place outside of this area, permission shall be obtained from the HSE Officer.
- Ensure that the entire camp site(s) is fenced, that access into and out of the camp is controlled and that gates are locked after hours and over weekends. Movement of construction personnel on site, outside of the demarcated development areas, shall be strictly prohibited.

7.14.2 Labour

- Proposed normal working hours shall be between 06hr and 18hr, Monday to Friday, where practically possible. However, these working hours may not be possible if tunnel/waterways are constructed over 24 hour shifts, since a 24 hour working day (consisting of 3 shifts) is required for underground works. The remoteness of the site will not have a major impact on surrounding communities during construction.

- As construction activities will be taking place over 24 hour periods, the surrounding communities as well as all adjacent landowners shall be notified by the Contractor accordingly.
- The Contractor shall employ local labour with appropriate qualifications and experience from the surrounding areas, as far as possible.
- The Contractor will maintain records of time worked, wages paid and training to show compliance.

7.14.3 Local Preference

- The Contractor shall give employment preference to residents of the project area.
- Where skilled workmen, artisans and operators are not available locally, they will be employed from non-local sources.
- The Contractor will make available to the Community Liaison Officer specific and relevant information on the available employment; this will include number and type of jobs, skill requirements for the jobs, duration of the jobs, remuneration scales, hours of work, conditions of work, procedures for the application of jobs, procedures for selecting job applicants, and training and certification available on the job.
- The Contractor will consider personnel from the applicants put forward by the Community Liaison Officer and will consider aptitude, health, previous training and expertise.
- No casual job seekers outside the construction site will be selected.
- The Contractor will maintain and submit records of all hiring, including dates of hiring and work commencement, the names and details of the applicants hired.
- The Contractor will maintain written records of all discussions with the Community Liaison Officer.

7.15 Industrial Hygiene, Occupational Hazards and Safety

The working conditions in the project are governed by the directives from the Project Regulatory Body. Ebocha Life Camp and Infrastructure Management will ensure that normal sanitary, bathing and cleaning facilities will be provided within the premises. The management will carry out periodic health check-up of workers of all sections.

Occupational hazards involved in project are related to dust pollution, noise pollution and injuries from equipment, fall from high places and electric shocks. Regulatory Body will give necessary guidelines for safety against these occupational hazards. The management will strictly follow these guidelines. All necessary first aid and medical facilities will be provided to the workers.

The project will be well equipped with proper fire protection and firefighting equipment. All operators and mechanics will be trained to handle firefighting equipment. One dispensary equipped with all medical facilities will be provided near the office. One Ambulance will be kept ready for 24 hours at site. Further all the necessary protective equipment will be provided to persons working in the project.

7.15.1 General Procedures

The Contractor will ensure the implementation of the following safety and security measures:

- Clearly mark dangerous areas and restrict access to these areas.
- Ensure compliance with the Occupational Health and Safety Act (No 85 of 1993) and the Health & Safety Act (Act No. of).
- Ensure that no person under the influence of alcohol or narcotic substances is permitted to work on the site.
- Ensure adequate signage is provided along the major roads and at the entrance of the construction site.
- In terms of construction worker safety, safety management plans shall be implemented.
- Community safety concerns are to be addressed by the Contractor.

A summary of health and safety management guidelines is shown in Tables 7.9 and 7.10.

Table 7.9: Health and Safety Guidelines

Element	Management Plan
controls	✚ A Health and Safety Plan will be developed in respect of construction worker safety. This plan shall be in line with Ebocha Life Camp and Infrastructure Management's SHE Policy and relevant legislation. ✚ A health and safety officer shall be employed to monitor project activities for any potential problems. ✚ Sufficient number of H & S Representative shall be appointed by the Contractor as dictated by staff numbers. ✚ Contractors shall adhere to the prescriptions of the relevant health and safety legislation and standards. The Contractor shall familiarize himself and his employees with the contents of the aforementioned legislation ✚ First Aid facilities shall be on hand at all times in accordance with international practice. ✚ The Contractor shall implement adequate and mandatory safety precautions relating to all aspects of the operation. Such safety measures and work procedures/instructions shall be communicated to construction workers. ✚ The wearing of Personal Protective Equipment (PPE) on site is mandatory for all personnel and construction team members. Minimum requirements shall include the wearing of an approved safety helmet and safety boots. Ensure that all labourers are supplied with the appropriate PPE. ✚ No one shall be allowed on site unless wearing approved, safety equipment.

Element	Management Plan
	- The Contractor's name or logo shall be dearly visible on the helmet along with the name of the person and their designation - Identity tags complete with a photograph shall be issued to all individuals that are to be present on site for more than 3 consecutive calendar days. - Casual visitors shall be required to sign a register at the security check point, the responsible person shall then be contacted before the visitor is allowed access to site. - Existing fences shall be maintained throughout the construction period. - All temporary fencing shall be removed on completion of the contract. - Spillages of chemicals or fluids shall be cleaned up immediately in accordance with the appropriate procedures prescribed by the DPR. - No open trenches shall be permitted without the use of demarcation tape. - Speed limits shall be enforced in all areas, including public roads and private property to avoid potential accidents.
	- Erection of scaffolding shall be undertaken by a certified practitioner. - Workers' right to refuse work in unsafe conditions shall be respected. - Personnel shall be trained in basic site safety procedures. - The Contractor shall design, test/exercise appropriate emergency preparedness programmes (plans, schedules, procedures and methods) for addressing environmental accidents, incidents and events such as spills of fuel, oil or lubricants; wild fires and heavy rainfall causing exceptional runoff, leading to soil erosion and silt laden runoff etc. - The contractor shall be obliged to ensure that workers are educated about HIV/AIDS and that safety measures are readily implemented. The local health services are to participate in order to ensure the implementation of education/condom distribution programmes.
Maintenance	- Ensure that experienced and skilled personnel are designated and authorised to take remedial and corrective action in the case of an accident or incident, e.g. fire officer, first aid officer and for spills. - Ensure that the emergency numbers for the area are clearly displayed and available at all times. - Ensure that basic fire-fighting equipment is available.
Hazard Risk and Emergency Response	
Potential Impacts	- A record shall be kept of all incidents on site. - Transport Spillage of fuel

Element	Management Plan
	- Overfilling of fuel tanks - Storage of fuel tanks
Sources	Sources Identified in the risk assessment include both construction and operational hazards
Controls	- Development of construction specific response procedures for; - Safety training - On-site and off-site emergency plans for fire and spill response - Monitoring - Incident reporting - Community consultation and information - Cleaning-up and remediation procedures - Develop construction work instructions for all high-risk activities. e.g. welding - Regular checks and drills shall be conducted to ensure that the risk and hazard control strategies are maintained and up to date.
Monitoring	All monitoring will occur according to appropriate plans and guidelines The complaints register shall be maintained. All complaints shall be investigated and, if appropriate acted upon.
Corrective Action	- Impervious bunded storage, capable of containing a minimum of 110% of storage volume of hazardous substances (incl. hydrocarbon fuels, oils, explosive emulsions, etc.) - Oil separation system - Spill kits - If reports or drills indicate an error I omission in risk and hazard management procedures, then procedures shall be altered or updated to ensure effective management. - If an incident occurs, the emergency procedures shall be enacted to ensure all impacts are minimized. - The prevention of potential overfilling of the fuel storage tanks shall be addressed to meet acceptable levels of risk. This can be done with adequate instrumentation and/or operating procedures. - large spillages need to be contained and if possible be directed away from the offloading vessels. - Fire protection and fighting of the spilt hydrocarbon product shall be achievable at the location of the contained material.
Open Fires/Flames on Site	
Control	- A Fire Management Strategy shall be compiled and implemented. - All construction personnel will receive training on fire hazards and

Element	Management Plan
	techniques to extinguish any fire that may be initiated on the site. - They shall also be made aware of the added risks during the dry summer months, as well as, of the fire Management Strategy to be implemented during construction. - The equipment requires, extinguishing any fires that may be initiated by construction activities, shall be installed on the site. - Flammable materials will be stored under conditions that will limit the potential for ignition and the spread of fires. - Staff will not be permitted to light fires on the site or on surrounding land, in areas other than those designated as safe by the Project Manager. - There will be a (recommended 5m) firebreak around the construction site. This area will be kept clear of vegetation and refuse. - Burning of vegetation cut during site clearing and establishment will not be permitted unless authorised by the Project Manager. All cleared vegetation will be removed to a landfill site designated by the HSE Officer. - The Contractor will supply fire-fighting equipment in Proportion to the fire risk presented by the type of construction and other on-site activities and materials used on site. This equipment will be kept in good operating order. - No fires shall be allowed adjacent to the boundary fence, either inside or: outside the construction site. - Any welding or other sources of heating of materials shall be done in a controlled environment, wherever possible and under appropriate supervision, in such a manner as to minimise the risk of veld fires and/or injury to staff. - The Contractor will take reasonable and active steps to avoid increasing the risk of fire through his activities on site. Accidental fires shall be prevented through proper sensitisation of employees towards the associated risks dangers and damage of property. - The use of open fires for cooking of food, etc. by construction personnel shall be restricted to designated cooking areas. - Restrict smoking activities to designated smoking areas. - Ensure that an emergency preparedness plan is in place in order to fight accidental veld fires shall they occur. - The adjacent land owners/users/managers shall also be informed and/or involved. - The use of branches of trees and shrubs for fire-making purposes shall

Element	Management Plan
	be strictly prohibited.
Corrective Action	Report any fires which occur to the Project Manager as soon as possible.
Plant Repair, Maintenance and Cleaning	
Controls	- No vehicle maintenance and repairs shall be undertaken within a 100m radius of any water Courses and drainage lines. - Any facilities susceptible to oil, petrol and diesel spillage will be located a minimum 100m from all surface water courses. - Repair yards, batching plants and stationary machines will be provided with impervious sumps, and spilled fluids and runoff will be kept in a conservancy tank until removed from the site in terms of the relevant legislative requirements. - Adequate correction facilities such as diversion mounds, ditches, drains, oil separation sumps and sedimentation ponds will be constructed at each location with a pollution potential. - All used oil will be stored in separate bunded areas for recycling by a recognised oil recovery service provider. - Sludges generated from desludging of oil separators shall be disposed at an approved hazardous waste facility. - No repair work on fleet and plant shall be conducted outside the designated workshop area or repair yard. - Where emergency repairs necessitate, work away from impervious bunded areas, use of drip trays may be allowed. - Spill containment kits shall be available at the construction camp and temporary lay down areas. - Regular inspections will be carried out to detect leaks and spillages. These facilities will be maintained as regularly as is necessary to ensure they meet the original specification.

Sources: Resourcefield 2020

7.16 Vegetation

7.16.1 Vegetation Clearing

All vegetative matter will be physically removed from all areas where construction is to take place. Prior to site clearance, a detailed survey of the vegetation in the area shall be undertaken by a qualified vegetation specialist and any protected plant species recorded shall be appropriately marked. The appropriate permits shall be obtained from the Forestry Department in the event that protected plants need to be relocated. All cleared areas will be stabilised as soon as possible in order to minimise the risk of erosion.

In terms of the Environment Conservation Act (No 73 of 1989), the disposal of vegetation by burying or burning is prohibited. No vegetative matter will be burnt or removed for firewood by any Ebocha Life Camp and Infrastructure Management employee or contractor prior to the necessary permission from the relevant authorities. The use of herbicides will only be allowed after a proper investigation into the necessity, the type to be used, the long-term effects and the effectiveness of the agent.

The Contractor will ensure:

- The areas needing to be cleared and the degree of clearing required shall be determined and demarcated in consultation with the HSE Officer before clearing begins.
- The Contractor may not deface, paint or otherwise mark and or damage natural features / vegetation of the site, unless agreed beforehand with the HSE Officer. Any features / vegetation defaced by the Contractor shall be restored to the satisfaction of the HSE Officer.
- The HSE Officer shall be present during vegetation clearing.

➢ **Plant Search and Rescue:**

- Plant search and rescue (i.e. the location and removal of specified plant species, without unnecessary damage, and their transfer to a specified location) and the collection of seed, will be conducted by the HSE Officer prior to the onset of any site clearing operations within the footprint of the upper and lower reservoirs.
- All vegetation species not readily relocated or required for end-use rehabilitation shall be contained in a temporary nursery constructed for this purpose on site.
- Sensitive areas and/or species that have been selected for conservation by the ecologist or HSE Officer, will be demarcated with danger tape/hazard tape. No activity will take place at these areas.

7.16.2 Protection of Vegetation

The Contractor will ensure that all works are undertaken in a manner, which minimises the impact on vegetation outside of the site area as designated in the construction site layout. However, it may be necessary in certain instances to remove or prune vegetation outside of the development in order to prevent possible damage to the facilities. This shall be undertaken in consultation with the Project Manager and HSE Officer.

7.16.3 Threatened and/or Protected Plant Species

A protocol describing the actions to be followed if a threatened species is found shall be in place, Prior to vegetation clearance, any threatened and/or protected plant species which have been identified by the vegetation specialist and/or Environmental Control Officer shall be removed and transplanted, wherever possible.

These plant species shall be planted in similar soil conditions and to the same depth as they were before removal. Care shall be taken during the removal of plants to ensure that they are not damaged. The plants shall be watered directly after transplanting to settle the soil. The Contractor shall be assisted by an experienced individual or organisation.

The purpose of the vegetation survey is to:

- determine the actual occurrence of threatened and or protected plant species; and
- ensure that appropriate mitigation measures are taken. i.e. removal of plants for genetic propagation, relocation of plants (the relocation of sensitive species is not considered a favourable option due to the unknown secondary impacts of the relocated plants on the receiving environment and the low probability of long-term survival of the relocated species due to high habitat specificity). Where it is absolutely essential to cut protected indigenous plants, Provincial Ordinances will be adhered to. The necessary permits will be obtained prior to commencement of any work.

7.16.4 Allen Vegetation

Monitoring the potential spread of declared weeds and invasive alien vegetation to neighbouring land and protecting the agricultural resources and soil conservation works are regulated by the Conservation of Agricultural Resources Act (No 43 of 1983) and shall be addressed on a continual basis, through an alien vegetation control and monitoring programme.

In view of the fact that the presence of declared weeds is illegal, it is recommended that the landowner/manager comply with the following legally prescribed requirements (refer to Sections 1. 2. 5 and 6 of the Conservation of Agricultural Resources Act (No 43 of 1983), as well as government notice:

a. The landowner/manager shall take steps to eradicate the declared weeds by using the methods prescribed in the regulations, namely
   - uprooting and burning, or
   - the application of a suitable chemical weed-killer (herbicide), or
   - any other method which will ensure their permanent eradication
b. One may not uproot or remove such plants and dump or discard them elsewhere to re-grow or to allow their seeds to be spread or blown onto other properties.
c. If the landowner/manager does not comply with the requirements under a) and b) above, he/she is guilty of a criminal offence.

The Contractor will remove all alien vegetation as listed in the Conservation of Agricultural Resources Act (No 43 of 1983), or as directed by the Environmental Officer during the construction period.

An alien control and monitoring programme shall be developed before the construction phase and to be carried over into the operational phase. The following elements shall be included in such a programme:

- The active control of all alien invasive species by means of manual removal, ring-barking, chemical control or a combination of these methods. The bigger trunks and branches shall be removed while the smaller branches can be used as a soil stabilizer against wind erosion in exposed areas, and also providing micro-habitat for seedling establishment.
- Rehabilitation of the cleared areas, starting with the establishment of a grass cover.
- All emergent seedlings shall be removed by hand and re-sprouting from existing rootstock shall be chemically treated in a continual monitoring and follow-up programme.

If properly planned and motivated this could serve as a trade-off programme with the potential of attracting external funding (e.g. Working for Water and/or Extended Public Works Programme). The method used for: clearing of alien plants shall include a full long-term alien eradication programme. The mature woody plants can be cut down to knee height and herbicide shall be applied to all exposed surfaces (a dye shall be mixed with the herbicide to assist with identifying plants where it has been applied). All alien plant material shall then be removed from site to reduce seeds from spreading.

All seedlings, young plants can be removed by hand, ensuring that roots are removed with the plant. Follow-up clearing shall be implemented following the initial alien removal (after approximately two months), to eradicate all the seedlings that will germinate following the removal of the mature specimens. Follow-up clearing shall be required on an annual basis to prevent the aliens from re-establishing. Sources of impacts and corrective measures on biodiversity is shown in table 7.11.

Table 7.11: Sources and Corrective Measures on Biodiversity

Element	Management Plan
Potential Impacts	Impact on both fauna and flora as a result of habitat destruction due to construction activities.
Sources	• Construction camp and labour • Mobile construction equipment • Traffic to and from site • Confine impacts to development area • Limit movement of vehicles and personnel through areas of sensitivity and within receiving environment. • Awareness programmes for construction and operational personnel. • Implementation of site-specific rehabilitation programmes. • Implementation of bio-monitoring programme.

Element	Management Plan
Corrective actions	- The Contractor will as soon as reasonably possible, but within 24 hours of becoming aware of a complaint relating to biodiversity interaction, responds to the complaint and register the complaint in the Environmental Register. In addition, the complaint shall be reported to the Environmental Practitioner as soon as possible such that the incident can be investigated by the Environmental Practitioner or Contractor.

Source: Resourcefield 2020

7.17 Waste Management Plan

The strategies for waste management to be adopted are summarised as follows:

- To reduce the volumes of wastes generated.
- To recycle and re-use wastes whenever feasible.
- To treat hazardous wastes and make them inert before disposal.
- To ensure safe and responsible collection, storage and disposal of all wastes.
- To provide auditable records of all waste streams.
- To monitor waste disposal activities in order to prevent future liabilities.
- To reduce the negative impact of the project operations on the environment.

Construction and facility operation activities will result in the generation of a variety of wastes. Waste management is of prime importance in pollution prevention during the operations and as such, it is a line responsibility. Line supervisors shall be actively involved in the monitoring and control of wastes generated by their activities.

The guideline for waste management would be used to further develop and articulate a tailored waste management plan that takes account of waste identification methods, waste storage, waste tracking, monitoring and audit of waste disposal sites. All effluents and other wastes emanating from project activities shall be treated in accordance with government regulations prior to disposal at appropriate and approved sites.

A user-friendly Waste Management Plan, covering all aspects of wastes produced in the course of the project shall be made available to all staff. Strategic waste sources and control measures are included in table 7.12.

Table 7.12: Strategic Sources of Waste and Control Measures

Element	Management Plan
Potential Impacts	Inefficient use of resources resulting in excessive waste generation, Litter or contamination of the site or water through poor waste management practices.
Sources	- Packaging - Construction wastes - Waste dirt - Storage of oils and fuels - Domestic waste form site offices and construction camp - Sludges generated from tunnel dewatering system.
Controls	- Adhere to waste management guidelines and any relevant license conditions imposed. - Where possible, construction wastes on site shall be reused or recycled. - Disposal of waste shall be in accordance with relevant legislative requirements. - The Contractor shall familiarize themselves with the definitions of waste and the handling, storage and transport of it as prescribed in the applicable environmental legislation. - The contractor will appoint a person to manage and control waste. - Integrated waste management on site will be carried out by applying, in order of preference, waste avoidance, reuse, recycling and disposal. - Burning of waste material will not be permitted except under special circumstances and with prior approval of the Project manager. - The Contractor will provide and maintain adequate facilities for litter collection (e.g. bins) at strategic locations around the site camp such as the office, garage, parking, housing facilities and locations where food is consumed. - All refuse receptacles shall be weather -, tamper- and vermin - proof. - Waste will be sorted at source (i.e. the separation of tins, glass, paper etc). Recycled waste of this sort will either be collected by a local contractor or removed by the contractor to an approved facility. - A high quality of housekeeping will be maintained on all construction sites to ensure that materials are not left where they can be washed or blown away to become litter. - Littering shall be prohibited and routine clean-up drives shall be implemented. - Stockpiled waste shall not remain on site for longer than 30 days - The contractor shall supply waste bins/skips throughout the site at locations where construction personnel or labourers are working. The bins shall be provided with lids and an external closing mechanism to prevent contents from blowing out, and shall be scavenger proof to prevent animals attracted to waste. Bins shall be emptied on a regular basis and the waste removed to the construction camp where it shall be contained in scavenger, water and windproof containers until disposed of.

Element	Management Plan
	- All waste (general and hazardous) generated during the construction phase may only be disposed of at appropriately licensed sites in terms of applicable Environmental legislation - The collection, storage and disposal of waste may not cause any nuisance (odours, fumes, aesthetic impacts, etc.). - No waste may be disposed of on neighbouring land. - Anything recyclable shall be recycled. - Illegal dumping shall be prohibited.
Maintenance	Litter collection at all construction sites will be undertaken at least once per working day. Work teams will be supplied with refuse bags which can be disposed of daily in skips at centralized locations. All waste containers will be emptied at least once a week. Waste documentation shall be completed and kept onsite.
Corrective Action	A complaints register shall be maintained, in which any complaint shall be investigated and, if appropriate, acted upon. Corrective actions are required to be undertaken immediately after a complaint is made or a non-conformance is identified.
Potential Impacts	Inefficient use of resources resulting in excessive waste generation, Litter or contamination of the site or water through poor waste management practices.
Sources	- Packaging - Construction wastes - Waste dirt - Storage of oils and fuels - Domestic waste form site offices and construction camp - Sludges generated from tunnel dewatering system.
Controls	- Adhere to waste management guidelines and any relevant license conditions imposed. - Where possible, construction wastes on site shall be reused or recycled. - Disposal of waste shall be in accordance with relevant legislative requirements. - The Contractor shall familiarize themselves with the definitions of waste and the handling, storage and transport of it as prescribed in the applicable environmental legislation. - The contractor will appoint a person to manage and control waste. - Integrated waste management on site will be carried out by applying, in order of preference, waste avoidance, reuse, recycling and disposal. - Burning of waste material will not be permitted except under special circumstances and with prior approval of the Project manager. - The Contractor will provide and maintain adequate facilities for litter collection (e.g. bins) at strategic locations around the site camp such as the office, garage,

Element	Management Plan
	parking, housing facilities and locations where food is consumed. - All refuse receptacles shall be weather -, tamper- and vermin - proof. - Waste will be sorted at source (i.e. the separation of tins, glass, paper etc). Recycled waste of this sort will either be collected by a local contractor or removed by the contractor to an approved facility. - A high quality of housekeeping will be maintained on all construction sites to ensure that materials are not left where they can be washed or blown away to become litter. - Littering shall be prohibited and routine clean-up drives shall be implemented. - Stockpiled waste shall not remain on site for longer than 30 days - The contractor shall supply waste bins/skips throughout the site at locations where construction personnel or labourers are working. The bins shall be provided with lids and an external closing mechanism to prevent contents from blowing out, and shall be scavenger proof to prevent animals attracted to waste. Bins shall be emptied on a regular basis and the waste removed to the construction camp where it shall be contained in scavenger, water and windproof containers until disposed of. - All waste (general and hazardous) generated during the construction phase may only be disposed of at appropriately licensed sites in terms of applicable Environmental legislation - The collection, storage and disposal of waste may not cause any nuisance (odours, fumes, aesthetic impacts, etc.). - No waste may be disposed of on neighbouring land. - Anything recyclable shall be recycled. - Illegal dumping shall be prohibited.
Maintenance	Litter collection at all construction sites will be undertaken at least once per working day. Work teams will be supplied with refuse bags which can be disposed of daily in skips at centralized locations. All waste containers will be emptied at least once a week. Waste documentation shall be completed and kept onsite.
Corrective Action	- A complaints register shall be maintained, in which any complaint shall be investigated and, if appropriate, acted upon. - Corrective actions are required to be undertaken immediately after a complaint is made or a non-conformance is identified.
Fuel Storage	
Controls	- All legal compliance requirements with respect to Fuel - storage and dispensing shall be met. - All fuel storage tanks (temporary or permanent) and associated facilities shall be designed and installed in accordance with the relevant oil industry standards, SANS codes and other relevant requirements. - The Contractor shall ensure that all liquid fuel and oils are stored in tanks with lids, which are kept firmly shut and under lock and key at all times.

Element	Management Plan
	- Areas for storage of fuel and other flammable materials shall comply with standard fire safety regulations and may require the approval of the Municipal Fire Prevention Officer. - Flammable fuel and gas shall be well separated from all welding workshops, assembly plants and loading bays where ignition of gas by an accidental spark may cause an explosion or fire. - The tank shall be erected at a safe distance from buildings, boundaries, welding sites and workshops and any other combustible or flammable materials. - Symbolic safety signs depicting "No Smoking", "No Naked Flames" and "Danger" are to be prominently displayed in and around the fuel storage area. - The capacity of the tank shall be clearly displayed and the product contained within the tank clearly identified. - There shall be adequate fire- fighting equipment at the fuel storage and dispensing area or areas. - The storage tank shall be removed on completion of the construction phase of the project. - All such tanks to be designed and constructed in accordance with a recognized code (international standard). - The rated capacity of tanks shall provide sufficient capacity to permit expansion of the product contained therein by the rise in temperature during storage. - Tanks shall be situated in a bonded area, the volume of which shall be at least 110% of the proposed volume of the tank. - The floor of the bonded area shall be smooth and impermeable, constructed of concrete or plastic sheeting with impermeable joints with a layer of sand over to prevent perishing. The floor of the bonded area will be sloped towards an oil trap or sump to enable any spilled fuel and/or fuel soaked water to be removed. - Any water that collects in the bund shall not be allowed to stand and shall be removed and the hydrocarbon digestion agent within shall be replenished. - Only empty and externally clean tanks may be stored on the bare ground. All empty and externally dirty tanks shall be sealed and stored on an area where the ground has been protected. - Any electrical or petrol-driven pump shall be equipped and positioned so as not to cause any danger of Ignition of the product.
Maintenance	- If fuel is dispensed from 200 litre drums, the proper dispensing equipment shall be used. - The drum shall not be tipped in order to dispense fuel. - The dispensing mechanism of the fuel storage tank shall be stored in a waterproof container when not in use. - All waste fuel and chemical impregnated rags shall be stored in leak-proof containers and disposed of at an approved hazardous waste site. - The amounts of fuel and chemicals stored on site will be minimised. - Storage sites will be provided with bunds to contain any spilled liquids

Element	Management Plan
	and materials. - Regular inspections will be carried out to detect leaks and spillages. All storage facilities will be maintained as regular as is necessary to ensure they meet the original specification. Inspections will be carried out on a daily, weekly and monthly basis by the HSE Officer. Quarterly audits will also be undertaken. - The contractors will be audited by Ebocha Life Camp and Infrastructure Management Generation, and the SHE department will be audited by independent auditors. - All equipment that leak 011 or fuel shall be repaired immediately or removed from the construction site.
Corrective Action	Absorbent material shall be available at tanks to absorb any spills.

Source: Resourcefield 2020

7.18 Legal and Other Requirements

- Ebocha Life Camp and Infrastructure Management and the Contractors shall commit themselves to comply with the relevant provisions of the applicable environmental legislation and associated regulations promulgated in terms of these laws.
- Ebocha Life Camp and Infrastructure Management shall enter into agreement with the local authority concerning any requirements directed towards protecting the environment. Contractors will be required to respect and comply with such agreements.
- All private agreements concluded by the Contractor with adjacent landowners during construction shall be ratified by the Project Manager, to absolve legal liability on the part of Ebocha Life Camp and Infrastructure Management.

Emergency Contingency Planning Requirements

Despite all care and diligence exercised in project execution, accidents do occur. Accidents could occur from equipment failure or third-party sabotage, all to the detriment of the environment. Consequently, Contingency Plans are usually made to handle such situations. Ebocha Life Camp and Infrastructure Management has incorporated into the engineering design of the proposed project, all the necessary safety measures to ensure that the release of products, hazards, incidents, near misses and accidents are minimized, if not completely eliminated.

Given the fact that accidents do occur due to human error, equipment failure or sabotage, there is a need to put in place sound and cost effective emergency response and contingency plans that can be promptly activated to minimize losses due to such accidents. Such contingency plans shall cover all project facilities and ancillary services.

Management Plans and Operational Procedures

Ebocha Life Camp and Infrastructure Management has designed the proposed EMP to comply with all applicable local and international statutory requirements and to meet the project objectives with respect to operations and maintenance reliability and health, safety and environment (HSE) performance excellence.

Ebocha Life Camp and Infrastructure Management shall undertake the project in accordance with the following standards:

- Federal Ministry of Environment Regulations and Guidelines
- Other applicable Nigerian Government Legislation;
- Ebocha Life Camp and Infrastructure Management Corporate Requirements;
- Hydrocarbon Project Specification and Concept;
- Project Design and Engineering Practice (DEP), safety manuals/ etc;
- Industry Standards and Codes of Practice.

7.19 Management and Regulatory Responsibilities on the EMP

The effective implementation of an Environmental Management Plan (EMP) requires a well-set-up organizational structure, which designates operational responsibilities to the appropriate technical and managerial departments and individuals involved in the life cycle of the operations of the project. The designated responsibilities are often based on technical and managerial capabilities of the designees and also assist in tracing the origins of lapses that may occur during operations.

Often times, when appropriate responsibilities are effectively apportioned and implemented by the designees, organizational management systems achieve the desired objectives. Organizational management responsibilities are often improved upon along the process when new areas of need emerge.

Ebocha Life Camp and Infrastructure Management having recognized the importance of a well-structured organization management system in the attainment of sustainable environmental development of its operations has put in place responsibility commitments designated to its operational and managerial departments and staff. This will help in the achievement of the desired goals.

7.19.1 Project Organization and Responsibilities

Ebocha Life Camp and Infrastructure Management has established a policy and schedule for responsibilities and training on matters relating to the environment. There is a line responsibility for which all level of staff is accountable. Line management will take full responsibility for environmental issues.

A focal point, the Management Safety, Health and Environmental Committee, consisting of the Technical Director, Head of Engineering, Plant Managers, Development Manager, Company Health and Safety/Environmental Manager, Company Doctor, HSE Reps — Sales, Logistics, has been set up to coordinate HSE performance and is responsible for compliance with safety and environmental standards and regulations. The Committee is charged with the following specific tasks:

- The developing and maintaining of the Environmental Management Plan (EMP) and associated plans for materials management, waste management, accident preparedness and response, inspection and monitoring, staff training;
- The implementation of the Environmental Management Plan related tasks;
- Conducting or organising periodic audits;
- Initiating or organising corrective actions when necessary;
- Preparing and managing documentation related to environmental performance;
- Regular and incidental reporting to the Ebocha Life Camp and Infrastructure Management management;
- Liaising and reporting to the appropriate environmental regulatory authorities.
- Improvement and effective implementation of Ebocha Life Camp and Infrastructure Management Corporate Social Responsibility Scheme.

Ebocha Life Camp and Infrastructure Management's management thus, affirms total commitment to safety and plans to ensure that all environmental considerations are integrated into related activities. Induction and training courses for staff are part and an effective parcel of environmental management system, which is of paramount importance to Ebocha Life Camp and Infrastructure Management.

7.19.2 Operational Controls for the EMP

The operational control for the effective implementation of the EMP is shown in the Table 7.14 below:

Table 7.14: Operational Controls for the EMP

Name	Duties
Project Coordinator	Oversee and coordinate all activities pertaining to the project and responsible for safety during the construction phase.
Operations Manager	Manage all technical operations pertaining to the project and responsible for safety during the operations phase.

Name	Duties
Health & Safety/Environmental Manager	Ensure that Ebocha Life Camp and Infrastructure Management operates in accordance with its HSE plans and assists line management in performing their line duties.
Facilities/Site Engineer	Monitor, report and ensure the efficient working conditions of all
Community/ Regulatory Liaison Officer	Liaise with the host communities and regulators on Ebocha Life Camp and Infrastructure Management 's behalf
Federal Ministry of Environment/NESREA	Ensure that environmental recommendations in the EIA to mitigate against construction impacts are implemented
Rivers State Ministry of Environment.	Ensure that environmental recommendations in the EMP will be adequate to mitigate against construction impacts and ensure implementation.

Source: Resourcefield 2020

The management and regulatory responsibilities on a project of this magnitude, mandate stakeholders' commitments to environmental and socio-economic issues attached to project sustainability. Ebocha Life Camp and Infrastructure Management, as a company, has a mandatory responsibility under the Nigerian law to perform its operations in the best environmentally and socio-economically sustainable way. So, also, the regulatory agencies, FMEnv and Rivers State Environment, are empowered by law to take responsibility for the monitoring of the operations of all organizations operating within the boundaries of the country/state to ensure environmental and socio-economic sustainability of the recipient communities.

The host communities also have an important stake in the environmental and socioeconomic sustainability of the project by giving the required support to both the operators and the regulators.

EMP Supporting Structure

The Implementation of the Environmental Management Plan shall be executed by the appropriate Ebocha Life Camp and Infrastructure Management Staff. Furthermore, the management of Ebocha Life Camp and Infrastructure Management shall demonstrate its visible commitment by allocating sufficient resources for the effective implementation of the EMP.

Management Review and Improvement Plan

Ebocha Life Camp and Infrastructure Management's CEO, HSE Manager and other senior management staff shall review and document at appropriate intervals the implementation process of the EMP and its performance to ensure its continual improvement and effectiveness.

Performance Monitoring and Reporting

It is necessary to monitor the environment, especially with regards to certain parameters, in order to be able to establish the efficacy or otherwise of recommended mitigation options. It has been established that monitoring shall focus on ways and means of protecting and managing recipient environmental habitats.

7.20 Reporting Requirements

In the cause of the operation of the project, the Operations Managers shall be responsible for monitoring and reporting the following:

- Provision of other ancillary services and facilities
- Health/ safety and environmental performance

The engineer shall be responsible for monitoring and reporting for the facilities and associated components.

Reports will be prepared and submitted to the Operations Manager who makes his own reports available to the regulators when required. The reports will be prepared for the following activities:

- discharge to the environment
- use of certain substances
- waste transfers for disposal
- environmental incidents

Environmental topics of concern shall be discussed at the regular safety meetings attended by all the relevant stakeholders.

7.20.1 Discharge Reports

Weekly summaries of laboratory results of discharges into the recipient environments shall be made by the Operations Manager and made available to the relevant stakeholders when required. Those required in addition to the chemical parameters shall also report volumes of discharge.

7.20.2 Environmental Incident Report

Pollution incidents and near misses' malfunction will be documented in environmental incident reports prepared by the Safety Officer, as and when such incidents occur. A copy of each such report will be provided to the regulators when required.

The pollution incident reports will include the following details: date, incident location, type of pollutant, source of pollutant, cause, volume, affected areas, action taken and follow-up activities.

7.20.3 Weekly Health, Safety and Enivironment Meetings

Weekly HSE meetings will be organized by the Safety Officer, which will cover health, safety and the environment. These will provide a forum for the personnel, operating crew to raise points of environmental concern and for the Safety Officer to discuss recent incidents or areas for improvement. The Safety Officer will keep a record of these meetings, including topics raised, action points, progress on previous action points and a list of attendees.

7.20.4 Community Relations Report

This report will be prepared by the Community Relations Officer on quarterly basis and made available to the relevant authorities when required. This will assist Ebocha Life Camp and Infrastructure Management in developing strategies to co-exist in the best sustainable way with their hosts and other relevant stakeholders. The report will rate the organizational performance based on actions taken in the interest of the relevant stakeholders and the response of the stakeholders to the organization's actions. The report will also focus on citizens' values and recommendations on the project for effective implementation of their inputs.

7.20.5 Environmental Auditing/Review

The effectiveness of the process relies on the availability and quality of information and data. In order to ensure that the EIA process remains valid and robust, the monitoring data shall be reliable. Audit schemes aim at verifying the effectiveness of environmental control and highlights areas of weakness in environmental management.

The audits are focused on areas of project perceived to be environmentally sensitive and having the highest environmental risk. The environmental audit process provides an assessment of the project, environmental management strategies and the effectiveness of the system in fulfilling the Company's environmental policy. Periodic auditing of the facilities and operations shall be embarked on every four years or as required by the regulators. The objectives of the environmental auditing shall include the following;

- identifying current environmental problems
- periodic evaluation of company environmental policies
- examination of environmental management practices and monitoring standards
- comparing environmental status with FMEnv and other local, national and international regulatory standards and requirements
- recommending areas of improvements in the company EMP
- the Project will perform its own internal environmental audits annually

Environmental Monitoring Schedule/Reporting

The environmental monitoring activities shall be scheduled for the various environmental components in project area. Ebocha Life Camp and Infrastructure Management is committed to ensuring that this schedule is strictly adhered to in order to effectively maintain a friendly operational environment.

Inspections, Audits and Monitoring

During the course of project operation, and eventual decommissioning of the projects, the agents of the regulatory authorities and Ebocha Life Camp and Infrastructure Management shall conduct regular inspections to determine the level of compliance with the guidelines of the EMP and applicable regulations and statutes. Specifically, the RSMEnv waste discharge requirements (FEPA, 1994), and Ebocha Life Camp and Infrastructure Management waste management guidelines will be complied with. Site inspections by Ebocha Life Camp and Infrastructure Management and regulatory authorities shall be regular though not necessarily according to any structured pattern. The inspection of facilities, in accordance with the industry's practice, will be at least once in six months.

7.1.1 Socio-Economic Environmental Audit

Socio-Economic Environmental audit will be conducted on regular basis for all operations throughout the lifespan of the project. This audit process shall be used to check predictions in the EIA process as well assess the environmental performance during the operation phase of the project development. This will demonstrate that environmental protection and management procedures as specified in the EIA are implemented.

CHAPTER 8

CONCLUSION

The findings of this Environmental Impact Assessment would provide adequate background information and benefits for Ebocha Life Camp and Infrastructure. The benefits include attraction of investors and the provision of employment and skill acquisition opportunities for the ever increasing unemployed class in the State and Nigeria at large.

The management of the proposed Ebocha Life Camp and Infrastructure project shall ensure strict compliance with Federal Ministry of Environment (FMEnv), NESREA, RMEnv and the ONELGA regulatory provisions by operating a compliance-monitoring programme that would lead to a sustainable project development. The result of the monitoring activities shall be forwarded regularly to the Rivers State Ministry of Environment (RMEnv), and other relevant regulators.

The EIA has developed an Environmental Management Plan (EMP), which incorporates various mitigation measures that will eliminate or reduce the potential impacts of the proposed project implementation on the environment. This EMP shall be implemented and maintained throughout the duration of the project with the adverse impacts mitigated to levels as low as reasonably practicable (ALARP).

With strict implementation of the EMP it would be possible to:

- Obtain relevant information on a continuous basis to evaluate the actual impacts compared with the predictions in this EIA report;
- Identify in advance any adverse changes in the ecosystems and reveal the causes;
- Enhance long-term planning for better environmental management and project sustainability;
- Impact mitigation monitoring shall also be carried without the involvement of regulators to check EMP compliance; and
- Guide the planning of future projects.

The sustainability of this project stems from the fact that it will bring about economic contributions to industrialization demand, boost availability of housing, food production and also satisfy environmental requirements. The sustainable development philosophy of minimizing cost and the impact on the environment has been adopted for this development project. The primary objectives would be to meet the needs of the present generation without compromising quality of life and the ability of future generations to meet their own need.

Based on this environmental impact analysis, the assessment team concludes that if the proffered mitigation and monitoring measures are followed, the proposed Ebocha Life Camp and Infrastructure project can be implemented and operated without significant adverse impact to the environment.

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APPENDIX 1: Consultation Attendance

Appendix 2: Soil and Water Samples Results

Physicochemical Characteristics of Surface water Samples

Parameter	SW_1	SW_2	SW_3	SW_4	SW_5	SW_6	SW_{C1}	SW_{C2}	Mean	Range	SD	WHO limit	FMENV Limit
Color (Pt Co Units NCASI)	8.25	8.21	8.18	8.27	8.23	8.14	8.18	8.23	8.21	8.14-8.27	0.05	5.0-15.0	-
pH	6.44	5.79	6.38	5.85	6.48	6.53	6.38	6.48	6.25	5.79-6.53	0.33	6.5-8.5	6.5-9.0
Temperature (oC)	32.4	35.1	32.6	34.7	34.3	34.7	32.6	34.3	33.97	32.4-35.1	1.17	-	-
Turbidity (NTU)	35.77	38.68	44.58	56.82	39.76	48.71	44.58	39.76	44.05	35.77-56.82	7.76	5	5
Salinity (ppt)	0.071	0.069	0.076	0.077	0.079	0.074	0.076	0.079	0.074	0.069-0.079	0.004	-	-
Hardness (mg/l)	39.8	40.3	39..5	38.9	39.2	39.4	39..5	39.2	39.52	38.9-40.3	0.54	250	250
Conductivity (µS/cm)	101.4	98.7	108.2	110.3	112.4	105.9	108.2	112.4	106.15	98.7-112.4	5.27	1000	400
Dissolved Oxygen (mg/l)	5.56	5.62	5.48	5.53	5.71	5.64	5.48	5.71	5.58	5.53-5.71	0.09	5	>4.0
Biological Oxygen Demand (mg/l)	0.85	0.55	0.68	0.77	0.58	0.83	0.68	0.58	0.71	0.55-0.85	0.13	-	-
Chemical Oxygen Demand (mg /l)	0.25	0.16	0.22	0.18	0.26	0.23	0.22	0.26	0.217	0.16-0.25	0.04	-	150
Total Hydrocarbon Content (mg/l)	0.151	0.114	0.124	0.136	0.128	0.115	0.124	0.128	0.128	0.114-0.151	0.01	-	-
Phosphate (mg/l)	0.24	0.31	0.22	0.54	0.62	0.58	0.24	0.31	0.418	0.22-0.62	0.18	-	-
Sulphate (mg/l)	4.15	4.08	4.11	4.06	4.12	4.04	4.15	4.08	4.09	4.04-4.15	0.04	250	250
Nitrate (mg/l)	3.56	3.53	3.66	3.51	3.49	3.56	3.56	3.53	3.55	3.49-3.66	0.06	10	10
Total Dissolved Solids (mg/l)	70.98	69.09	75.74	77.21	78.68	74.13	70.98	69.09	74.31	69.09-78.68	3.69	1000	1000
Total Suspended Solids (mg/l)	14.9	16.12	18.58	23.68	16.57	20.3	14.9	16.12	18.36	14.90-23.68	3.23	-	-
Copper (mg/l)	0.214	0.188	0.205	0.208	0.175	0.211	0.214	0.188	0.2002	0.175-0.214	0.02	1	0.01
Iron (mg/l)	2.21	2.164	2.208	2.191	2.216	2.215	2.21	2.164	2.2007	2.164-2.216	0.02	0.36	0.36
Lead (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	<1.0
Zinc (mg/l)	0.72	0.84	0.76	0.78	0.83	0.87	0.76	0.84	0.8	0.72-0.87	0.06	3	<1.0
Cadmium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<1.0
Chromium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	0.05
Potassium (mg/l)	0.14	0.23	0.25	0.18	0.22	0.28	0.25	0.23	0.217	0.14-0.28	0.05	-	-

Parameter	SW_1	SW_2	SW_3	SW_4	SW_5	SW_6	SW_{C1}	SW_{C2}	Mean	Range	SD	WHO limit	FMENV Limit
Barium (mg/l)	0.11	0.08	0.15	0.21	0.23	0.18	0.15	0.08	0.16	0.14-0.23	0.06	-	-
Faecal Coliform (cfu/100ml)	8	12	10	13	12	7	10	12	10.33	7.0-13.0	2.42	0	0
Total Heterotrophic Bacteria (cfu/ml)	1.1×10^5	2.6×10^5	1.7×10^5	2.8×10^5	2.3×10^5	1.8×10^5	1.7×10^5		2.1×10^5	1.1×10^5-2.8×10^5	0.63	100	100

Source: Fieldwork/Laboratory Analysis 2020

Physicochemical Characteristics of Groundwater Samples

Parameter	BH 1	BH 2	BH 3	BH_C1	Mean	Range	WHO Limit	FMEnv Limit
Appearance	Clear	Clear	Clear	Clear	Clear	Clear	-	-
Odour	nil	nil	Nil	nil	nil	nil	-	-
pH	6.53	5.69	6.61	6.25	6.27	5.69-6.61	6.5-8.5	6.5-9.0
Turbidity (NTU)	2.21	3.5	3.8	3.2	3.17	2.21-3.8	5.0	5.0
Salinity	0.04	0.08	0.07	0.06	0.06	0.04-0.08	-	-
TDS (mg/l)	51.5	20.1	43.8	35.3	37.6	20.1-43.8	1000	-
TSS (mg/l)	2.6	3.2	2.4	2.1	2.5	2.1-3.2	50	500
Conductivity (µS/cm)	180	20.2	36.4	25.9	65.6	20.2-180	1000-1500	-
Total Hardness (mg/l)	14.0	4.0	24.0	11.8	13.4	4.0-24.0	250	150
Temperature (oC)	28.8	27.1	28.2	27.8	27.9	27.1-28.8	40^{oc}	Ambient
DO (mg/l)	2.52	0.27	5.27	3.22	2.82	0.27-5.27	<5	5
BOD (mg/l)	1.94	<0.001	2.83	1.36	2.04	1.36-2.83	10	-
COD (mg/l))	3.5	<0.001	4.7	1.40	3.2	1.40-4.7	10	-
THC (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.01	-
Nitrate (mg/l)	1.08	1.48	1.82	2.6	1.74	1.08-2.6	10	50
Phosphate (mg/l)	0.15	<0.10	0.28	0.16	0.19	0.15-0.28	10	-
Sulphate (mg/l)	8.3	12.2	9.5	8.8	9.7	8.3-12.2	500	100
Chloride (mg/l)	6.8	2.0	3.10	9.4	5.3	2.0-9.4	500	250
Magnesium (mg/l)	3.33	0.21	1.80	1.11	1.6	0.21-3.33	≤ 50	-
Aluminium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	≤ 0.2	-
Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.025-0.01	-

Parameter	BH 1	BH 2	BH 3	BH_C1	Mean	Range	WHO Limit	FMEnv Limit
Barium (mg/l)	ND	ND	ND	ND	ND	ND	-	-
Cadmium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	≤ 0.005
Chromium (mg/l)	0.015	<0.01	0.04	<0.01	0.02	0.015-0.04	0.03-0.05	-
Cobalt (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.0002	0.0002
Copper (mg/l)	0.028	<0.01	0.12	0.026	0.05	0.026-0.12	0.03-2	-
Iron (mg/l)	0.105	0.1	0.21	0.12	0.20	0.1-0.24	≤ 0.3	≤ 0.3
Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	≤ 0.01	≤ 0.01
Manganese (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	≤ 0.01	-
Mercury (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	≤ 0.01	-
Nickel (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02 - 0.05	-
Vanadium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
Zinc (mg/l)	0.23	0.03	0.31	0.05	0.15	0.05-0.23	0.1-5.0	-

Source: Fieldwork/Laboratory Analysis 2020

Physicochemical Characteristics of Soil Samples

Parameter	SS_1	SS_2	SS_3	SS_4	SS_5	SS_6	SS_7	SS_8	SS_9	SS_{10}	Mean	Range	SD
Permeability (%)	40.1	41.4	45.3	45.8	40.5	42.2	46.7	47.2	44.6	45.3	43.91	40.1-46.7	2.62
Porosity (%)	62.3	62.8	65.4	65.7	63.4	63.6	66.5	67.3	65.8	66.3	64.91	62.3-67.3	1.73
Bulk density (mg/kg)	0.3	0.1	0.6	0.7	0.8	0.6	0.4	0.2	0.5	0.3	0.45	0.1-0.8	0.23
% Sand	75	78	80	78	81	77	84	78	76	77	78.4	75-84	2.63
% Silt	17	13	13	14	11	14	9	13	15	18	13.7	9.0-17	2.63
% Clay	8	9	7	8	8	9	7	9	9	5	7.9	5.0-9.0	1.29
pH	5.76	5.74	5.67	5.45	5.73	5.7	5.62	5.65	5.72	5.71	5.675	5.45-5.76	0.09
Conductivity (dS/m)	47.8	48.3	42.6	42.3	45.4	44.7	43.6	44.1	47.2	46.8	45.28	42.3-48.3	2.16
Moisture content (%)	45.5	45.3	43.4	43.5	46.3	45.7	43.5	43.6	44.5	44.7	44.6	43.4-46.3	1.07
Nitrate (mg/kg)	6.34	6.35	6.47	6.51	6.33	6.32	6.28	6.32	6.43	6.44	6.379	6.28-6.51	0.08
Phosphate (mg/kg)	2.11	2.08	2.13	2.11	2.15	2.17	2.18	2.14	2.12	2.08	2.127	2.08-2.18	0.03
Sulphate (mg/kg)	3.44	3.43	3.38	3.35	3.47	3.45	3.41	3.39	3.44	3.43	3.419	3.35-3.47	0.04
Calcium (mg/kg)	30.3	30.5	33.5	34.2	31.7	31.5	35.5	34.5	32.6	32.4	32.67	30.3-35.5	1.74

Parameter	SS_1	SS_2	SS_3	SS_4	SS_5	SS_6	SS_7	SS_8	SS_9	SS_{10}	Mean	Range	SD
Magnesium (mg/kg)	2.85	2.87	2.76	2.78	2.68	2.71	2.81	2.83	2.65	2.67	2.761	2.65-2.87	0.08
Potassium (mg/kg)	1.56	1.58	1.61	1.63	1.49	1.51	1.46	1.48	1.38	1.41	1.511	1.38-1.63	0.08
Sodium (mg/kg)	0.24	0.31	0.22	0.24	0.25	0.26	0.18	0.21	0.23	0.25	0.239	0.18-0.31	0.03
THC (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron (mg/kg)	63.4	64.7	58.3	57.8	65.1	64.5	61.3	60.6	63.8	64.1	62.36	57.8-64.7	2.69
Lead (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (mg/kg)	0.21	0.17	0.05	0.03	0.11	0.13	0.22	0.24	0.18	0.21	0.155	0.03-0.24	0.07
Zinc (mg/kg)	2.05	2.11	2.12	2.08	2.13	2.14	2.15	2.17	2.08	2.15	2.118	2.05-2.17	0.04

Source: Fieldwork/Laboratory Analysis 2020