DRAFT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

FOR THE

PROPOSED 7,500KM OPEN METROPOLITAN FIBRE NETWORK IN LAGOS, OGUN, OYO, OSUN, ONDO, EKITI, KWARA AND KOGI STATE

BY

O'ODUA INFRACO RESOURCES LIMITED

SUBMITTED TO

FEDERAL MINISTRY OF ENVIRONMENT

Environment House, Mabushi, FCT, Abuja

DECEMBER, 2020

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LIST OF ABBREVIATIONS AND ACRONYMS

%	-	Percentage
^{o}C	-	Degree Celsius
A/C	-	Air Condition
AC	-	Alternate Current
AfDB	-	African Development Bank
ALARP	-	As Low as Reasonably Practicable
AQ	-	Air Quality
APPI	-	Area of Potential Project Influence
As	-	Arsenic
AS	-	Approach Surface
ASTM	-	American Society for Testing and Materials
ATCN	-	America Tower Company, Nigeria
Ba	-	Barium
BAT	-	Best Available Technique
BATNEEC	-	Best Available Technology Not Entailing Excessive Cost
BOD	-	Biochemical Oxygen Demand
BTRAIN	-	Backbone Transmission Infrastructure Network
BTEX	-	Benzene, Toluene, Ethylbenzene, and Xylene
C	-	Simpson's Dominance Index
Ca	-	Calcium
CATV	-	Community Antenna Television
CBD	-	Convention on Biological Diversity
Cd	-	Cadmium
CDC	-	Community Development Committee
CDMA	-	Code Division Multiple Access
CEC	-	Cation Exchange Capacity

CFC	-	Chlorofluorocarbons
CH_4	-	Methane
Cl^-	-	Chloride Ion
CLO	-	Community Liaison Officer
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
COD	-	Chemical Oxygen Demand
C.O.D	-	Corrugate Optic Duct
Cr	-	Chromium
CSR	-	Corporate Social Responsibility
Cu	-	Copper
dBA	-	Decibels
DC	-	Direct Current
Deg	-	Degree
DO	-	Dissolved Oxygen
EA	-	Environmental Assessment
EAG	-	Environmental Assessment Guidelines
EIA	-	Environmental Impact Assessment
EIS	-	Environmental Impact Statement
ESMP	-	Environmental and Social Management Plan
EMF	-	Electromagnetic Field
EMS	-	Environment Management System
EPA	-	Environmental Protection Agency
ESA	-	Environmentally Sensitive Areas
ESMS	-	Environmental and Social Management System
EPA	-	Environmental Protection Agency
Fe	-	Iron
FEPA	-	Federal Environmental Protection Agency
FGD	-	Focus Group Discussion

FOC	-	Fibre Optic Cable
FMEnv	-	Federal Ministry of Environment
FRN	-	Federal Republic of Nigeria
FRSC	-	Federal Road Safety Commission
Ft	-	Feet
FTTH	-	Fibre to the Home
GHGs	-	Greenhouse Gases
GIS	-	Geographical Information Systems
GPS	-	Global Positioning System
GSM	-	Global System Communications
GW	-	Groundwater
H_2S	-	Hydrogen Sulphide
HDD	-	Horizontal Directional Drilling
HDPE	-	High Density Polyethylene
HCO_3^-	-	Bicarbonate Ion
Hg	-	Mercury
HSE	-	Health Safety and Environment
HSE-MS	-	Health Safety and Environment Management System
HSSE	-	Health, Safety, Security, and Environment
HUB	-	Hydrocarbon Utilizing Bacteria
HUF	-	Hydrocarbon Utilizing Fungi
IAAF	-	International Amateur Athletic Federation
ICT	-	Information and Computer Technology
IFC	-	International Finance Corporation
IOT	-	Internet of Things
IPTV	-	Internet Protocol Television
ITCZ	-	Inter-Tropical Convergence Zone
ITU	-	International Telecommunication Union
K	-	Potassium

Km	-	Kilometre
Km/h	-	Kilometre per hour
KVA	-	Kilo Volt-Amps
LAN	-	Local Area Network
LAU	-	Land Use Act
Lat	-	Latitude
LCA	-	Life Cycle Analysis
LED	-	Light-emitting Diodes
LGA	-	Local Government Area
Long	-	Longitude
LRET	-	Long-Range Environmental Transport
MDS	-	Material Safety Data Sheet
Mg	-	Magnesium
MMF	-	Multi-Mode Fiber
Mo-Gas	-	Motor Gasoline
MPLS	-	Muilt-Protocol Label Switching
MSC	-	Mobile Switching Centre
N	-	Nermetea
N	-	North
NCC	-	Nigeria Communication Company
NEs	-	Network Elements
NESREA	-	National Environmental Standards and Regulations Enforcement Agency
NGOs	-	Non-Governmental Organisations
NH_4^+	-	Ammonium
NGDC	-	New Generation Green Data center
NGN	-	Nigerian Naira
Ni	-	Nickel
NiMet	-	Nigerian Meteorological Agency

NO_2	-	Nitrogen Dioxide
NO_3	-	Nitrate
NPC	-	National Population Commission of Nigeria
NPE	-	National Policy on the Environment
NW	-	North West
OAN	-	Open Access Network
OIRL	-	O'odua Infraco Resources Limited
OSH	-	Occupational Safety and Health
B-OTDA	-	Brillouin Optical Fibre Time Domain Analysis
OTDR	-	Optical Time Domain Reflectometer
PAH	-	Polynuclear Aromatic Hydrocarbons
PAST	-	Paleontological Statistics
Pb	-	Lead
PCB	-	Polychlorinated biphenyls
pH	-	Hydrogen ion concentration
Plc	-	Public Limited Company
PM	-	Particulate Matter
POA	-	Point of Access
POP	-	Persistent Organic Pollutants
PPE	-	Personal Protective Equipment
PVC	-	Polyvinyl chloride
QA/QC	-	Quality Assurance/ Quality Control
QHSE	-	Quality, Health, Safety, and Environment
RAID	-	Redundant Array of Independent Disks
RH	-	Relative Humidity
SEPA	-	State Environmental Protection Agency
SHOC	-	Safe Handling of Chemical
SIA	-	Social Impact Assessment
SO_4	-	Sulphate

SO_x	-	Sulphur Oxides
SOW	-	Scope of Work
Sp	-	Species
SPM	-	Suspended Particulate Matter
SM	-	Single-Mode
SMF	-	Single-Mode Fiber
SMS	-	Safety Management System
SONET	-	Synchronous Optical Networking
SSW	-	South South West
STI	-	Sexually Transmitted Infection
TAH	-	Total Aliphatic Hydrocarbon
TDS	-	Total Dissolved Solids
THB	-	Total Heterotrophic Bacteria
THC	-	Total Hydrocarbon Content
THF	-	Total Heterotrophic Fungi
TMAX	-	Temperature maximum
TMIN	-	Temperature minimum
TOC	-	Total Organic Content
TOCS	-	Take Off Climb Surface
ToR	-	Terms of Reference
TPH	-	Total Petroleum Hydrocarbon
TS	-	Transitional Surface
TSS	-	Total Suspended Solids
UNEP	-	United Nations Environment Programme
UNFCCC	-	United Nations Framework Convention on Climate Change
UNICEF	-	United Nations International Children Emergency Fund

US AID	-	United States Agency for International Developments
USB	-	Universal Serial Bus
USD	-	United States Dollars
USEPA	-	United States Environmental Protection Agency
V	-	Vanadium
V	-	Volts
VDU	-	Vacuum Distillation Unit
VOC	-	Volatile Organic Carbon
VOD	-	video-on-demand
VOIP	-	Voice Over Internet Protocol
VPN	-	Virtual Private Network
W	-	West
WDM	-	Wavelength Division Multiplexing
WHO	-	World Health Organization
WIFI	-	Wireless Internet for Frequent Interface
WMO	-	World Meteorological Organization
WMP	-	Waste Management Plan
WWTU	-	Waste-Water Treatment Unit
Zn	-	Zinc

LIST OF ESIA PREPARERS

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Declaration

O'odua Infraco Resources Limited, the proponent of *Open Metropolitan Fibre Network*, identifies and accepts responsibility for all statements and judgments made in this report entitled '*ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT OF OPEN METROPOLITAN FIBRE NETWORK IN LAGOS, OGUN, OYO, OSUN, ONDO, EKITI, KWARA AND KOGI STATES*'.

Executive Summary

1.1 Background Information

Internet usage in Nigeria has grown so exponentially that many of the services available for the people are internet based. There is a great potential for Internet bandwidth utilization in the country looking at the population of the country as the most populous Black Country in the world. The country presently has active submarine fiber optic cables connecting the country to the world through Europe deployed by different organizations with huge Internet broadband capacities. However, the Internet broadband penetration in the country is still very low with about 10% of the Oceanic Optical fiber capacities utilized and just 6% of fiber optic broadband penetration. Over 99% of the Internet broadband connection today in Nigeria is through the mobile wireless networks with less than 1% connection via the fixed wired/wireless.

In a bid to expand the networks infrastructure across the country and to provide more efficient services to the local consumers, Nigeria Communication Company (NCC) through O`odua Infraco Resource Limited wishes to embark on an Open Access Metropolitan Fibre Network (laying of Fibre Optic backbone and Metro) in Lagos, Ogun, Oyo, Osun, Ondo, Ekiti, Kwara and Kogi States. This project is part of government National Broadband Plan (2020-2025) that we lead to digital economy achievement, jobs and livelihood enhancement, e-learning, e-government, e-medicine, e-judiciary e.t.c.

Considering the associated and potential environmental and social effects that could attend the construction and operation of optic fibre, there is an obvious need for O`odua Infraco Resource Limited to plan for and implement a sound and cost-effective environmental management program. In line with the environmental statutory and regulatory requirements of the Federal Republic of Nigeria (FRN), State Governments, International Finance Corporation (IFC)/World Bank as well as O`odua Infraco Resource Limited corporate policy on environmental protection and sustainable development, the company decided to conduct an Environmental and Social Impact Assessment (ESIA) in line with Federal Ministry of Environment approval for the proposed Open Metropolitan Fibre Network project in Lagos, Ogun, Oyo, Osun, Ondo, Ekiti, Kwara and Kogi States in line with the regulatory requirements, and following the conditions of the EIA Act. Accordingly, O`odua Infraco Resource Limited **(the proponent)** commissioned Spatial Ecosystems Limited, Environmental, Health and Safety consultants (accredited by FMEnv, NESREA, DPR, and LASEPA) to carry out the ESIA its proposed Open Metropolitan Fibre Network project at the proposed locations in Lagos, Ogun, Oyo, Osun, Ondo, Ekiti, Kwara and Kogi States.

During the field survey, information on relevant environmental attributes in the project area that collectively represent the baseline characteristics of the project area was collected in line with the Federal Ministry of Environment (FMEnv) sampling guidelines. The data gathering involved the collection of samples for analyses as well as socio-economic consultation with various stakeholders of the area.

1.2 ESIA Objective

The assessment was carried out to amongst other things:

- determine the baseline (biophysical, social, and health) conditions of the proposed project environment;
- determine and document the sources of impact from the proposed development/project activities and identify the environmental, social, and health components of the environment that can be potentially impacted;
- proffer appropriate mitigation measures for negative impacts and make recommendations aimed at sustaining the beneficial impacts of the projects on the environment;
- aid early selection of best available techniques (including technology and method of operation) that can help in realizing the project environmental objectives; and
- develop cost-effective Environmental and Social Management Plan (ESMP) as well as provide recommendations for monitoring and management activities

1.3 ESIA Work Scope

The ESIA scope of work includes:

- Review of the relevant national and international regulatory framework.
- Extensive and comprehensive literature review specific to the proposed project site to generate background information on the environmental and social characteristics of the study area.
- One-season field sampling and survey of the project area and the use of previously approved EIAs.
- Review of legal and administrative framework.
- Assessment of all potential and associated impacts from the activities of the optic fibre development; from site preparation to operation. Impact assessment using a multi-criteria approach to evaluate their significance, duration, extent, and possible interaction with other impacts. Appropriate use of national and international standards as benchmarks.

- Development of appropriate and practicable mitigation measures for all identified negative impacts. Mitigation measures are expected to either completely prevent or ameliorate impacts to the barest minimum.
- Preparation of appropriate and cost-effective environmental management plan (EMP); to cover both short and long-term approaches. The EMP will equally include monitoring plans to ensure the effectiveness of the mitigation measures and identify possible residual impacts to improve on established measures.

1.4 ESIA Methodology

1) Project scoping exercise
2) Site verification
3) Desktop literature survey
4) Stakeholder consultation
5) Baseline field data gathering
6) Project impact assessment and development of mitigation measures
7) Development of Environmental and Social Management Plan
8) ESIA submission and
9) Post ESIA impact mitigation monitoring

1.5 Legal and administrative framework

The proposed project is affected by several national, state, and international legislation that has been considered by the ESIA. A review of relevant legislation was done and briefed.

- National Policy on Environment (1989, Revised 1999, 2016)
- Environmental Impact Assessment (EIA) Act CAP E12, LFN 2004
- Land Use Act L5 LFN 2004
- Forestry Law CAP 55, 1994
- Endangered Species Act (Cap 108), 1990
- Labour Act, 1999
- Harmful Wastes CAP HI LFN 2004
- Water Resources Act CAP W2 LFN 2004
- Embedded Generation Regulation, NERC, 2012
- Workmen Compensation Act, 1987
- Abandonment Guidelines 1995

- National Environmental Standards and Regulations Enforcement Agency (NESREA) Act 92, 2007
- National Guidelines on Environmental Audit in Nigeria, 1999 (revised in 2011)
- National Environmental (Sanitation and Wastes Control) Regulations, 2009 (S. I. 28)
- National Environmental (Noise Standards and Control) Regulations, 2009 (S.I.35)
- Nigerian Safety and Security of Radioactive Sources Regulations of 2006
- Employee Compensation Act of 2010
- Nigerian Communications Act, 2003
- Nigerian Urban and Regional Planning Act CAP N138, LFN 2004
- Powers of Standards Council -The SON Act Cap. S9 LFN 2004
- National Information Technology Development Agency Act of 2007,
- National Health Act 2014
- Public Health Law (L.N 47 of 1955, Cap 103)
- Nuclear Safety and Radiation Protection Act
- Oyo State Ministry of Environment and Natural Resources
- Oyo State Solid Waste Management Authority
- Ekiti State Ministry of Environment and Natural Resources
- Ekiti State Environmental Protection Agency
- Ekiti State Environmental Health and Sanitation Law 2004
- Ekiti State Urban and Regional Planning Law No. 86 of 1992.
- Lagos State Environmental Management and Protection Law (2017)
- Lagos State Waste Management Agency
- Ogun State Ministry of Environment
- Ogun State Environmental Protection Agency (OGEPA) Law of 1995
- Ondo State Ministry of Environment
- Osun State Ministry of Environment and Sanitation
- Osun State Ministry of Lands, Physical Planning and Urban Development
- Kwara State Ministry of Environment and Forestry
- Kogi State Environmental
- Protection Board Law of 2005
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal, 1989 (Nigeria signed the Basel Convention document on 15th March 1990 and ratified it on 13th March 1991. Nigeria also ratified the amendment to the Basel Convention on 24th May 2004)

- UNFCCC, Paris agreement of 2016 [The agreement was signed on 22 September 2016 and ratified by Nigeria on 16th May 2017]
- United Nations Guiding Principles on the Human Environment [Nigeria signed the Basel Convention document in 1992 and ratified in 1994]
- Polluters Pays Principle (Adopted by Nigeria in 1999)
- United Nations Framework Convention on Climate Change (1992)
- Nagoya Protocol of 2010
- Kyoto Protocol of 2004
- Cartagena Protocol on Bio-safety of 2003
- Montreal Protocol on Substances that Deplete the Ozone Layer, 1988

2.1 Justification of Project

The Internet society puts Nigeria at 128th for fixed broadband population penetration with 0.01% while the country was put at 101st in Internet user penetration globally with 38% penetration. Globally, internet broadband accessibility is the major driving force of development. World Bank has validated that a 10% increase in broadband penetration in developing countries guarantees a corresponding increase in GDP by 1.3%. Nigeria has huge internet broadband capacity at her shores through the submarine fiber optic cable to Europe which is not being maximized presently. Hence, there is an urgent need to deploy last mile technologies that will maximize the available internet broadband capacity

It is against this backdrop that the Nigerian Government instituted the Open Access Metropolitan Fibre Network to raise the level of ICT in government departments, attract the foreign investment, drive social & economic development and fulfil the Vision 2020 long-term development planning objective of Nigeria.

The Federal Government will provide subsidy incentives for the project to the tune of N4,828,991,703.59 (Four Billion, Eight Hundred and Twenty-Eight Million, Nine Hundred and Ninety-one Thousand, Seven hundred and three Naira, Fifty-nine kobo) while O'odua Infraco is spending Three (3) times more in the sum of N16, 509, 900, 000.00 (Sixteen Billion, Five Hundred and Nine Million, Nine Hundred Thousand Naira) In keeping with the project's quality standards, the project's useful life is estimated at 50 years.

2.2 Envisage Sustainability

The project's sustainability is addressed under the following:

Economic Sustainability: This project will be beneficial to the nation in so many ways. The project shall provide employment opportunities; support the local community and the nation economy as a whole. For example, during the construction phase of the object, indirect and direct job opportunities will be provided for skilled and semi-skilled labour force.

Technical Sustainability: The Open Metropolitan Fibre Network provides abundant and flexible access for citizens to use government service anywhere anytime. Open Metropolitan Fibre Network is a unified network that features horizontal physical network and vertical virtual network with MPLS VPN technology. Each department can keep its own independence. To ensure technical sustainability, the following principles shall be enshrined in the project:

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

Social Sustainability: There will be a Robust stakeholder engagement and also establishment of a grievance mechanism that will be designed to receive and facilitate the resolution of concerns and grievances about the Project's environmental and social performance as part of its Environmental and Social Management System (ESMS).

Environmental Sustainability: The project construction, installation and commissioning activities techniques vary according to the environment, and we are guided by Regulatory and Engineering Design standards. Working in marshy/swampy areas and water crossing would be approached using appropriate technologies to reduce risk levels. The regulatory requirements involving FMEnv, State and Local Government Councils environmental laws, regulations, standards and edits, and ratified international conventions as well as OIRL HSE policy, shall be adopted and implemented to sustain the project environmentally throughout the project's life span. Good housekeeping and waste management practices shall be adopted. There shall be continuous consultations with the host communities. There shall be strict adherence to the implementation of the Environmental and Social Management Plan (ESMP) to ensure sustainability of the project.

2.3 Project Options and Alternatives

The following options were appraised in the course of this proposed project:
No project options; Delayed project options; and Go-ahead option. The Project option chosen was Go-ahead option because it admits and emphasizes the vital need for the planned development. Considering its many benefits, this option was significantly weighed positive. This option will contribute to improved and increased production which will enhance the revenue base of Nigeria. It will also enhance job creation and many more direct and indirect socio-economic benefits.

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

a) Route alternatives
b) Transmission Technology Alternatives
c) Fibre Cable Type Alternatives
d) Duct Alternatives

3.1 Project and Process Description

The 7,500km of Backbone and metro network shall be constructed from Lagos to Ogun, Ogun to Oyo, Oyo to Osun, Osun to Ondo, Ondo to Ekiti, Ekiti to Kogi and Oyo to Kwara. The Data Center will be setup in Lagos, and some Metro access system located in cities like Ibadan. Akure, Ado Ekiti, Osogbo, Abeokuta Ilorin and Lokoja. A point of Access (POA) shall be setup in all the 117Local government Areas and viable locations in the southwest region including Kwara and Ogun States.

3.2 Project Activities

The project activities will broadly cover the following areas:

- **Pre-construction activities include**
  - Acquiring of Right of Way (Row)
  - Site Preparation (Vegetation and Land Clearing)
  - Materials Delivery, Etc.
  - Mobilisation (Transport) to the Site (Equipment, Personnel and Construction Modules)
- **Construction activities include**

- Trenching of Fibre Optic route
- Laying of Fibre cables
- installation of various equipment, power generation equipment, etc.
- Civil works
- Backfilling
- Commissioning of Optic Fibre
- Demobilization

- **Operational activities include**
  - Operation of the Open Access Metropolitan Fibre Network
  - Maintenance or inspection of fibre cable along the RoW
  - Maintenance of data center and Metro access system locations
- **The decommissioning activities include**
  - Removal of Open Access Metropolitan Fibre Network for relocation or sale

The optical fiber is made up of two concentric cylindrical strands of silica surrounded by a plastic coating. The center most silica strand is the cone of the fiber with a refractive index1 of approximately 1.48. The core of the fiber physically transports most of the optical power. The core is surrounded by another strand of silica called the cladding. The cladding has a slightly lower refractive index, 1.46 and provides the interface that confines the optical signal to the core. The outermost layer of the optical fiber is the buffer coating. This thin plastic covering protects the glass from mechanical and environmental damage.

Fiber with large (greater than 10 μm) core diameter may be analyzed by geometric optics. Such fiber is called *multi-mode fiber*, from the electromagnetic analysis. In a step-index fiber, rays of light are guided along the fiber core by total internal reflection. Rays that meet the core-cladding boundary at a high angle (measured relative to a line normal to the boundary) are completely reflected. The minimum angle for total internal reflection is determined by the difference in index of refraction between the core and cladding materials. Rays that meet the boundary at a low angle are refracted from the core into the cladding, where they are not useful for conveying light along the fiber. In this way, the minimum angle for total internal reflection determines the *acceptance angle* of the fiber, often reported as a numerical aperture. A high numerical aperture makes it easier to efficiently couple a transmitter or receiver to the fiber

Data Center is the heart of the platform. It will have a network equipment area to provide centralized maintenance for network equipment such as the service access switch, service convergence router, firewall, and egress router. It provides high-speed and convenient service for public.

The Cloud Computing System includes following aspects:

1) Automated Operations Portal
2) Real-time Monitoring & System Self-healing
3) Cloud storage
4) Service operation and manager system of New Generation Green Data center (NGDC)
5) Unattended network management
6) Visualization of business management

Fibre Laying Techniques include the following: Ducting & Trenching, Horizontal Directional Drilling, Crossings, Splicing e.t.c.

For the proposed project maintenance, there shall be preventive maintenance and post-fault maintenance. For preventive maintenance, all activities shall be performed using spare (inactive) fibres or working (active) fibres that are multiplexed with the transmission signals without interfering with the transmission signals. On the other hand, from the standpoint of post-fault maintenance, optical fibre cable maintenance involves reception of a transmission system alarm or trouble report from a customer, fibre fault testing, and cable repair/cable removal (that is, cable re-routing).

3.3 Waste Management Plan

Wastes shall be generated during all the phases of the **proposed project** i.e, the preconstruction, construction and operation such as used filters, used oil, decommissioned diesel generators (DGs, decommissioned Air Conditioners (ACs), used batteries, brown waste – grass cuttings, dry leaves and fibre optic cables
. O'odua Infraco Resources Limited (**OIRL)** through its **Contractor** shall engage government approved waste handlers in each State for management of hazardous and non-hazardous wastes.

OIRL waste management procedure describes details with respect to authority and responsibility, resources, standards and procedures, inspections, waste management, control and emergency procedures.

The waste management procedure specifies responsibilities of the MD/CEO with respect to provision of resources. The Environment unit is responsible for co-ordination of all activities, monitoring and ensuring compliance, documentation, and maintenance records amongst others. The Environment Specialist shall ensure effectiveness and success of the procedure, proper documentation of source, quantity, destination and proper tracking of all wastes till disposal/reuse/recycling and ensure that contractors comply with objective of this procedure.

RoW Supervisors monitors the **Contractors** who are responsible for the collection and segregation of all wastes in the site, storage of these wastes before their final disposal/reuse/recycling by the State approved waste handler and maintain records of waste materials generated from the site. All employees shall work strictly in accordance with laid down instructions and procedures to ensure minimal waste generation at source, proper disposal/reuse/recycling of all wastes and proper response in times of environmental emergencies.

The wastes shall immediately be removed from site and transferred through the engaged waste handlers. The 3R of (Re-use, Recycle and Reduce) principle of waste management shall be adopted in managing the waste that shall be generated during the implementation of the project

3.4 Project Schedule

The project is scheduled to reach completion in 3 years. On approval of the project ESIA by FMEnv, hopefully in the fourth quarter of 2020, site preparation will commence immediately. This will run concurrently with preparation for procurements. This will follow by Trenching of Fibre Optic route, Laying of Fibre cables, installation of various equipment, power generation equipment, etc.) and civil works. The commission is envisaged in the fourth quarter of 2022.

4.1 Baseline Social and Environmental Characteristics of the Project Area

The baseline environmental and social characteristics of the proposed project area were established based on one (1) climatic season on-site field sampling carried out in the study area. The wet season field sampling exercise was conducted on Monday 15th through Saturday 26th September, 2020 while the secondary data for dry season was culled from phase 11 ATCN EMP report for Lagos, Ondo, Oyo, Osun, Ogun, Kogi and Kwara states which was carried out between 6th and 15th March 2020.

The baseline condition was stabled for the following components of the environment

1) Weather and climate
2) Air quality and Noise
3) Surface water
4) Groundwater
5) Soil
6) Sediment
7) Vegetation and wildlife

The sampling was carried out in accordance with the requirements of *EIA Act CAP E12, LFN 2004***.** Grid and transect sampling approaches were adopted with respect to environmental components intended for sampling. A total of Seventy-Two (72) geo-referenced sampling stations and additional twenty-four (24) control points were established for air quality, noise, soil and vegetation (3 samples and 1 control for each senatorial district in each state) while twenty-four (24) geo-referenced sampling stations and additional 8 controls points were established for groundwater (1 sample and 1 control for each senatorial district in each state). For surface water and sediment, fifteen (15) geo-referenced sampling stations and additional 3 controls points were established in line with the FMEnv ESIA Terms of Reference (ToR).

4.2 Description of the Baseline Environment

The study area which is located in South-western Nigeria. Southwestern Nigeria lies within longitude 2^0 48' - 6^0 0' E and latitude $5^0$5' - 9^0 12'N. Southwestern Nigeria has two distinct seasons; the dry season, from November to March and the raining season, which is from April to October. Southwestern Nigeria lies within what has been classified as warm humid climate.

Rainfall

The south Western region of Nigeria experiences a double rainfall maxima characterised by two high rainfall peaks, with a short dry season and a longer dry season falling between and after each peak. The first rainy season begins around March and last to the end of July with a peak in June, this rainy season is followed by a short dry break in August known as the August break which is a short dry season lasting for two to three weeks in August. This break is broken by the short rainy season starting around early September and lasting to mid-October with a peak period at the end of September. The ending of the short rainy season in October is followed by long dry season. This period starts from late October and lasts until early March with peak dry conditions between early December and late February

The annual rainfall received in this region is very high, usually above the 2,000 mm (78.7 in) rainfall totals giving for tropical rainforest climates worldwide.

Wind Speed and Direction

The annual mean wind speeds in the study areas ranged from about 2 to 9.5 m/s and the annual power density range between 3.40 and 520 kW/m^2 based on recent reported data. The trend shows that wind speeds are low in the south and gradually increases to relatively high speeds in the north. Generally, the wind in the study areas varies between the gentle breeze, moderate breeze and high breeze.

The proposed project would have no effect on the wind direction. However, wind could aid the distribution of pollutants in the areas.

Relative humidity

The regional Relative Humidity data of the study areas are presented in Figure 4.31 to Figure 4.45 and it shows the pattern of variation at various periods of the year. Relative humidity is highest at the peak of rainy season and lowest at peak of dry season. It could be as high as 80% between night and morning during wet season and as low as 18% at mid-day during dry season. Generally, the drier months between December and February have lower values.

Air pollutant gases and greenhouses gases are important air quality indicators. Given the nature of the project with the potential for emissions, these gases were determined in situ. The study showed that most of the pollutant gases such as hydrogen sulphide (H_2S), Oxides of sulfur (SOx), Nitrogen oxides (NOx) and greenhouse gases such as Carbon monoxide (CO) and NOx were below the stipulated limits by the FMEnv.

The concentration of particulates in the ambient air during dry season ranged from 19.35 µg/m³ to 127.18µg/m³ (mean value of 68.631µg/m³) for particle size of 10 micron. During wet season, SPM ranged from 31.4 µg/m³ to 87.7µg/m³ (mean value of 59.5µg/m³). All the values recorded for particle size were below the FMEnv limit of 250µg/m³.

The results of Power Density intensities measured at the site were very low ranging from 0.001 to 0.016 µW/m² during wet season and from 0.020 to 0.380 µW/m². When compared with the ICNIRP limits, the values obtained from both dry and wet seasons were very low.

The average noise levels recorded at the project areas during dry season was 44.87 dB and 51.00dB during wet season. A large proportion of background noise in the area is due to human activities around the project area. In spite of this, the mean values recorded were below the FMEnv limit of 90dB (A) for 8 hours exposure respectively.

Groundwater

During the wet season the values of pH ranged from 5.7 which was slightly acidic to 7.4 which was slightly basic during dry season while it ranged from 6.82 which was slightly acidic to 8.1 which was slightly basic.

The water Turbidity ranged from 0.00 to 19 NTU during the wet season while it ranged from 0.00 to 1.0NTU during dry season. Total Suspended Solids ranged from 0.5 to 27.0mg/L during wet season while it ranged from 0.00 to 11.0mg/L during dry season. Electrical conductivity varied between 9.0 and 43.5µS/cm in wet season and 120.2 to 892µS/cm during dry season.

The groundwater Dissolved Oxygen (DO) recorded for wet season was between 3.21 and 4.75 mg/L while it was between 0.00 and 5.2mg/L during dry season.

Sodium has values ranging from 1.6 to 77.23 mg/L and 0.29 to 21.1mg/L during wet and dry seasons respectively. Also, Potassium has values ranging from 0.03 to 9.74 mg/L during wet season and 0.00 to 2.45mg/L during dry season. Calcium ranged from 70.161 to 7.795mg/L during wet season while it had a mean value of 11.675mg/L during dry season. The heavy metal concentration values were low in all the sampling locations during the two seasons under consideration and do not pose any pollution threat related to hydrocarbon contamination.

Surface water pH recorded ranged from 6.05 to 6.97 which is slightly acidic with a mean value of 6.51 during wet season
COD concentration ranged from 15 to 54mg/L with a mean of 34.5mg/L during wet season
Electric conductivity refers to the total ionic composition of water. In many cases, the electrical conductivity can be correlated with the Total Dissolved Solids (TDS) levels. Conductivity ranged from 20 to 70.6us/cm with a mean of 45.3us/cm. TDS on the hand ranged from 12.8 to 36mg/L during wet season.

Calcium had 36.58mg/L; the average sodium concentration was 25.93mg/L; while potassium retuned average value of 4.56mg/L. Heavy metal concentrations were generally low and within acceptable limits, with Iron ranging from 0.3mg/l to 1.89mg/L; barium having a constant value at all the locations with a concentration of <0.001mg/l. Also, chromium, nickel and vanadium were below equipment detection limits of 0.001mg/l.

Sediment Studies
The sediments in the entire area were mainly acidic with pH ranging from 6.0 to 6.9.

Total Organic Carbon (TOC %): The sediments exhibited wide variability in terms of total organic carbon content. TOC ranged from 1.79 to 5.3%, with a mean value of 3.55%. The production, accumulation and degradation of organic matter are greatly dependent on climate. Temperature, sediment moisture and topography are the major factors affecting the accumulation of organic matter in sediments. Electrical Conductivity (E.C): The E.C. of the sediments varied between 10 to 220 µS/cm with a mean value of 115µS/cm.

Total Hydrocarbon Content (THC): The THC of the sediments ranged from 0.01 to 0.13mg/kg in all the locations.

The mean concentration of the heavy metals and related sediment micronutrient elements were as follows; Iron (390 mg/kg), Chromium (0.025mg/kg), Nickel (2.846 mg/kg), Barium (<0.001 mg/kg). These values are consistent with levels of these metals as found in non-contaminated or none anthropogenically impacted sediments.

Soil Studies

The pH of the top soil in the wet season ranged from 6.0 to 6.9which is slightly acidic while the subsoil also ranged from 6.0 to 6.9 which is slightly acidic. However, during dry season, pH ranged from 4.9 which was acidic to 8.22 which was basic for top soil while the subsoil ranged from 4 to 9.87 which was basic.

In the topsoil samples collected in the wet season, sodium ranged from 10.3 to 206.16mg/kg, with a mean value of 108.25mg/kg; potassium ranged from 6.27mg/kg to 86.15mg/kg, with a mean value of 46.21mg/kg; while calcium ranged from 10.86mg/kg to 167.43mg/kg, with a mean of 89.15mg/kg.

In the bottom soil samples collected in the wet season, sodium ranged from 7.11mg/kg to 142.63mg/kg, with a mean value of 74.87mg/kg; potassium ranged from 7.07mg/kg to 76.14mg/kg, with a mean of 41.61mg/kg; while calcium ranged from 9.87mg/kg to 157.43mg/kg, with a mean of 83.65 mg/kg.

In the topsoil samples collected in the dry season, sodium ranged from 0.513 to 69.32mg/kg with a mean value of 34.91mg/kg; potassium ranged from 0.34mg/kg to 24.09mg/kg, with a mean value of 12.21mg/kg; while calcium ranged from 2.16mg/kg to 75mg/kg, with a mean of 38.58mg/kg.

In the bottom soil samples collected in the dry season, sodium ranged from 0.548mg/kg to 75.67mg/kg, with a mean value of 38.11mg/kg; potassium ranged from 0.15mg/kg to 18.5mg/kg, with a mean of 9.33mg/kg; while calcium ranged from 3.01mg/kg to 100mg/kg, with a mean of 51.51mg/kg.

The mean concentration of heavy metals in top soils as obtained in the wet season were: Fe(584.15mg/kg) Cu(0.66mg/kg), Zn(61.5mg/kg), Cd(<0.002 mg/kg), Cr(0.124mg/kg), Pb(3.53mg/kg), Ni(0.745 mg/kg), V(<0.002 mg/kg).

Also the mean concentration of heavy metals in sub soils as obtained in the wet season were: Fe(495.12mg/kg) Cu(0.934mg/kg), Zn(0.425mg/kg), Cd(<0.00 mg/kg), Cr(0.282mg/kg), Pb(3.517mg/kg), Ni(0.92mg/kg), V(<0.002 mg/kg).

On the other hand, the mean concentration of heavy metals in top soils as obtained in the dry season were: Fe(306.6mg/kg) Cu(15.97mg/kg), Zn(11.66mg/kg), Cd(<0.605mg/kg), Cr(24.57mg/kg), Pb(0.98mg/kg), Ni(0.48mg/kg), V(0.11 mg/kg).

Also, the mean concentration of heavy metals in sub soils as obtained in the dry season were: Fe(343.7mg/kg) Cu(17.71mg/kg), Zn(14.22mg/kg), Cd(0.95 mg/kg), Cr(29.44mg/kg), Pb(1.43mg/kg), Ni(0.75mg/kg), V(0.125 mg/kg).

4.3 Flora and Fauna

The vegetations along the optic fibre routes are rich in species diversity and the floristic composition is characterized by the following: *Raphia hookerii, Uapaca hendolotic, Elaeis guineensis, Pterocarpus santalinoides, Cleiostopholis patens, Anthocteista vogelii, Symphonia globulifera Mitragyna ciliata, Dalbergia ecastaphythm, Alchornea cordifolia, Ficus spp., Treculia africana. Rauwolfia macrophylla, Funtumia africana, Alstonia cinerria, Musanga necropolises, Albania spp., Klainedoxa gabonensis, and Irvingia gabonensis Necropolises, Albania spp., Klainedoxa gabonensis, and Irvingia gabonensis* occur in this ecotype mostly.

The species according to Raunkaerian classification showed that most of the plant species belong to the Phanerophytes. The helophytes and epiphytes were the least. This shows the woody nature of the forest. There is a serious and indiscriminate exploitation of the fresh forest water species. Restriction and strict laws on felling and logging is necessary in such areas.

The physiognomy of the vegetation of the project site is classified into three distinct layers, namely the upper, middle and the lower layers. The upper layer include species of Alstonia booneii, Piptaderiastrum africanum, Klainedoxa gabonensis etc. The second canopy layer is completely closed with marked canopy contact. Species in this layer are between 11 – 18 m tall and include Cleiostopholis patens, Raphia spp., Anthocleista vogelii, Uapaca hendelotii, Musanga cecropoides. The lowest strata is poor in species composition and occupied by herbs, ferns, grasses, sedges and some lianas. These include Maranthocloa congensis, Cyrtosperma senegalensis, Afromomum spp., Costus afer and Diplazium sammantic. In the gaps, dense tangles of shrubs and lianas practically form impenetrable vegetation closely held together. These completely cover and overhang the entire forest.

Fauna involved a survey/census of mammals, birds' reptiles, and amphibians around the study area Grey Dove, Kite, Hawk, Eagle, Gorilla, Pigeon, Crocodile, Owl, Deer, Cane Mouse, Squirrel, Shrew, Grasscutter, Yellow Antelope, Monkey, Pigmy

Hippopotamus, Bush Pigs, Porcupine, Civet cat, Tortoise, Monitor Lizard, Agama Lizard, Snake Lizard, Alligator, Cobra.

Geology of the Study Areas

Geology of Oyo State

Oyo State is entirely underlain by Precambrian basement complex rocks. The basement complex is dominated by undifferentiated quartzo-feldspathicbiotite- and hornblende-bearing gneisses, schists and migmatites (Wright *et al*., 1985). Intercalated among the gneisses and migmatites are numerous supracrustal relics which are referred to as the "older metasediments" in Nigeria. They are structurally complex which helps to distinguish them from the "younger metasediments". Older metasediments occur as a northeast-north trending, discontinuous bands through the western and eastern parts of Oyo State.

Geology of Lagos State

The study area and its environs lie within the extensive Dahomey basin, containing Recent - Cretaceous sediment built-up. The basin extends from the eastern part of Ghana through Togo and Republic of Benin to the western margin of the Niger/Delta basin, just before the Mahin mud coast in Nigeria. The basin is separated from the Benue trough by a basement ridge, a paleographic highland. It is bounded in the east by Benin hinge line, a major regional fault structure marking the western limit of the delta basin.

Geology of Ondo State

There are two geological formations in Ondo state. These are

- Region of sedimentary rocks in the south-the sedimentary rocks are mainly of the PostCretaceous sediments and the cretaceous Abeokuta formation.
- The region of precambrian basement complex is mainly of the medium grained gneisses. These are strongly foliated rocks frequently occurring as outcrops. On the surface of these outcrops, severely contorted alternating bands dark and light colored minerals can be seen. These bands of light colored minerals are essentially feldspar and quartz, while the dark colored bands contain abundant biotic mica. A small proportion of the state, especially to the north east overlies the coarse grained granites and gneisses, which are poor in dark ferromagnesian minerals. Some few kilometers north of Aaye occurs the basement complex: sedimentary rocks boundary.

Geology of Ogun State

The geology of the Project Area comprises sedimentary and basement complex rocks, which underlie the remaining surface area of the state. It also consists of intercalations of argillaceous sediment. The rock is soft and friable but in some places cement by ferruginous and siliceous materials. The sedimentary rock of consists of Abeokuta formation lying directly above the basement complex. This in turn is overlain by Ewekoro, Oshosun and Ilaro formations, which are all overlain by the coastal plain sands (Benin formation).

Geology of Ekiti State

Ekiti State is underlain by metamorphic rocks of the PreCambrian basement complex, the great majority of which are very ancient in age. These basement complex rocks show great variations in grain size and in mineral composition. The rocks are quartz gneisses and schists consisting essentially of quartz with small amounts of white micaceous minerals.

In grain size and structure, the rocks vary from very coarse-grained pegmatite to mediumgrained gneisses. The rocks are strongly foliated and they occur as outcrops especially in Efon-Alaaye and Ikere Ekiti areas (Smyth and Montgomery, 1962).

Geology of Osun State

Geology of the study area is covered by Iwo Sheet 60 on a scale of 1:250 000 with structural features exhibited by rocks including foliation in the gneisses, lineation, folds, faults and joints. Rocks found all over the study area are schists, associated with quartzite ridges of the type in Ilesa area. The basement rocks are categorized by Rahaman (1976) as migmatite gneiss, quartzite, politic schist, biotite granite, charnockite, granite, gneiss and porphyritic granite. The study area basement complex is of different groups. The first group consists of the migmatite complex, including banded magmatic, auguen gneisses and peg matites with outcrops in Ilesa and Ife Areas. Metasediments consisting of schiests and quartzites, calsilicates, meta conglomerates, amphibiolites and metamorphic iron beds make up the second group. They are found in Iwo and Ikire areas. Other parts of the State are underlain by undifferentiated metamorphic rocks.

Geology of Kogi State

The northern segment of the area falls within the southern middle Niger Embayment (Bida Basin) covering places like Lokoja, Obajana and Koton- Karfi. The zone comprises of the Agbaja Ironstone Formation (Jones, 1958), Lokoja Formation and Patti Formation, which are essentially made up of conglomerates, coarse to fine grained feldsparthic, sandstones, siltstones (Gegubeki) clay and oolitic, pisolitic and concretionary ironstone.

Geology of Kwara State

Kwara state is largely underlain by the Pre-Cambrian basement complex rocks hence the characteristic formation of inselberg landscape. This relief system is generally flat and marked by numerous domed-shaped hills and by occasional flat-topped ridges varying in height from 300m to 700-m. The northeastern part of Kwara State is referred to as the Yorubaland Plateau, beyond which the elevations begin to decrease towards the Niger River basin.

4.5 Baseline Social and Economic Condition

The primary objective of this study was to survey the baseline social and economic features of Oyo, Ondo, Osun, Ekiti, Ogun, Kwara, Kogi and Lagos States' communities where the proposed project is located. The aim of the study was to ascertain the potential effects of the proposed project on the social and economic lives of the people of the community including potentially positive effects. Specifically, this study was undertaken to achieve the following objectives:

- Establish baseline Socio-economic and Health Status of the host community.
- Identification or definition of ameliorative/mitigation/enhancement measures such as to protect and promote socio-economic and public safety.
- Advise on management or implementation plan so as to control levels of impacts.
- Define a monitoring mechanism that would ensure performance.
- Incorporate Socio-economic and Health factors in decision making.

Methodology of the Study

These were a modification of focus Group Discussion (FGDs) aimed at involving the local people as part of consultation and community engagement. The groups were made up of village head, clerics, representatives of the youth, and some selected elders of the communities. The objective of the group discussions was to identify community's perception of the proposed project, the problems associated with it, and how such problems may be mitigated. Information from such discussions was used to confirm and cross check the veracity of some of the answers provided in the questionnaires. A well-structured questionnaire was designed, field tested for cultural acceptability, amended and adopted. Interviewers were trained to administer the questionnaire on community members. All comments and contributions from the respondents were noted.

A total of One Thousand, Two Hundred (1,200) questionnaires based on 50 questionnaires per a senatorial district were administered and Eight Hundred and Fifty-five (855) were retrieved. (See sample questionnaire at appendix 4.2). The questionnaires were administered based on age, gender, occupation income, access to infrastructure in the project locations. The questionnaires were designed to provide the age, occupation, educational level, waste and sewage disposal method, common ailment of the residents in the past six months. Also, to know the perception of the residents along the optic fibre routes about the proposed project.

5.1 Associated and Potential Impacts of the Project

The proposed projects will interact with the environment in various ways known as the "*development's aspects*" which could cause change or alteration in the baseline environmental condition, this change is known as ''*impact*''. The identified environmental aspects of the proposed development that can cause impacts on the environment include:

Pre-Construction phase activities

- Acquiring of Right of Way (Row)
- Site Preparation (Vegetation and Land Clearing)
- Materials Delivery, Etc.
- Mobilisation (Transport) to the Site (Equipment, Personnel and Construction Modules)

B. Construction phase activities

- Trenching of Fibre Optic route
- Laying of Fibre cables

- installation of various equipment, power generation equipment, etc.)
- civil works
- Backfilling
- Commissioning of the proposed project
- Demobilization

C. The operational phase activities are

- Operation of the Open Access Metropolitan Fibre Network
- Maintenance or inspection of fibre cable along the RoW
- Maintenance of data center and Metro access system locations

D. The decommissioning activities include

- Removal of Open Access Metropolitan Fibre Network for relocation or sale

The overall intent of the ESIA study is to identify and characterise all the associated and environmental impacts or effects that will be caused by the Open Access Metropolitan Fibre Network project. Though there are several approaches for the prediction and evaluation of project environmental impacts, the ISO 14001 method was selected for this study. The ISO 14001 method is simple to apply, provides a high level of detail, and relies on limited data.

Based on the method adopted, impacts ranging from low to severe significance were identified, qualified, and quantified. Among the impacts that have high significance ranking include:

a) Temporary displacement of people along Optic fibre RoW
b) Injury and trapped impact to personnel from heavy lifting during construction
c) air pollution and climate change potential arising from fugitive emissions
d) surface water contamination from wastewater and effluent discharges
e) explosion and fire from routine activities and accidental occurrences
f) noise pollution from process equipment
g) land and water pollution from potential oil spill incidents
h) Traffic and transport impact from the loading of finished products

6.1 Mitigation Measures

The actions and measures that O'odua Infraco Resources Limited intends to take to reduce (or eliminate) negative impacts and promote positive environmental, social, and health impacts of the proposed project are therefore presented in this chapter. In these mitigation measures, the emphasis is placed on those negative impacts rated as significantly medium and high. These measures are aimed at reducing the impacts to As Low As Reasonably Possible (ALARP). The residual impacts that could arise despite these mitigation measures were also noted. Significant negative impacts are expected to be mitigated through effective implementation of the Health, Safety, and Environment (HSE) policies put in place during the different phases of the project

Residual Effects can be considered as those that remain significant following the application of mitigation measures, although they are likely to have been reduced in magnitude as a result of the mitigation measure implemented.

Overall, on balance, with the provision of the proposed mitigation measures outlined, the positive impacts of the scheme will considerably outweigh the negative impacts. The public as a whole will benefit from the completion of the project.

Once the mitigation measures outlined are implemented, the residual impact of construction and operation on the different elements identified will not be significant.

An overall mitigation measure is to undertake a Job Hazard Analysis, to enable each worker to assess the risks associated with the job and work safely using procedural guidelines in handling equipment and the facilities.

Effective and responsible handling and disposal of wastes are key elements in the environmental management system. Wastes refer to any material (solid, liquid, gaseous, or mixture) that is surplus to requirements. Waste management for the project shall be carried out in line with the OIRL waste management policy and guidelines, as well as international best practices.

OIRL shall take all practical and cost-effective measures to minimise the generation of wastes, by employing the four Rs (Reduce, Reuse, Recycle, and Recovery) through the process of optimization or redesign, efficient procedures, and good housekeeping.

Waste shall be managed in the following ways:

- Inventorisation
- Classification
- Segregation
- Wastes quantification
- Wastes tracking; and
- Wastes disposal

7.1 Environmental and Social Management Plan (ESMP)

OIRL has established a comprehensive Environmental and Social Management Plan (ESMP) to achieve its corporate health, safety, and environment (HSE) policy objectives and to fulfill its regulatory compliance requirements to FMEnv, NCC and State Ministries of Environment. This ESMP is developed to help fulfill the requirements for environmental protection as stipulated in Environmental Impact Assessment (EIA) Act Cap E12, LFN 2004. The ESMP provides the procedures and processes that will be used to check, monitor, and continually improve the effectiveness of the recommended mitigation and enhancement measures.

Risk Assessment and Management Plan

Risk assessment and management shall be an integral part of the proposed project's execution. Risks related to project execution and operations shall be identified by a structured approach. Risk assessments shall be planned and conducted in advance of appropriate activities to allow resolution of risk without schedule interruption. Personnel shall be included in risk assessments to ensure that risks are correctly identified and assessed.

Emergency Response Plan (ERP)

OIRL has developed plans and procedures to identify the potential for and response to environmental accidents and health and safety emergencies and for preventing and mitigating potentially adverse environmental and social impacts that may be associated with them.

The objective of the ERP is to ensure that any emergency affecting the place of operational activities is dealt with efficiently and professionally so that the safety of personnel is not compromised in any way, the environmental pollution risks are prevented or minimized, and that all other losses which may arise from emergencies are prevented or minimized. The ERP addresses emergency response procedures for the Contractor, Subcontractors, and all personnel working for the Project.

Emergency Incident Reporting

In a situation of a fire outbreak or other emergency that poses an immediate danger to people or property, an employee should sound the fire alarm if they can do so safely before evacuating. Follow emergency evacuation procedures. An employee should calmly notify others, and respond to the emergency as appropriate. Procedures for responding to specific types of emergencies are described below. Do not attempt to handle emergency duties – e.g., firefighting – for which you do not have training.

Community Engagement Policy

Community is made up of the people who live, work, visit, or invest in the communities along the optic fibre Right of Way. Community Engagement is the process through which the community is informed about and/or invited to contribute, through consultation or involvement, to proposals or policy changes relating to their communities, events, strategic plans, issues, and projects.

7.2 Performance Indicators Monitoring

The ESMP also incorporated the Performance Indicators Monitoring Programme which will be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. The Monitoring Program recommends construction phase surveillance and operation phase monitoring to be jointly carried out by a third party consultant and HSE department.

A weekly monitoring programme was recommended for emissions, noise, and wastewater quality monitoring. Other parameters such as surface water, groundwater, and soil qualities could be monitored every quarter. A three year (3) environmental audit was also recommended for the facility in line with FMEnv requirement.

8.0 Decommissioning and Restoration Plan

The life span of any proposed project is hinged on some considerations. It is important to put in place plans to recover and/or restore the project site to its original state after the project is closed or decommissioned. This requires a good understanding of all the environmental components of the project on the ecosystem during its lifespan (50 years). At the decommissioning stage, the facility is taken out of its current operational use with the isolation of its units. When a project has undergone this process, it is then abandoned or modified for reuse.

Outline of Planning and Implementation Programme are as follow:

1) OIRL shall commence activities related to decommissioning, at least, one (1) year before abandonment,
2) Determine the scope of decommissioning,
3) Engagement and due consultation of stakeholders (including FMEnv, State Ministries of Environment,, communities, NCC, etc.) shall be instituted,
4) Put in place a Decommissioning Plan Report for review and approval by FMEnv. The plan shall include:
    - identification of all components of the project that will be disengaged, removed, or exhumed;
    - method(s) for removal or re-use of any project unit/ material if applicable;
    - effort being put in place to mitigate any environmental impacts associated with the decommissioning process; and
    - appropriate site remediation/rehabilitation programme
5) Ensure the safety of operation, taking into consideration all appropriate international conventions, regulatory requirements, and corporate policies.
6) Remove all structures (surface and sub-surface structures) with due regard for the protection of the environment.

Following decommissioning and abandonment, OIRL shall carry out site remediation and restoration work as part of the project's environmental management programmes. This will entail:

1) A survey of the decommissioned site for contamination as part of a conceptual site model and a strategy plan;
2) Evaluation of the site hydrology and geology;
3) Preparation of a site assessment report to be approved by FMEnv and NCAA

4) Interim action or remediation is designed to confirm the applicability and feasibility of one or more potential remedial options.

9.1 Conclusion

Open Access Metropolitan Fibre Network Environmental and Social Impact Assessment (ESIA) draft report was prepared *following the Environmental Impact Assessment (EIA) Act CAP E12, LFN 2004*. The study area baseline environmental description was based on one season of field sampling consolidated by a review of previous studies on the same environment.

The goal of the ESIA process was to get to a position where the Project does not have any major residual impacts on the environment, certainly not ones that would endure into the long term or extend over a large area. Therefore, following the application of mitigation measures, the residual impacts became short-term, mostly localized, and reversible. Similarly, recommendations were also proffered for the beneficial impacts of the projects to enhance/sustain them.

To establish the project's operational requirements aimed at ensuring it delivers its stated business objective in an environmentally responsible manner, an Environmental and Social Management Plan (ESMP) was developed. The ESMP translated the mitigation/enhancement measures to action points. Similarly, performance indicators monitoring and audit programmes were recommended. This is to ensure that all impact indicators for the various environmental components are within statutory limits throughout the project life. To this end, O'odua Infraco Resources Limited hereby solicits approval of the project by the Federal Ministry of Environment (FMEnv).

Acknowledgment

O'odua Infraco Resources Limited sincerely appreciates the representatives of the Federal Ministry of Environment, State Ministries of Environment for Oyo, Ondo, Osun, Ogun, Lagos, Ekiti, Kwara and Kogi, and Nigerian Communications Commission for the unflinching supports they gave throughout the assessment study. The contributions of the O'odua Infraco Resources Limited and Spatial Ecosystems Limited study team (the ESIA Consultant) are also generously recognised and appreciated.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Information and Computer Technology (ICT) applications gives ability to individuals and the society at large to directly contribute to the efficiency of a country's economic development in this global information and knowledge exchange age. ICT plays a very important role in promoting sustainable development of each country in the 21st century.

Internet usage in Nigeria has grown so exponentially that many of the services available for the people are internet based. There is a great potential for Internet bandwidth utilization in the country looking at the population of the country as the most populous Black Country in the world. The country presently has active submarine fiber optic cables connecting the country to the world through Europe deployed by different organizations with huge Internet broadband capacities. However, the Internet broadband penetration in the country is still very low with about 10% of the Oceanic Optical fiber capacities utilized and just 6% of fiber optic broadband penetration. Over 99% of the Internet broadband connection today in Nigeria is through the mobile wireless networks with less than 1% connection via the fixed wired/wireless.

In a bid to expand the networks infrastructure across the country and to provide more efficient services to the local consumers, Nigeria Communication Company (NCC) through O`odua Infraco Resource Limited wishes to embark on an Open Access Metropolitan Fibre Network (laying of Fibre Optic backbone and Metro) in Lagos, Ogun, Oyo, Osun, Ondo, Ekiti, Kwara and Kogi States. This project is part of government National Broadband Plan (2020-2025) that we lead to digital economy achievement, jobs and livelihood enhancement, e-learning, e-government, e-medicine, e-judiciary e.t.c.

Considering the associated and potential environmental and social effects that could attend the construction and operation of optic fibre, there is an obvious need for O`odua Infraco Resource Limited to plan for and implement a sound and cost-effective environmental management program. In line with the environmental statutory and regulatory requirements of the Federal Republic of Nigeria (FRN), State Governments, International Finance Corporation (IFC)/World Bank as well as O`odua Infraco Resource Limited corporate policy on environmental protection and sustainable development, the company decided to conduct an Environmental and Social Impact Assessment (ESIA) in line with Federal Ministry of Environment approval for the proposed Open Metropolitan Fibre Network project in Lagos, Ogun, Oyo, Osun, Ondo, Ekiti, Kwara and Kogi States in line with the regulatory requirements, and following the conditions of the EIA Act. Accordingly, O`odua Infraco Resource Limited **(the proponent)** commissioned Spatial Ecosystems Limited, Environmental, Health and Safety consultants (accredited by FMEnv, NESREA, DPR, and LASEPA) to carry out the ESIA its proposed Open Metropolitan Fibre Network project at the proposed locations in Lagos, Ogun, Oyo, Osun, Ondo, Ekiti, Kwara and Kogi States.

During the field survey, information on relevant environmental attributes in the project area that collectively represent the baseline characteristics of the project area was collected in line with the Federal Ministry of Environment (FMEnv) sampling guidelines. The data gathering involved the collection of samples for analyses as well as socio-economic consultation with various stakeholders of the area.

1.2 Project proponent

O'odua Infraco Resources Limited (OIRL) is an Infraco Consortium created to develop high speed and efficient Fibre Optic Cable (FOC) Open Access Network (OAN) across the south-West region of Nigeria, interconnecting to other Infraco's where necessary in order to establish a National coverage via region-to-region interconnection (Six Geo-political zones) and thereby avoiding Open Access Network duplication of infrastructure and drives down prices for end users. OIRL was incorporated on the 11th of January, 2017 with her head office located at 1, Adzope Crescent, off Kumasi Crescent, Wuse II Abuja, F.C.T, Nigeria.

The Nigerian Communication Company (NCC) licensed O'odua Infraco Resources Ltd (OIRL) in 2018 to provide and operate on wholesale basis an Open Access Metropolitan Fibre Network in the South West area of Nigeria which will cover over 7,500km of Backbone and Metro fibre. The license has tenure of over 20 years and is subject to automatic renewal. We focus on deploying and delivering three layers of open access model that allow for separation of roles and responsibilities.

1.3 Objectives of the ESIA Study

The aim of the ESIA is to:

- ✓ provide an overview of the study area via existing secondary information as well as from a field study.
- ✓ identify the environmental data that will affect the proposed additional development activities in the Field;
- ✓ identify knowledge and data gaps, highlight issues of concern, and make recommendations for mitigation and planning.
- ✓ identify the potential and associated environmental impacts
- ✓ identify general regulatory or mitigative measures and monitoring requirements that must be dealt with by O`odua Infraco Resource Limited.

- ✓ evaluate the extent of all observed impacts (negative and beneficial), of production activities on the ecology/environmental media i.e. air, land, water and socio-economic activities of the area
- ✓ recommend preventive, reduction and control measures for observed/associated adverse impacts of the project;
- ✓ provide the basis for consultation with regulatory authorities, the public and other stakeholders; and support subsequent applications for associated environmental permits.
- ✓ develop a cost effective ESMP that recommends plans and procedures to manage observed impacts and recover from exceptional events throughout the lifetime of the project;
- ✓ prepare a detailed ESIA presenting clear and concise information on the environmental impact of the project activities.

1.4 EIA Terms of Reference

As statutorily required, a "Term of Reference" (ToR) was prepared by O`odua Infraco Resource Limited and was submitted to FMEnv, Abuja for Approval. This provided a framework for achieving the overall objectives of the ESIA. The summary of the ToR is as follows:

- Outline the general scope of the ESIA study including the overall data requirement on the proposed Open Metropolitan Fibre Network project and affected environment.
- Define the procedures and protocols first for identification and assessment of associated and potential impacts and also for developing an effective Environmental and Social Management Plan (ESMP) for the proposed project.
- Define the framework for interaction and integration of views of a multidisciplinary ESIA team with regulators, host communities and other stakeholders.
- Define the relevant framework of legal and administrative requirements of the proposed Project.
- Develop decommissioning and Remediation plan after project ends

1.5 Scope of the ESIA

The ESIA scope of work includes:

- Review of the relevant national and international regulatory framework.
- Extensive and comprehensive literature review specific to the proposed project site to generate background information on the environmental and social characteristics of the study area.
- One-season field sampling and survey of the project area and the use of previously approved EIAs.
- Description of the proposed project activity and processes.

- Review of legal and administrative framework.
- Information and data collection on the social and biophysical environmental characteristics of the proposed project area. High-risk impact zones to be given special attention. Data and information required should cover the following;

    - Elements of the physical environment such as; climate and meteorology, ambient air quality, water quality, geology, soil, vegetation; and
    - Human attributes like; socio-economic characteristics, demography, cultural values, land use, concerns, and interests of the potentially affected persons/communities.

- Assessment of all potential and associated impacts from the activities of the optic fibre development; from site preparation to operation. Impact assessment using a multi-criteria approach to evaluate their significance, duration, extent, and possible interaction with other impacts. Appropriate use of national and international standards as benchmarks.
- Appraisal of alternatives to the initial project proposal. Key issues include; location characteristics, engineering/technological options, and the sensitivity of their impacts on the human and natural environment. The alternative that is the most environmentally sustainable and economically viable shall be selected.
- Development of appropriate and practicable mitigation measures for all identified negative impacts. Mitigation measures are expected to either completely prevent or ameliorate impacts to the barest minimum.
- Preparation of appropriate and cost-effective environmental management plan (EMP); to cover both short and long-term approaches. The EMP will equally include monitoring plans to ensure the effectiveness of the mitigation measures and identify possible residual impacts to improve on established measures.

1.6 ESIA Methodology

The ESIA was carried out in line with procedures provided in the Environmental Impact Assessment (EIA) Act Cap E12, LFN 2004. The study was carried out by a multidisciplinary team of experienced researchers employing standard methods from pure science, engineering, social and health sciences in order to obtain basic data for impact identification and establishment of mitigation and monitoring measures. The study generally involved desktop studies, field research, consultation, impact assessment and proffering of mitigation measures and development of an Environmental and Social Management Plan (ESMP).

a. Desktop Studies

Desktop studies were undertaken to acquire information on climate, geology, soil, vegetation, socio-economics, and other environmental aspects of the proposed project area. The materials consulted included textbooks, articles, charts, maps and previous study reports on the proposed project area. It involved the study of existing literature particularly reports of previous FMEnv approved ESIA studies.

b. Fieldwork Activities/Laboratory Analysis

Fieldwork activities/Laboratory analysis were carried out to complement secondary data gathered from literature and to collect new and additional primary data to fill information gaps. The one season field study was carried out from 1st to 19th September, 2020 (One Wet Season) in accordance with requisite environmental sampling protocol.

c. Validation

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

d. Consultations with Stakeholders

Stakeholder consultation is a very important aspect of the ESIA study and this was carried out with the proposed project stakeholders along the proposed project route (FMEnv, State Ministries of Environment, Land and Housing, Industry, Trade and Commerce, Physical Planning and Urban Development, Works and Transport and host communities). This was done to ensure that the views and opinions of all stakeholders regarding the proposed Project as associated with potential impacts are integrated into the ESIA.

e. Impact Assessment Methodologies

This involved impact identification, prediction and evaluation. Impact evaluation was carried out using ISO 14001, while the overall assessment was carried out through the use of the 'Strength of Relationship Matrix Approach' method. This method defines, numerically, the degree of interdependence of the various environmental parameters that were considered. The 1 - 5 ratings were assigned to characterize the interrelationship. The impact evaluation results obtained formed the basis for the development of the Environmental and Social Management Plan (ESMP) for the proposed project.

f. Project Logistics

The logistic support related to the ESIA includes a preliminary project kick-off/pre-mobilization meeting which was held between OIRL and the project Environmental Consultant. The meeting discussed the Terms of Reference in relation to the work plan submitted by the Consultants. The details of the scope of services for the project were agreed upon; field work and sample collection at the proposed project site and surrounding areas for the climatic season, consultation and interaction with Stakeholders in the project area, administration of ESIA survey questionnaires in-depth interviews, focus group discussions, analysis of results, preparation of draft ESIA Report and submission of ESIA Report to the Federal Ministry of Environment were carried out.

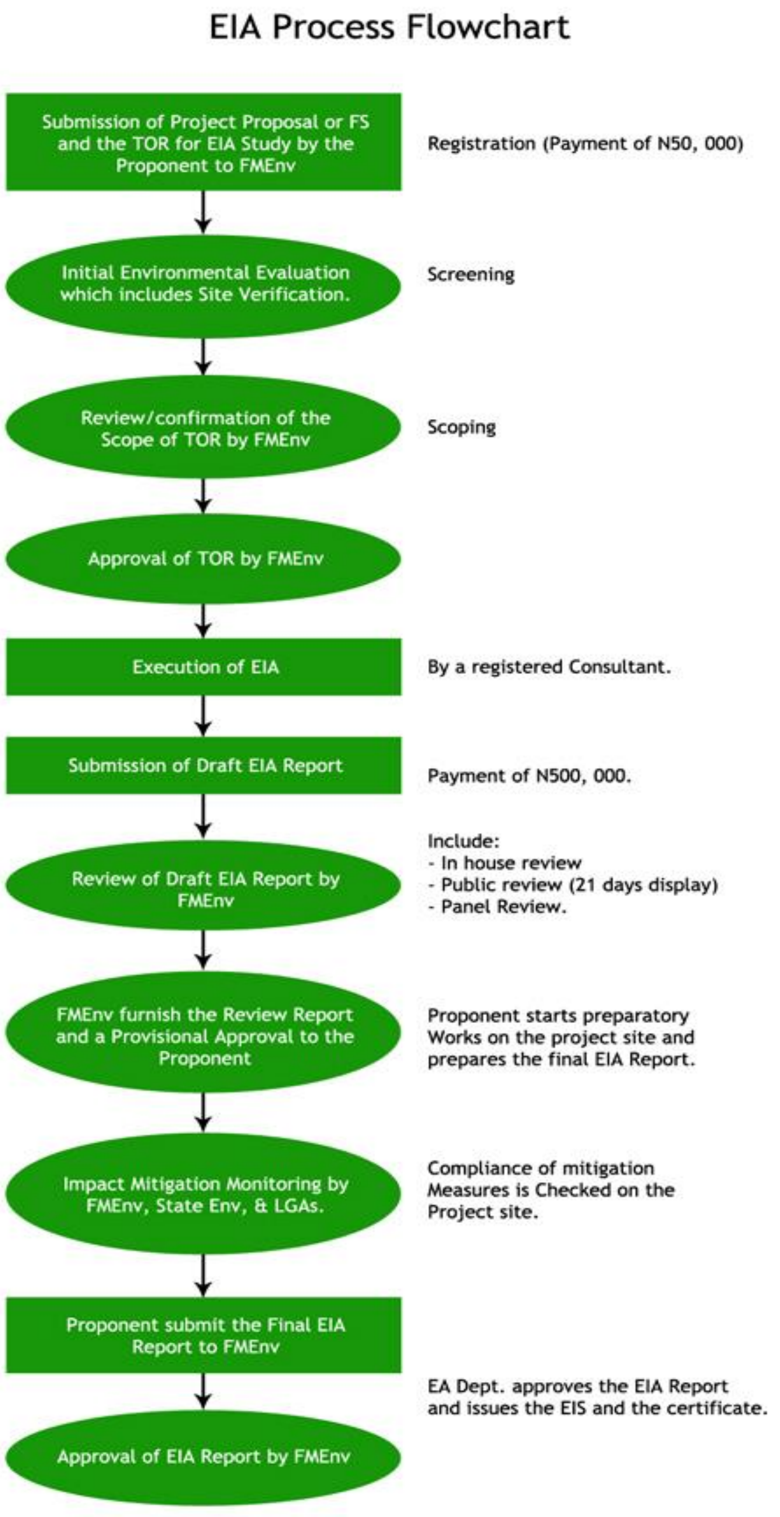

Figure 1.1: ESIA process flowchart (source: https://ead.gov.ng/)

1.7 Administrative and Legal Framework

The cornerstone of environmental law is founded on the principle of sustainable development which asserts that natural resources and treasures are held in trust by the current custodian for the full benefit, use, and enjoyment of the people; not only for this generation but for generations yet unborn (Brundtland Commission, 1987). The first step in managing compliance with environmental legal requirements is to determine which requirements apply to an organization's activities, products, and services. The environmental regulation of business organizations is intended to protect human health and prevent damage to the environment.

Traditionally, environmental regulation has covered environmental media (air, water, and land), together with wildlife protection and conservation. It has focused on the control of polluting emissions and on maintaining and improving water quality and waste management.

The Federal Environmental Protection Agency (FEPA), now Federal Ministry of Environment, was established by Decree 58 of 1988 as amended by Decree 59 of 1992, and as further amended by Decree 14 of 1999 with a mandate for the overall responsibility of ensuring a good quality environment in Nigeria.

In this section, the main legal requirements, regulations, and guidelines that affect the operation of the Optic Fibre are discussed below.

1.7.1 National Legislation/Regulations/Policies

1.7.1.1 Federal Ministry of Environment (FMEnv)

1.7.1.1.1 National Policy on the Environment (1989 revised in 2016)

Environmental management in Nigeria is based on the National Policy on the Environment (1989), as revised in 1999 and 2016. The goal of this policy is to achieve sustainable development and in particular to:

- Secure for all Nigerians the quality of the environment which is adequate for their health and wellbeing.
- Conserve and use the environment and natural resources for the benefit of present and future generations.
- Restore, maintain, and enhance the ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity and the principle of optimum sustainable yield in the use of these natural resources and ecosystems.
- Raise public awareness and promote understanding of essential linkages between environment and development and to encourage individual and community participation in environmental improvement efforts.
- Co-operate in good faith with other countries, international organizations/agencies to achieve optimal use of trans-boundary natural resources, and effective prevention or a statement of trans-boundary environmental pollution.

1.7.1.1.2 Environmental Impact Assessment (EIA) Act No. Cap E12, LFN 2004

The EIA Act Cap E12, LFN 2004 stipulates that the public or private sector of the economy shall not embark on or undertake or authorize projects or activities without prior consideration, at an early stage of their environmental effects. The Act makes EIA mandatory for any major development project, prescribes the procedure for conducting and reporting EIAs. The Act also clearly stipulates among other things the objectives of an EIA, a list of project activities for which an EIA is mandatory; minimum content of an EIA, regulatory authority of FMEnv; offenses, and penalties.

1.7.1.1.3 National Environmental Impact Assessment Procedural and Sectoral Guidelines

In response to the promulgation of the EIA Act of 1992, the FMEnv developed a National EIA Procedure in 1995. The procedure provides steps to be followed from the stage of project conception to commissioning to ensure that the project is implemented with maximum consideration for the environment. In almost all cases the following technical activities will characterize the procedure: Project Proposal, Initial Environmental Examination (IEE), Screening, Scoping, EIA Study, Review, Decision making, Monitoring, and Auditing as shown in figure 1.2 below.

1.7.1.1.4 Harmful Waste (Special Criminal Provisions) Act Cap H1 2004

The Act prohibits the carrying, depositing, and dumping of harmful waste on any land, territorial water, and matters relating thereto and criminalized any such activities with appropriate sanctions.

1.7.1.1.5 S.I. 9 National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations 2004

S.I. 9 National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations 2004 impose restrictions on the release of toxic substances and stipulate requirements for pollution monitoring units, machinery for combating pollution and contingency plan by industries; submission of lists and details of chemicals used by industries to FMEnv; requirement of a permit by industries for the storage and transportation of harmful or toxic waste; the generator's liability; strategies for waste reduction; permissible limits of discharge into public drains; protection of workers and safety requirements; environmental audit (or EIA for new industries) and the penalty for contravention.

1.7.1.1.6 National Environment Protection (Management of Hazardous and Solid Wastes) Regulations 1991

The National Environment Protection (Management of Hazardous and Solid

Wastes) Regulations, S.1.15 of 1991 (No. 102, Vol. 78, August 1991) define the requirements for groundwater protection, surface impoundment, land treatment, waste piles, landfills, and incinerators. The Regulations describe the hazardous substances tracking programme with a comprehensive list of acutely hazardous chemical products and dangerous waste constituent. The requirements and procedures for inspection, enforcement, and penalty are also described.

1.7.1.1.7 National Guidelines on Environmental Audit in Nigeria, 1999 (revised in 2011)
The National Guidelines on Environmental Audit in Nigeria was first published in 1999 by the then Federal Environmental Protection Agency (FEPA). However, there was a review of it in 2011 which became necessary due to various emerging trends and issues bearing on the environment. The review also places National Environmental Standards and Regulations Enforcement Agency (NESREA) in better stead to ensure proper environmental auditing of the regulated community, as well as assist the regulated community to carry out mandatory and voluntary self-audit of their facilities.

1.7.1.1.8 EIA Sectorial Guideline on Telecommunications
Provides guidance on the content of an EIA report as well as procedures for the EIA process for Telecommunications.

1.7.1.2 National Environmental Standards and Regulations Enforcement Agency (NESREA)
The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established by the Federal Government of Nigeria as a parastatal of the Federal Ministry of Environment (FMEnv). The NESREA Act was accented to by Mr. President on July 30, 2007. NESREA is charged with the responsibility of enforcing all environmental laws, guidelines, policies, standards, and regulations in Nigeria. It also has the responsibility to enforce compliance with provisions of international agreements, protocols, conventions, and treaties on the environment. NESREA was also empowered to develop the National Environmental (Standard for Telecommunication and Broadcast Facility) regulation of 2011. Consequently, Regulation 5(4)(1)(b) of NESREA, 2011 stipulated that all new telecom facilities shall have a minimum of 10meter set back from the perimeter wall of the base premises of the mast.

However, based on a communique issued on 16th January 2014 during the inter-ministerial review meeting between the Federal Ministry of Environment and Federal Ministry of communication and technology on the localization of telecommunication infrastructure, an amendment was adopted on setback which stipulates that BTS shall be a minimum of 10m, measured from the foot of the building to the nearest occupied building. However, in situations where 10 setbacks cannot be achieved, the joint ministerial committee comprising of FMCT, NCC, FMEnv, and NESREA has the power to consider a setback of 7.5m after they must have considered possible alternative options and other parameters.

1.7.1.2.1 National Environmental (Sanitation and Wastes Control) Regulations, 2009 (S. I. 28)

The purpose of these Regulations is the adoption of sustainable and environmentally friendly practices in environmental sanitation and waste management to minimize pollution. For Industrial Sanitation, the provisions of the regulations state that a person in care, management, or control of any industrial facility shall:

- Provide welfare facilities such as potable water, conveniences, and cloakrooms.
- Provide educational and pictorial signs to direct persons where they can drop wastes.
- Provide receptacles for recyclable materials inappropriate and easily accessible locations.
- Service, maintain, and empty the receptacles regularly.
- Keep the premises, drains, and all public or private lands, streets, lanes, walkways; beaches, or docks within 5 meters of the boundary of the property free from the litter at all times.
- Ensure that discarded materials are regularly collected and disposed of sanitarily.
- Ensure that recyclable materials are properly packed and neatly stacked.
- Ensure the sorting and segregation of solid waste at the source.

1.7.1.2.2 National Environmental (Noise Standards and Control) Regulations, 2009 (S.I.35)

The purpose of these Regulations is to ensure the maintenance of a healthy environment for all people in Nigeria, the tranquility of their surroundings and their psychological well-being by regulating noise levels and generally, to elevate the standard of living of the people by:

a) Prescribing the maximum permissible noise levels a facility or activity to which a person may be exposed.
b) Providing for the control of noise and for mitigating measures for the reduction of noise.
c) Giving effect to the provisions of section 22 of the Act.

The regulations among others state the permissible noise levels to which a person may be exposed; control and mitigation of noise; permits for noise emissions above permissible levels; and enforcement.

1.7.1.3 Nigerian Safety and Security of Radioactive Sources Regulations of 2006

The responsibilities of the regulations include the following, among others:

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

1.7.1.4 Land Use Act L5 LFN 2004

The Land Use Act L5 LFN of 2004 protects the rights of all Nigerians to use and enjoy the land in Nigeria which must be protected and preserved. The land acquisition must follow all the due process of law.

1.7.1.5 Forestry Law CAP 55, 1994

This Act provides for the preservation of forests and the setting up of forest reserves.

- Prohibits any act that may lead to the destruction of or cause injury to any forest produces forest growth or forestry property in Nigeria.
- Prescribes the administrative framework for the management, utilization, and protection of forestry resources in Nigeria.

1.7.1.6 Employee Compensation Act of 2010

An Act to provide for compensation for injuries and death suffered by workmen in the course of their employment. This legislation, which was the first of its kind in Nigeria, sought to incorporate international standards relating to workmen's compensation and cater to the welfare of injured workmen.

(1) An employer shall pay compensation to any of his employees who suffers injury from any accident arising out of and in the course of his employment. (2) An employer shall pay compensation to the person or persons entitled to the estate of any of his employees who dies as a result of an accident arising out of and in the course of his employment.

1.7.1.7 Nigerian Communications Act, 2003

The Nigerian Communications Act 2003 was signed into law by Mr. President on the 8th of July, 2003. The Act strengthens the capacity of the Nigerian Communications Commission (NCC) to properly carry out its Regulatory Activities. The Act among other states the objectives of the commission, scope, funding, power, etc.

Extract from this Act includes:

1. The primary object of the Act is to create and provide a regulatory framework for the Nigerian communications industry and all matters related thereto and for that purpose and without detracting from the generality of the foregoing, specifically to:
   - Promote the implementation of the national communications or telecommunications policy as may from time to time be modified and amended.
   - Establish a regulatory framework for the Nigerian communications industry and for this purpose to create an effective, impartial, and independent regulatory authority.
   - Promote the provision of modern, universal, efficient, reliable, affordable, and easily accessible communications services and the widest range thereof throughout Nigeria.
   - Encourage local and foreign investments in the Nigerian communications industry and the introduction of innovative services and practices in the industry following international best practices and trends.
   - Ensure fair competition in all sectors of the Nigerian communications industry and also encourage the participation of Nigerians in the ownership, control, and management of communications companies and organizations.
   - Encourage the development of a communications manufacturing and supply sector within the Nigerian economy and also encourage effective research and development efforts by all communications industry practitioners.
   - Protect the rights and interests of service providers and consumers within Nigeria.
   - Ensure that the needs of the disabled and elderly persons are taken into consideration in the provision of communications services.
   - Ensure efficient management including planning, coordination, allocation, assignment, registration, monitoring, and use of scarce national resources in the communications sub-sector, including but not limited to the frequency spectrum, numbers, and electronic addresses, and also promote and safeguard national objectives of the Act interests, safety, and security in the use of the said scarce national resources.

2. This Act applies to the provision and use of all communications services and networks, in whole or in part within Nigeria, or on a ship or aircraft registered in Nigeria.

1.7.1.8 Engineering Design Codes and Standards

This specification covers the minimum standards and requirements or the construction, properties, testing and packing of the Corrugated Optic Duct (COD).

- Application: Telecommunication, Electrical Power and Metallic Cable.
- The COD shall be designed, manufactured and packed so that the physical transmission and operation and maintenance characteristics shall not degrade when exposed to the environmental conditions during storage and transportation in exportation of COD to foreign countries.
- The following international standards shall be applied, and deemed to be an integral part of this specification:
- ASTM F 405 Standard Specification for Corrugated Polyethylene Pipe and Fittings.
- ASTM D 2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- ASTM D 1505 Standard Test Method for Density of Plastics.
- ASTM D 882 Standard Test Method for Tensile Properties of Plastics.

1.7.1.9 Labour Act, 2004

Nigeria has ratified all eight core International Labour Organization Conventions. The Labour Act (2004) is the primary law protecting the employment rights of individual workers. The Act covers protection of wages; contracts; employment terms and conditions; recruitment; and classifies workers and special worker types.

1.7.1.10 Endangered Species Act (Cap 108), 1990

The Endangered Species Act (Control of International Trade and Traffic) Cap.108 Law of Nigeria, 1990 prohibits the hunting, capture, and trade of endangered species.

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

The act was to do the following:

(a) the formulation of national policies for urban and regional planning and development;
(b) the preparation and implementation of the National Physical Development
Plan and regional plans on the recommendation of the Minister;
(c) the formulation of urban and regional planning standards for Nigeria on the recommendation of the Minister;
(d) the promotion and fostering of the education and training of town planners and support staff;
(e) the promotion of co-operation and co-ordination among States and local
governments in the preparation and implementation of urban and regional plans;

(f) the promotion and conduct of research in urban and regional planning;
(g) the making of recommendation and dissemination of research results for adoption by user organizations;
(h) the supervision and monitoring of the execution of projects in urban and regional planning;
(i) the development control over Federal lands; and
(j) the provision of technical and financial assistance to States in the preparation and implementation of plans.

1.7.1.12 Powers of Standards Council -The SON Act Cap. S9 LFN 2004

This is an enabling Act. It has given powers to the Standards Council to designate, establish and approve standards in respect of metrology, materials, commodities, structures and processes for the certification of products in commerce and industry throughout Nigeria and to carry out any other functions imposed on it under this Act or any other written law; power to make rules. See Ss 4,12,14,23 etc.

1.7.1.13 National Information Technology Development Agency Act of 2007

NITDA (under the auspices of the Federal Ministry of Communications Technology) hereby issues the following guidelines on Nigerian Content Development in Information and Communications Technology. NITDA shall exercise the power to institute a sustainable implementation framework for the guidelines.

1.7.1.14 Criminal Code Act, Cap 77 LFN 1990

The Nigerian Criminal Code of 1990 makes it an offensive punishment with up to six months 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 carry on business in the neighbourhood, 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 that infection of any disease dangerous to life whether human or animal.

1.7.1.15 National Health Act 2014

There is hereby established for the Federation the National Health System} which shall define and provide a framework for standards and regulation of health services}and which shall - Establishment of the National Health System.

- encompass public and private providers of health services;
- promote a spirit of cooperation and shared responsibility among all providers of health services in the Federation and any part thereof;
- provide for persons living in Nigeria the best possible health services within the limits
- of available resources;
- Set out the rights and obligations of health care providers} health workers} health establishments and users; and

- Protect, promote and fulfil the rights of the people of Nigeria to have access to health care services.
- The National Health System shall include –
- the Federal Ministry of Health;
- The Ministry of Health in every state and the Federal Capital Territory Department responsible for Health;
- parastatals under the federal and state ministries of health;
- all local government health authorities;

1.7.1.16 Federal Roads Maintenance Agency (FERMA) Act no 7 of 2002.

Federal Roads Maintenance Agency (Establishment, etc) was established by Act No.7 of 2002 enacted by the National Assembly and assented to by President Olusegun Obasanjo. With this Act establishing the Federal Roads Maintenance Agency and for matters connected herewith, FERMA became Nigeria's first institutional mechanism for monitoring and maintaining all Federal roads in the country.

1.7.1.17 Public Health Law (L.N 47 of 1955, Cap 103)

In Nigeria the Public Health Law provides justification or the execution of development projects under guidelines that promotes health by protecting the environment and safeguarding the humans' health. The Public Health Laws empower Medical Officers of Health (operating at the local government council, under the supervision of the state and Federal Ministry) to ensure the promotion of good health (Subsection 6 and 7).

1.7.1.18 Nuclear Safety and Radiation Protection Act

An Act to establish the Nigerian Nuclear Regulatory Authority whose functions shall include the control and regulation of the use of radioactive substances, material, equipment, emitting, and generating ionising radiation.

1.7.2 State Duties/Legislations

Following Section 24 of the FMEnv Act, Chapter131of the Laws of the Federal Republic of Nigeria, 1990, the State Environmental Protection Edicts are enacted. The edict empowers the state environmental protection agency to establish such environmental criteria, guidelines/specifications, or standards for the protection of the state's air, lands, and waters as may be necessary to protect the health and welfare of the people. The functions of SEPAs among others include:

- ❖ Routine liaison and ensuring effective harmonization with the FMEnv. to achieve the objectives of the National Policy on the Environment.
- ❖ Co-operating with the FMEnv. and other relevant regulatory agencies in the promotion of environmental education.

- Been responsible for monitoring compliance with waste management standards.
- Monitoring the implementation of the EIA and Environmental Audit Report.
- Monitoring compliance with EAR guidelines and procedures on all developmental policies and projects within the state.

Oyo State Ministry of Environment and Natural Resources

Oyo State Ministry of Environment and Natural Resources work to restore and transform the ministry for optimal utilization of its human and material resources for effective flood control, waste management, pollution control, green revolution culminating in hygienic, clean and aesthetically pleasing environment. Their objectives include the following:

- Be responsible for formulation, enforcing and coordinating policies, statutory rules and regulation on Solid Waste collection and disposal, general environmental protection, flood control and regulation of the ecological system and all activities related therein, throughout the State:
- Conduct public enlightenment campaigns and disseminate vital information on environmental and ecological matters, and to mobilize the inhabitants of all area for effective observance of environmental rules and guidelines, for purpose of healthy and safe environment;
- Render advisory services and support to all Local Government in the State in areas of Flood Control, Solid Waste Management, Ecological and Sanitation Matters;
- Preparation of annual State of the Environment report for the State and transmit same to the Secretariat of the National Council on Environment;
- Monitor sources of toxic pollutants in air, land and water and offering of necessary advice to industrial establishments;
- Initiate measure to ensure pollution-free air, land, water throughout the State including any other steps to obviate, mitigate or eliminates environmental discomfort to individuals or groups or danger to lives and properties;
- Ensure that the lawns and the surroundings of the departmental offices in Secretariat precincts are kept tidy and well-trimmed;
- Study, investigate, advice and recommend any all matters pertaining to beautification and citizens' participation relating of same to the Government;
- Obtain research findings from the relevant Federal and State Agencies for the purpose of policy formulation and dissemination of same on environmental sanitation and beautification to the public in the State;
- Carry out both administrative supervision and establishment duties with a view to ensuring well-managed finances and administration of the Ministry in line with Government policies.

Oyo State Solid Waste Management Authority

- To achieve efficient waste management systems by employing adaptable solutions and best practices as well as encouraging regional integration and customer focused service delivery methods
- To develop and implement sustainable waste management strategies targeted at improving public health standard

Ekiti State Ministry of Environment and Natural Resources

The Ministry of Environment and Natural Resources comprises of six departments, they are:

1. Administration and Supplies
2. Forestry

Various Directorate under Forestry Department are:

1.
   - Director Forestry
   - Director Enforcement and Compliance
   - Director, Non – Timber Forest Produce
   - Director, Afforestation
   - Director, Forestry Extension
   - Director, Wild Life Services
2. Finance and Accounts
3. Environmental Health and Sanitation
4. Nature Conservation
5. Planning, Research and Statistics

The Ministry also supervises two Parastatals namely;

- State Environmental Protection Agency
- Ekiti State Waste Management Board

Function

The functions of the Ministry are summarised as follows:

- To achieve a sustainable healthy environment in Ekiti;
- To secure qualitative environment adequate for good health and well being of the masses;
- Conserve and use the environment and nature resources for the benefit of present and future generation;
- To enforce forestry laws and regulation for the control and protection of the State's forestry resources;
- To promote public awareness and understanding of essential linkage between environment resources and development;
- To encourage individual and community participation in environment efforts;
- To collaborate with relevant stakeholders on environment matters;

- To check and control erosion and flooding problems in Ekiti State;
- To monitor and control all forms of environmental degradation;
- To restore, maintain and enhance the ecosystem and ecological processes essential for the functioning of the biosphere so as to preserve biological diversity.

Functions of Waste Management Board

To make Ekiti State cleaner and a better place through effective Waste Management, the Ministry embarks vigorously on:

- Intensified effort on waste collection and waste segregation;
- Provision of Waste Bins and zoning Towns and villages for waste collection;
- Establishes and maintains approved sanitary landfill sites within the State for the disposal of waste;
- Sets guidelines and monitors private sector participation in the maintenance of waste management vehicles and equipment.

Functions of Environmental Protection Agency

The Ministry provides effective protection of the environment through:

- Erosion and Flood Control
- Environmental Education and Awareness
- Planning and Monitoring
- Pollution Abatement Technology
- Watershed Management
- Environmental Impact Assessment.

Ekiti State Environmental Protection Agency

The statutory responsibility of protecting and/or ensuring the protection of the environment in Ekiti State rests on the Ekiti State Environmental Protection Agency. The Ekiti State Environmental Protection Agency is responsible for formulating, enforcing and coordinating policies, statutory rules and regulation on Solid Waste collection and disposal, general environmental protection, flood control and regulation of the ecological, system and all activities related therein throughout Ekiti State.

The Agency conducts public enlightenment campaign and disseminates vital information on environmental and ecological matters, and to mobilise the inhabitants of all areas for effective observance of environmental rules and guidelines, for the purpose of healthy and safe environment; It offers also, advisory services and support to all Local Government Areas in the State in areas of Flood Control, Solid Waste Management, Ecological and Sanitation Matters.

Ekiti State Environmental Health and Sanitation Law 2004

The Ekiti State Environmental Health and Sanitation Law No. 4 of 2004 enacted by the administration of Governor Ayodele Fayose made adequate provision to protect streets and drainages from littering and unhealthy use as waste receptacles by pedestrians, occupiers of houses or operators of businesses in buildings abutting all categories of streets in Ekiti state.

Section 8(2)(a) provides that "every occupier of any building shall keep clean the drains, sidewalks and gutter area from the sidewalk into the street" while Section 8(2)(h) states that every occupier of any building shall "not litter, sweep out or throw ashes, refuse, paper, nylon and rubbish into any street, public place or vacant plot". Section 9 (1) also states that "no pedestrian shall dispose of any scrap paper, newspaper, candy wrapper, fruit skin and similar refuse anywhere except in litter bins" while Section 10(2) states that "no passenger shall throw litter, fruit skins, scrap paper or other item onto the road from any vehicle". Section 11(2) provides that "All streets shall be free from obstruction and from construction or demolition materials" while Section 11(4) states that "No person shall dump indiscriminately any domestic, industrial or commercial waste, sand or gravel or discarded vehicle spare parts or tyres along highways, roads, channels…" Similarly, Section 19(1) provides that "All vehicles or containers used in transporting or conveying refuse shall be securely covered in such a way that the contents do not litter the road".

Ekiti State Urban and Regional Planning Law No. 86 of 1992.

The Ministry shall be responsible for:

- the initiation, formulation of policies, programmes and review of all aspects of physical planning urban development, urban regeneration and building control in the state.
- Implementation of its policies, through the relevant agencies established under the provision of this Law;
- Preparation and approval of the following hierarchies of physical development plans;
- Regional Plans;(ii) Sub-regional Plans;(iii) District Plan;(iv) Model City Plans;(v) Urban/Town Plans;(vi) Urban Regeneration Plans(vii) Development Guide Plans; and(viii) Local Plans including layout and subdivision Plans;(e) Provision of technical assistance to all government ministries and agencies on matters relating to physical planning, urban development, urban regeneration and building control;
- Determination of locations of infrastructure facilities and centres of economic activities in the State.
- Offering advice on State development project/programmes with socio-economic and environmental impacts as be referred to it from time to time;

- Formulation of legislations on physical planning, urban development, urban regeneration and building control in the State;
- Formulations o guidelines for fostering inter-ministerial, intergovernmental bilateral and multi-lateral cooperation on physical planning, urban development, urban regeneration and building control;
- Adoption of measure for the promotion of physical planning, urban development, urban regeneration and building control policies in the State;
- Conducting research on planning urban development, urban regeneration, building construction and control;
- Creation and administration of data base for physical planning, urban development, urban regeneration, building construction and control in the State;
- Consideration of all matters referred to it by the State Executive Council, other governments ministries, agencies and the general public;
- Liaising with agencies of other governments including Federal, State and Local Government in the execution of its physical planning, urban development, urban regulation and building control programme and projects;
- Regulating the location, positioning, dimensions, appearance, display and manner in which urban furniture shall be affixed to land in the State;
- Prescription of fees chargeable fir its services;
- Executing such other planning, urban development, urban regeneration and building control functions and duties as may be assigned to it by the Governor.

Lagos State Environmental Management and Protection Law (2017)
The objectives of this Law is to provide a clean, safe and healthy environment for all residents in the State as well as to enable citizens access the various public amenities or segments of the environment for recreational, educational, health, cultural and economic purposes.

The Law is meant for effective and efficient administration of the environment and in furtherance of its ministerial responsibilities.

The Agencies, Authorities, Boards, Departments, Offices and Units under the Ministry include but not limited to the following-

(a) Lagos Waste Management Authority (LAWMA);
(b) Lagos State Environmental Protection Agency (LASEPA);
(c) Lagos Water Corporation (LWC);
(d) Lagos State Water Regulatory Commission (LSWRC);
(e) Lagos State Wastewater Management Office (LSWMO);
(f) Lagos State Signage and Advertisement Agency (LASAA);
g) Lagos State Parks and Gardens Agency (LASPARK);

(h) Office of Drainage Services;
(i) Lagos State Environmental Sanitation Enforcement Agency (LSESEA);
(j) Environmental Trust Fund;
(k) Public Utilities Monitoring and Assurance Unit (PUMAU); and
(l) Any other Agency, Board, Department, Office or Unit as may be established under the provisions of this Law

The ministry is saddled with the following responsibilities:

- Waste Management
- Environmental Sanitation and Protection Service
- Pollution Control
- Ecological and Conservation matters
- Control and regulation of Outdoor Advertisement
- Drainage services
- Deflooding
- Sewage Management
- Coastal and Hinterland Erosion control
- Evaluation of Environmental Impact Assessment (EIA) and
- Environmental Audit Report (EAR)

Lagos State Waste Management Agency

The Lagos State Waste Management Agency (LAWMA) is an agency under the direct supervision of the Lagos State Ministry of Environment. The Board's functions include the collection, transport, processing, recycling or disposal and monitoring of waste materials. This includes solid, liquid and gaseous substances. Other responsibilities include the development of guidelines, standards and regulations for pollution control and waste management as well as inspection and compliance monitoring of industrial facilities (Nigerian Government, 2011).

Ogun State Ministry of Environment

The Ministry has five (5) departments and two (2) sister Agencies namely, Ogun Environmental Protection Agency (OGEPA) and Ogun State Emergency Management Agency (SEMA). Among the five departments of the ministry, the Department of Environmental Conservation And Resources is charged with the following responsibilities.

- Environmental Sanitation, Protection Service and Street Sweeping Exercise.
- Landscaping and Beautification
- Environmental and Natural Resources Conservation
- Nature and Biodiversity Conservation
- Management and Conservation of Threatened and Endangered species of animals and plants

- Meteorological Service (Meteorological Stations, Monitoring etc
- Water Shed Management
- Ground and Surface Water Monitoring
- Sewage and Water Quality Monitoring
- Monitoring the impact of Global Climate Change on drought and Desertification
- Global Warming
- Monitoring and Conservation of Atmosphere, Hydrosphere, Lithosphere and Biosphere
- Activities of the defunct Natural Resources Conservation Council
- Petroleum and Solid Mineral Monitoring.

Ogun State Environmental Protection Agency (OGEPA) Law of 1995

Environmental protection functions are performance by the Ogun State Environmental Protection Agency (OGEPA). This agency is responsible for the protection and improvement of the environment within the state as well as assisting in implementation and enforcement of the National Environmental Regulations and guidelines within Ogun state. In carrying out its duties of environmental protection, OGEPA is required to cooperate with relevant federal and state ministries, local government councils, statutory bodies, research and educational institutions. Although the primary authority for the project lies with FMEnv, OGEPA plays a role as a key stakeholder.

Ondo State Ministry of Environment

The statutory responsibility of protecting and/or ensuring the protection of the environment in Ondo State rests on the Ondo State Ministry of Environment. The Ondo State Ministry of Environment has the following duties and responsibilities:

- Formulating, enforcing and coordinating policies, statutory rules and regulation on Solid Waste collection and disposal, general environmental protection, flood control and regulation of the ecological, system and all activities related therein, throughout Ondo State;
- Conduct public enlightenment campaign and disseminates vital information on environmental and ecological matters, and to mobilise the inhabitants of all areas for effective observance of environmental rules and guidelines, for the purpose of healthy and safe environment;
- Renders advisory services and support to all Local Government in the State in areas of Flood Control, Solid Waste Management, Ecological and Sanitation Matters;
- Preparation of master plan for drainage, solid and liquid wastes, and general aesthetics, and of annual State of the environment report for

Ondo State and transmit same to the secretariat of the National Council of Environment;

Osun State Ministry of Environment and Sanitation

Ministry of Environment & Sanitation takes charge of formulating, enforcing, coordinating policies, statutory rules and regulations on solid waste collection, disposal, general environmental protection and flood control in Osun State. The ministry implements an integrated waste management system for cleanup, collection, transportation, disposal, treatment, and recycling to improve hygiene and sanitation. Also, to sustain our environment and ensure clean air, clean water, clean soil, and safe pesticides, Osun State Ministry of Environment control and limit effluent discharge, environmental hazards, as well as ground and soil water contamination.

Osun State Ministry of Lands, Physical Planning and Urban Development

The areas of responsibilities include but are not limited to:

- Land policy and land matters such as land use, allocation, survey services, acquisition of land for state purposes, compensation for acquired lands, servicing and monitoring of Land Use and Allocation Committee and Lands Registry (administration and control).
- Ensure proper development through Preparation and Monitoring of Development Schemes, monitor Private Estate Developers Scheme, develop Master and District Plans for Urban Centres, Urban Renewal Programmes, approval of building plans and layout and Statutory and Regional Planning.
- Collection of Neighbourhood Improvement Charge (NIC) and preparation and sale of Model Building Plans.
- Extraction of Laterite.
- Site selection for government and other institutions.
- Supervision of the Capital Territory Development Authority.
- Maintenance of the data bank

Kwara State Ministry of Environment and Forestry

The Ministry was created in the year 2004 with 4 Directorate Namely; Personnel, Finance & Supply, Environmental Services: Forestry Services and Hotel & Tourism.
It was later in the year 2009 that Directorate of Hotels and Tourism were expunged from the Ministry.
The Directorate of Environmental services is saddled with the responsibilities of:

1. Formulating and enforce policies, rules and regulations on the general environmental protection, control and regulation of the ecological system, industrial and domestic wastes management including solid waste

collection and disposal, appropriate management of liquid waste and effluents among others;
2. Formulating and enforce policies, rules and regulations on the general environmental protection, control and regulation of the ecological system, industrial and domestic wastes management including solid waste collection and disposal, appropriate management of liquid waste and effluents among others;
3. Coordinating the activities of all agencies and organizations connected with environmental and ecological matters in the state;
4. Liaising with State Ministries, Department of Local Government, Statutory Bodies and Research Agencies on matters and facilities relating to environmental protection;
5. Monitoring sources of toxic pollution in the State's environmental (air, land and water), and offer necessary advice;
6. Implementing applicable enactment and standards of activities related to the environment in cooperation with the Federal environmental Protection Agencies (Federal Ministry of Environment) and other bodies.

Kogi State Environmental Protection Board Law of 2005

The Kogi State Environmental Protection Board Law came into force on December 14, 2005. Section 30 subsection 2 of the law states that "every person who intends to engage in any form of development such as manufacturing or industrial activities shall submit to the Board, an Environmental Impact Assessment Report and obtain a certification from the Board.

Objectives:

The key functions of the Ministry are to:

The functions of the Board are:

- Implement policies and programmes within the context of the Federal Ministry of Environment's plans aimed at enhancing the position and improvement of the protection of the environment of the State.
- Enforce policies, rules and regulations on general environmental protection, control and regulation of the ecological system or all activities related thereto;
- Conduct public enlightenment campaigns and disseminate vital information on environmental and ecological matters;
- Render services and support to all local governments in the State in areas of flood and erosion control and other ecological matters.
- Take measures to guarantee consistent effectiveness of environmental structures throughout the State for flood control;

- Formulate master plans for drainage, solid and liquid wastes management and the development of environmental standard;
- Liaise with State Ministries, Department, Local Governments, Statutory bodies and research agencies on matters and facilities relating to environmental protection;
- Initiate appropriate action on the environmental impact and implications of industrial, agricultural and other related activities;
- Monitor sources of toxic pollution in the air, land and water and offer necessary advice to the government and ensure proper abatement by industrial establishments;
- Initiate measures to ensure pollution-free air, land and water throughout the State including any other steps to inculcate environmental discipline in individuals or groups;
- Enforce applicable laws and standards on activities related to the environment in cooperation with the Federal Ministry of Environment and any other body;
- Initiate measures towards prevention of ecological problems in the State.

1.7.3 International Laws and Regulations

Nigeria subscribes to several International Regulations and Conventions relating to Environmental Protection. International Development Partners/Agencies such as the World Bank and other financial organizations interested in development projects have sets of environmental categorizations, assessments, and management standards, which must be complied with by project proponents before these institutions invest in them.

Some of the guidelines/conventions/treaties are outlined below:

1.7.3.1 Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal, 1989 (Nigeria signed the Basel Convention document on 15th March 1990 and ratified it on 13th March 1991. Nigeria also ratified the amendment to the Basel Convention on 24th May 2004 11/1/2014 14)

The convention focuses attention on the hazards of the generation and disposal of hazardous wastes. The convention defines the wastes to regulated and controls their trans-boundary movement to protect human and environmental health against their adverse effects. Some highlights of the convention include:

- The generator of hazardous waste should carry out duties about the transport and disposal of such generated waste in a manner that is consistent with the protection of the environment, whatever the place of disposal.

- All should recognize that any State has the sovereign right to ban the entry or disposal of foreign hazardous wastes and other wastes in its territory.
- It should be recognized also that there is an increasing desire for the prohibition of transboundary movements of hazardous wastes and their disposal in other States, especially developing countries.
- Hazardous wastes and other wastes should, as far as is compatible with environmentally sound and efficient management, be disposed of in the State where they were generated.
- Transboundary movements of such wastes from the State of their generation to any other State should be permitted only when conducted under conditions which do not endanger human health and the environment, and under conditions in conformity with the provisions of this Convention.
- Control of transboundary movement of hazardous wastes and other wastes will act as an incentive for their environmentally sound management and the reduction of the volume of such transboundary movement.
- States should take measures for the proper exchange of information on and control of the transboundary movement of hazardous wastes and other wastes from and to those States.

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

The Paris Agreement builds upon the Convention and for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework, and an enhanced capacity-building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

1.7.3.3 Agenda 21 – United Nations Conference on Environment and Development– also called the **Earth Summit [Nigeria signed the Basel Convention document in 1992 and ratified in 1994]**

Held in Rio de Janeiro, Brazil (1992), with recommendations from the WHO Commission, more than 150-member states adopted ***Agenda 21*** – an action plan to guide future strategies for health and environment activities on a national and international level which provided the background for FEPA's EIA framework to ensure environmental sustainability of all types of activities in the oil and gas industry (FEPA, 1995).

1.7.3.4 United Nations Guiding Principles on the Human Environment [Nigeria signed the Basel Convention document in 1992 and ratified in 1994]

The United Nations (UN) published the concept of Guiding Principles on the Human Environment in 1972. Ten of these Guiding Principles were defined as formal declarations that express the basis on which an environmental policy can be built and which provide a foundation for action.

1.7.3.5 The Rio Declaration on Environment and Development [Nigeria signed the Basel Convention document in 1992 and ratified in 1994]

The UN Conference on Environment and Development met at Rio de Janeiro in June 1992, at which time it reaffirmed the 1972 declaration on the Human Environment, and sought to build upon it. This was done to establish a new and equitable global partnership through the creation of new levels of cooperation among states, key sectors of societies, and people. It was also to aid work towards international agreements, which respect the interests of all, protect the integrity of the global environmental development system, and recognize the integral and interdependent nature of the earth.

1.7.3.6 Polluters Pays Principle (Adopted by Nigeria in 1999)

In environmental law, the polluter pays principle is enacted to make the party responsible for producing pollution responsible for paying for the damage done to the natural environment. It is regarded as a regional custom because of the strong support it has received in most Organisation for Economic Co-operation and Development (OECD) and European Community (EC) countries.

The polluter pays principle underpins environmental policy such as an ecotax, which, if enacted by the government, deters and essentially reduces greenhouse gas emissions. Some eco-taxes underpinned by the polluter pays principle include: The Gas Guzzler Tax, in the US, Corporate Average Fuel Economy (CAFE)- a "polluter pays" fine. The U.S. Superfund law requires polluters to pay for the cleanup of hazardous waste sites when the polluters can be identified.

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

1.7.3.7 International Finance Corporation (IFC) Environment, Health and Safety Guidelines for Telecommunication [Date of acceptance by Nigeria - 27 October. 2001]

The IFC and the World Bank Group have developed a set of Sectoral Environment, Health and Safety (EHS) Guidelines specific to particular industries sectors or types of projects. The guideline requirements for the Telecommunication sector are as follows:

Right of Way

- All rights-of-way should be aligned considering environmental factors to minimize the need for physical alteration and impact on sensitive natural environments, cultural resources, agricultural lands, and residential and commercial areas.
- The land acquisition shall require the identification and quantification of any impacts on land-based livelihood and compensation to landowners and other uses. An assessment should be carried out if the route shall pass through environmentally sensitive areas.

Wastes

- Project sponsors should recycle or reclaim wastes where practicable. If not, wastes must be disposed of in compliance with local laws and regulations.
- Hazardous materials, process residues, solvents, oils, sludge, process water, domestic sewage must be disposed of in a manner to avoid soil, groundwater, and surface water contamination.
- Restricts the use of transformers or equipment containing polychlorinated biphenyls (PCB) or any PCB related materials/systems. Such materials shall be disposed of in line with existing local regulations. It also restricts the use of chlorofluorocarbons (CFC) including halon generating equipment/systems.
- Design storage and liquid impoundments areas for fuel, raw and in-process materials, solvents, wastes, and finished products with secondary containment to prevent spills and contamination of soil, groundwater, and surface waters.

Air Quality and Noise

- Periodic monitoring of air quality as well as provision and maintenance of ventilation, air containment control equipment, protective respiratory equipment, and air quality monitoring equipment. It also stipulates the use of protective equipment in the workplace where exposure is greater than local or international standards.
- Provision of administrative and engineering controls including sound-insulated equipment and control rooms to reduce the noise level at work areas. It also requires periodic maintenance of plant equipment and the use of hearing protective equipment in areas of exposures above 85dB (A).
- Noise measurements shall not exceed 55dB (A) and 45dB (A) for daytime and night time respectively in residential, institutional, and educational areas and 70dB (A) for both day and night time in industrial and commercial areas.

Workplace Incidence

- Monitor the workplace regularly for radiation and field levels and equipment integrity.
- Develop strict procedures for de-energizing and checking electrical equipment before maintenance.
- Conduct personnel training in revival techniques for electrocution.
- Test for the presence of flammable and explosive gases or vapour in all confined spaces (tanks, sumps, sewers, etc.) before entry and occupancy. Provide adequate ventilation before entry and during occupancy of these spaces.

Hazardous Material Handling

- Hazardous (reactive, flammable, radioactive, corrosive, and toxic) materials must be stored in clearly labelled containers. Handling and storage should be in line with local regulatory requirements.
- Provisions of fire prevention systems and secondary containment for storage facilities.

Health

- Personnel exposed to high temperature and/or humidity should be allowed frequent breaks from such areas.
- Pre-employment and periodic medical examinations should be conducted for all personnel, and specific surveillance programmes instituted for personnel potentially exposed to toxic or radioactive substances.

Safety

- Elevated platforms, walkways, stairways, and ramps should be equipped with handrails, toe boards, and non-slip surfaces.

- Electrical equipment should be grounded, well insulated, and conforms to applicable codes.
- Eye protection should be worn by personnel when in areas of risks of flying chips or sparks or where intense lights are generated.
- Safety program to be established for construction and maintenance activities.

Personnel to be trained in HSE matters including accident prevention, safety lifting practices, the use of Material Safety Data Sheet (MSDS), safe chemical handling practices, and proper control and maintenance of equipment and facilities.

1.7.3.8 International Telecommunication Union (Date of Entry by Nigeria - 1961/4/11)

The International Telecommunication Union (ITU) has developed a set of guidelines to enable telecommunication industry operators to comply with necessary local and national regulatory authorities' requirements and standards. The guidelines also guide operators to be employed in measuring the electromagnetic field and calculation of exposure levels in various situations. These recommendations are contained in the ITU-T's (the standardization bureau of the ITU) documents titled "Series K Protection against Interference".

The ITU-T K.52 Recommendation provides guidelines for operators in assessing levels of exposure for their telecommunication installation through the evaluation of the Electromagnetic Field (EMF) and accessibility considerations.

The guideline stipulates the procedure to be employed by operators in complying with EMF safety limits. The recommended steps for compliance are:

- The operator must identify the compliance limits.
- The operator must determine the need for EMF exposure assessment for the installation of telecommunication equipment.
- Where the above is required; the operator must do so by calculations or measurements.
- Where the EMF exposure assessment indicates that the exposure levels may exceed the recommended limits in residential areas, the operator should identify and apply the necessary mitigation measures.

The ITU-T Recommendations K.61 gives guidance to operators on measurement and numerical calculation of EMF for compliance with human exposure limits in respect of telecommunications installations. In making the recommendation, the union considered the following documents:

- ITU-T Recommendation K.52 (2000) Guidance on complying with limits for human exposure to EMF.

- IEC 61566:1997, measurement of exposure to radiofrequency electromagnetic fields-Field strength in the frequency range 100KHz to 1GHz.
- IES 60657:1979, Non-ionizing hazards in the frequency range 10MHz to 300,000MHz.
- ISO/IEC: 1995, Guide to the expression of uncertainty in measurement.

1.7.3.9 Nagoya Protocol of 2010 (Ratified by Nigeria on 12 October 2014)

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity, also known as the Nagoya Protocol on Access and Benefit Sharing (ABS) is a 2010 supplementary agreement to the 1992 Convention on Biological Diversity (CBD). Its aim is the implementation of one of the three objectives of the CBD: the fair and equitable sharing of benefits arising out of the utilization of genetic resources, thereby contributing to the conservation and sustainable use of biodiversity. However, there are concerns that the added bureaucracy and legislation will overall, be damaging to the monitoring and collection of biodiversity, to conservation, to the international response to infectious diseases, and research.

The protocol was adopted on 29 October 2010 in Nagoya, Japan, and entered into force on 12 October 2014. It has been ratified by 114 parties, which includes 113 UN member states and the European Union. It is the second protocol to the CBD; the first is the 2000 Cartagena Protocol on Biosafety.

Access obligations

Domestic-level access measures aim to:

- Create legal certainty, clarity, and transparency.
- Provide fair and non-arbitrary rules and procedures.
- Establish clear rules and procedures for prior informed consent and mutually agreed on terms.
- Provide for issuance of a permit or equivalent when access is granted.
- Create conditions to promote and encourage research contributing to biodiversity conservation and sustainable use.
- Pay due regard to cases of present or imminent emergencies that threaten human, animal, or plant health.
- Consider the importance of genetic resources for food and agriculture for food security.

1.7.3.10 Kyoto Protocol of 2004 (Ratified by Nigeria on 5th November 2004)

The Kyoto Protocol is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits state parties to reduce greenhouse gas emissions, based on the scientific consensus that (part one) global warming is occurring and (part two) it is extremely likely that human-made CO_2 emissions have predominantly caused it. The Kyoto Protocol was adopted in Kyoto, Japan on 11 December 1997 and entered into force on 16 February 2005. There are currently 192 parties (Canada withdrew from the protocol, effective December 2012) to the Protocol.

The Kyoto Protocol implemented the objective of the UNFCCC to reduce the onset of global warming by reducing greenhouse gas concentrations in the atmosphere to "a level that would prevent dangerous anthropogenic interference with the climate system" (Article 2). The Kyoto Protocol applies to the six greenhouse gases listed in Annex A: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur hexafluoride (SF_6).

The Protocol is based on the principle of common but differentiated responsibilities: it acknowledges that individual countries have different capabilities in combating climate change, owing to economic development, and therefore puts the obligation to reduce current emissions on developed countries on the basis that they are historically responsible for the current levels of greenhouse gases in the atmosphere.

Other developed countries without second-round targets are Canada (which withdrew from the Kyoto Protocol in 2012) and the United States (which has not ratified). As of January 2019, 124 states have accepted the Doha Amendment, while entry into force requires the acceptances of 144 states. of the 37 countries with binding commitments, 7 have ratified.

1.7.3.11 Stockholm Convention Against Persistent Organic Pollutants of 2004 (Signed on 23/05/2001, ratified by Nigeria on 24/05/2004 and came to force on 22/08/2004)

Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty, signed in 2001 and effective from May 2004, that aims to eliminate or restrict the production and use of persistent organic pollutants (POPs). In 1995, the Governing Council of the United Nations Environment Programme (UNEP) called for global action to be taken on POPs, which is defined as "chemical substances that persist in the environment, bio-accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment".

Following this, the Intergovernmental Forum on Chemical Safety (IFCS) and the International Programme on Chemical Safety (IPCS) prepared an assessment of the 12 worst offenders, known as the *dirty dozen*. The INC met five times between June 1998 and December 2000 to elaborate the convention, and delegates adopted the Stockholm Convention on POPs at the Conference of the Plenipotentiaries convened from 22–23 May 2001 in Stockholm, Sweden.

The negotiations for the Convention were completed on 23 May 2001 in Stockholm. The convention entered into force on 17 May 2004 with ratification by an initial 128 parties and 151 signatories. Co-signatories agree to outlaw nine of the dirty dozen chemicals, limit the use of DDT to malaria control, and curtail inadvertent production of dioxins and furans.

Parties to the convention have agreed to a process by which persistent toxic compounds can be reviewed and added to the convention if they meet certain criteria for persistence and transboundary threat. The first set of new chemicals to be added to the Convention was agreed upon at a conference in Geneva on 8 May 2009.

As of June 2018, there are 182 parties to the Convention, (181 states and the European Union). Notable non-ratifying states include the United States, Israel, Malaysia, and Italy. The Stockholm Convention was adopted to EU legislation in REGULATION (EC) No 850/2004. Key elements of the Convention include the requirement that developed countries provide new and additional financial resources and measures to eliminate production and use of intentionally produced POPs, eliminate unintentionally produced POPs where feasible, and manage and dispose of POPs wastes in an environmentally sound manner. Precaution is exercised throughout the Stockholm Convention, with specific references in the preamble, the objective, and the provision on identifying new POPs.

When adopting the Convention, provision was made for a procedure to identify additional POPs and the criteria to be considered in doing so. at the first meeting of the Conference of the Parties (COP1), held in Punta del Este, Uruguay from 2–6 May 2005, the POPRC was established to consider additional candidates nominated for listing under the Convention.

The Committee is composed of 31 experts nominated by parties from the five United Nations regional groups and reviews nominated chemicals in three stages. The Committee first determines whether the substance fulfills POP screening criteria detailed in Annex D of the Convention, relating to its persistence, bioaccumulation, the potential for long-range environmental transport (LRET), and toxicity. If a substance is deemed to fulfill these requirements, the Committee then drafts a risk profile according to Annex E to evaluate whether the substance is likely, as a result of its LRET, to lead to significant adverse human health and/or environmental effects and therefore warrants global action. Finally, if the POPRC finds that global action is warranted, it develops a risk management evaluation, according to Annex F, reflecting socioeconomic considerations associated with possible control measures. Based on this, the POPRC decides to recommend that the COP list the substance under one or more of the annexes to the Convention. The POPRC has met annually in Geneva, Switzerland since its establishment.

The seventh meeting of the Persistent Organic Pollutants Review Committee (POPRC-7) of the Stockholm Convention on Persistent Organic Pollutants (POPs) took place from 10–14 October 2011 in Geneva, Switzerland. POPRC-8 was held from 15–19 October 2012 in Geneva, POPRC-9 to POPRC-13 were held in Rome.

1.7.3.12 Cartagena Protocol on Bio-safety of 2003 (Singed on May 24, 2000, ratified on Jul 15, 2003, and came into action on Oct 13, 2003)

The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an international agreement on biosafety as a supplement to the Convention on Biological Diversity effective since 2003. The Biosafety Protocol seeks to protect biological diversity from the potential risks posed by genetically modified organisms resulting from modern biotechnology.

The Bio-safety Protocol makes clear that products from new technologies must be based on the precautionary principle and allow developing nations to balance public health against economic benefits. It will for example let countries ban imports of genetically modified organisms if they feel there is not enough scientific evidence that the product is safe and requires exporters to label shipments containing genetically altered commodities such as corn or cotton.

1.7.3.13 Montreal Protocol on Substances that Deplete the Ozone Layer, 1988 (Ratified by Nigeria on 22/09/1988)

The Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion. It was agreed on 26 August 1987, and entered into force on 26 August 1989, followed by the first meeting in Helsinki, May 1989. Since then, it has undergone eight revisions, in 1990 (London), 1991 (Nairobi), 1992 (Copenhagen), 1993 (Bangkok), 1995 (Vienna), 1997 (Montreal), 1998 (Australia), 1999 (Beijing), and 2016 (Kigali, adopted, but not in force). As a result of the international agreement, the ozone hole in Antarctica is slowly recovering. Climate projections indicate that the ozone layer will return to 1980 levels between 2050 and 2070.

The treaty is structured around several groups of halogenated hydrocarbons that deplete stratospheric ozone. All of the ozone-depleting substances controlled by the Montreal Protocol contain either chlorine or bromine (substances containing only fluorine do not harm the ozone layer). Some ozone-depleting substances (ODSs) are not yet controlled by the Montreal Protocol, including nitrous oxide (N2O) For a table of ozone-depleting substances controlled by the Montreal Protocol see. For each group of ODSs, the treaty provides a timetable on which the production of those substances must be shot out and eventually eliminated. This included a 10-year phase-in for developing countries identified in Article 5 of the treaty.

The stated purpose of the treaty is that the signatory states "Recognizing that worldwide emissions of certain substances can significantly deplete and otherwise modify the ozone layer in a manner that is likely to result in adverse effects on human health and the environment. Determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it with the ultimate objective of their elimination based on developments in scientific knowledge"

"Acknowledging that special provision is required to meet the needs of developing countries"
shall accept a series of stepped limits on CFC use and production, including:

from 1991 to 1992 its levels of consumption and production of the controlled substances in Group I of Annex A do not exceed 150 percent of its calculated levels of production and consumption of those substances in 1986;

from 1994 its calculated level of consumption and production of the controlled substances in Group I of Annex A does not exceed, annually, twenty-five percent of its calculated level of consumption and production in 1986.

from 1996 its calculated level of consumption and production of the controlled substances in Group I of Annex A does not exceed zero.

1.7.3.14 International Commission on Non-Ionizing Radiation Protection (ICNIRP)

IN 1974, the International Radiation Protection Association (IRPA) formed a working group on non-ionizing radiation (NIR), examined the problems arising in the field of protection against the various types of NIR. at the IRPA Congress in Paris in 1977, this working group became the International Commission on Non-Ionizing Radiation Protection (ICNIRP). In cooperation with the Environmental Health Division of the World Health Organization (WHO), the IRPA/ICNIRP developed several health criteria documents on NIR as part of WHO's Environmental Health Criteria Programme, sponsored by the United Nations Environment Programme (UNEP). Each document includes an overview of the physical characteristics, measurement and instrumentation, sources, and applications of NIR, a thorough review of the literature on biological effects, and an evaluation of the health risks of exposure to NIR. These health criteria have provided the scientific database for the subsequent development of exposure limits and codes of practice relating to NIR.

Table 1.1: Basic Restrictions for Time-Varying Electric and Magnetic Fields for Frequencies up to 10 GHz. [a]

Exposure Characteristics	Frequency Range	Current Density for Head and Trunk (mA m^{-2}) (RMS)	Whole-Body Average SAR (W kg^{-1})	Localized SAR (head and trunk) (W kg^{-1})	Localized SAR (limbs) (W kg^{-1})
Occupational Exposure	up to 1 Hz	40	—	—	—
	1–4 Hz	40/f	—	—	—
	4 Hz–1 kHz	10	—	—	—
	1–100 kHz	f/100	—	—	—
	100 kHz–10 MHz	f/100	0.4	10	20
	10 MHz–10 GHz	—	0.4	10	20
General Public Exposure	up to 1 Hz	8	—	—	—
	1–4 Hz	8/f	—	—	—
	4 Hz–1 kHz	2	—	—	—
	1–100 kHz	f/500	—	—	—
	100 kHz–10 MHz	f/500	0.08	2	4
	10 MHz–10 GHz	—	0.08	2	4

Note:

1. *f* is the frequency in hertz.
2. Because of electrical inhomogeneity of the body, current densities should be averaged over a cross-section of 1 cm^2 perpendicular to the current direction.
3. For frequencies up to 100 kHz, peak current density values can be obtained by multiplying the RMS value by √2 (≈1.414). For pulses of duration t_p, the equivalent frequency to apply in the basic restrictions should be calculated as $f = 1/(2t_p)$.
4. For frequencies up to 100 kHz and for pulsed magnetic fields, the maximum current density associated with the pulses can be calculated from the rise/fall

times and the maximum rate of change of magnetic flux density. The induced current density can then be compared with the appropriate basic restriction.
5. All SAR values are to be averaged over any 6-min period.
6. Localized SAR averaging mass is any 10g of contiguous tissue; the maximum SAR so obtained should be the value used for the estimation of exposure.
7. For pulses of duration t_p, the equivalent frequency to apply in the basic restrictions should be calculated as $f = 1/(2t_p)$. Additionally, for pulsed exposures in the frequency range 0.3 to 10 GHz and localized exposure of the head, to limit or avoid auditory effects caused by thermoelastic expansion, an additional basic restriction is recommended. This is that the SA should not exceed10mJ kg^{-1} for workers and 2mJ kg^{-1} for the general public averaged over 10g tissue.

Table 1.2: Reference Levels for Occupational and General Public Exposure to Time-Varying Electric and Magnetic Fields (Unperturbed RMS Values).[a]

Exposure Characteristics	Frequency Range	E-Field Strength (V m^{-1})	H-Field Strength (A m^{-1})	B-Field (μT)	Equivalent Plane Wave Power Density S_{eq} (W m^{-2})
Occupational Exposure	up to 1 Hz	—	1.63×10^5	2×10^5	—
	1–8 Hz	20,000	$1.63 \times 10^5/f^2$	$2 \times 10^5/f^2$	—
	8 Hz–25 Hz	20,000	$2\times10^4/f$	$2.5 \times10^4/f$	—
	0.025–0.82 kHz	500/f	20/f	25/f	—
	0.82–65 kHz	610	24.4	30.7	—
	0.065–1 MHz	610	1.6/f	2.0/f	—
	1-10 MHz	610/f	1.6/f	2.0/f	—
	10-400 MHz	61	0.16	0.2	10
	400-2,000 MHz	$3f^{1/2}$	$0.008f^{1/2}$	$0.01f^{1/2}$	f/40
	2–300 GHz	137	0.36	0.45	50
General Public Exposure	up to 1 Hz	—	3.2×10^4	4×10^4	—
	1–8 Hz	10,000	$3.2 \times10^4/f^2$	$4\times10^4/f^2$	—
	8 Hz–25 Hz	10,000	4,000/f	5,000/f	—
	0.025–0.8 kHz	250/f	4/f	5/f	—

	0.8–3 kHz	250/f	5	6.25	—
	3–150 kHz	87	5	6.25	—
	0.15-1 MHz	87	0.73/f	0.92/f	—
	1-10 MHz	$87/f^{1/2}$	0.73/f	0.92/f	—
	10-400 MHz	28	0.073	0.092	2
	400–2,000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$0.0046f^{1/2}$	f/200
	2-300 GHz	61	0.16	0.20	10

[a] Note:

1. *f* as indicated in the frequency range column.
2. Provided that basic restrictions are met and adverse indirect effects can be excluded, field strength values can be exceeded.
3. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, H^2, and B^2 are to be averaged over any 6-min period.
4. For peak values at frequencies up to 100 kHz see Table 1.5, note 3.
5. For peak values at frequencies exceeding 100 kHz. Between 100 kHz and 10 MHz, peak values for the field strengths are obtained by interpolation from the 1.5-fold peak at 100 kHz to the 32-fold peak at 10 MHz. For frequencies exceeding 10 MHz, it is suggested that the peak equivalent plane wave power density, as averaged over the pulse width does not exceed 1,000 times the S_{eq} restrictions, or that the field strength does not exceed 32 times the field strength exposure levels given in the table.
6. For frequencies exceeding 10 GHz, S_{eq}, E^2, H^2, and B^2 are to be averaged over any $68/f^{1.05}$-min period (*f* in GHz).
7. No E-field value is provided for frequencies<1 Hz, which are effectively static electric fields. Perception of surface electric charges will not occur at field strengths of less than 25 kVm^{-1}. Spark discharges causing stress or annoyance should be avoided.

Table 1.3: Reference Levels for Time-Varying Contact Currents from Conductive Objects

Exposure Characteristics	Frequency Range	Maximum Contact Current (mA)
Occupational Exposure	up to 2.5 kHz	1.0
	2.5–100 kHz	0.4*f*
	100 kHz–110 MHz	40
General Public Exposure	up to 2.5 kHz	0.5
	2.5–100 kHz	0.2*f*
	100 kHz–110 MHz	20

f is the frequency in kHz

Table 1.4: Reference Levels for Electric Field Strength, Magnetic Field Strength and Power Density in Uncontrolled Environments

Frequency (MHz)	Electric Field Strength (E_{RL}), (V/m, RMS)	Magnetic Field Strength (H_{RL}), (A/m, RMS)	Power Density (S_{RL}), (W/m²)	Reference Period (minutes)
10 – 20	27.46	0.0728	2	6
20 – 48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{0.5}$	6
48 – 300	22.06	0.05852	1.291	6
300 - 6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000 - 15000	61.4	0.163	10	6
15000 – 150000	61.4	0.163	10	$616000 / f^{1.2}$
150000 – 300000	$0.158 f^{0.5}$	$4.21\times10^{-4} f^{0.5}$	$6.67\times10^{-5} f$	$616000 / f^{1.2}$
Frequency, *f*, is in MHz.				

Table 1.5. Reference Levels for Electric Field Strength, Magnetic Field Strength and Power Density in Controlled Environments

Frequency (MHz)	Electric Field Strength (E_{RL}), (V/m, RMS)	Magnetic Field Strength (H_{RL}), (A/m, RMS)	Power Density (S_{RL}), (W/m²)	Reference Period (minutes)
10 – 20	61.4	0.163	10	6
20 – 48	$129.8 / f^{0.25}$	$0.3444 / f^{0.25}$	$44.72 / f^{0.5}$	6
48 – 100	49.33	0.1309	6.455	6
100 - 6000	$15.60 f^{0.25}$	$0.04138 f^{0.25}$	$0.6455 f^{0.5}$	6
6000 – 15000	137	0.364	50	6
15000 – 150000	137	0.364	50	$616000 / f^{1.2}$
150000 – 300000	$0.354 f^{0.5}$	$9.40\times10^{-4} f^{0.5}$	$3.33\times10^{-4} f$	$616000 / f^{1.2}$
Frequency, *f*, is in MHz.				

1. For exposures shorter than the reference period, field strengths may exceed the reference levels, provided that the time average of the squared value of the electric or magnetic field strength over any period equal to the reference period shall not exceed E_{RL}^2 or H_{RL}^2, respectively. For exposures longer than the reference period, including indefinite exposures, the time average of the squared value of the electric or magnetic field strength over any period equal to the reference period shall not exceed E_{RL}^2 or H_{RL}^2, respectively.
2. Where exposure is estimated in terms of power density and for exposures shorter than the reference period, power density levels may exceed the reference levels provided that the time average of the power density over any period equal to the reference period shall not exceed S_{RL}. For exposures longer than the reference period, including indefinite exposures, the time average of the power density over any period equal to the reference period shall not exceed S_{RL}.
3. Spatially non-uniform external field strengths or power density can be spatially averaged, provided the sampling scheme applied ensures that none of the basic restrictions are exceeded at spatially-averaged exposures equal to the reference level. If spatial averaging is not applied, the spatial peak field strength shall be compared to the reference levels. In the case of field strengths, spatial averaging is concerning the squared values of the field strength samples while for power density, spatial averaging is concerning the power density samples.
4. For simultaneous exposure to multiple frequencies and where exposure is estimated in terms of power density, each of the power density frequency component amplitudes shall be divided by the corresponding reference level for that frequency, and the sum of all these ratios shall not exceed unity. This may be expressed as: $\sum (S_i/S_{RL}) \leq 1$.
5. For simultaneous exposure to multiple frequencies and where exposure is estimated in terms of field strength, each of the squares of the field strength frequency component amplitudes shall be divided by the square of the corresponding field strength reference level for that frequency, and the sum of all these ratios shall not exceed unity. This may be expressed as $\sum (E_i/E_{RL})^2 \leq 1$ for electric field strength or $\sum (H_i/H_{RL})^2 \leq 1$ for magnetic field strength.
6. For pulsed RF field exposures estimated in terms of power density, the time-averaged power density, averaged over any period equal to the reference period, shall not exceed S_{RL}, and the power density, as averaged over the pulse width, shall not exceed 1000 times the reference level, S_{RL}.
7. For pulsed RF field exposures estimated in terms of field strength, the time average of the squared value of the electric or magnetic field strength over any time equal to the reference period shall not exceed E_{RL}^2 or H_{RL}^2. Also, the time average of the squared value of the electric or magnetic field strength, as averaged over the pulse width, shall not exceed 1000 times E_{RL}^2 or H_{RL}^2,

respectively. Therefore, the RMS electric or magnetic field strength, determined over the pulse, shall not exceed 32 times E_{RL} or H_{RL}, respectively.

1.7.3.15 Public Exposure Guidelines to Radio Waves

Health effects related to short-term, high-level exposure have been established and form the basis of two international exposure limit guidelines (ICNIRP, 1998; IEEE, 2002). at present, these bodies consider the scientific evidence related to possible health effects from long-term, low-level exposure to ELF fields insufficient to justify lowering these quantitative exposure limits.

WHO's guidance

For high-level short-term exposures to EMF, adverse health effects have been scientifically established (ICNIRP, 2003). International exposure guidelines designed to protect workers and the public from these effects should be adopted by policymakers. EMF protection programs should include exposure measurements from sources where exposures might be expected to exceed limit values.

Regarding long-term effects, given the weakness of the evidence for a link between exposure to ELF magnetic fields and childhood leukaemia, the benefits of exposure reduction on health are unclear. Given this situation, the following recommendations are given:

- Government and industry should monitor science and promote research programmes to further reduce the uncertainty of the scientific evidence on the health effects of ELF field exposure. Through the ELF risk assessment process, gaps in knowledge have been identified and these form the basis of a new research agenda.
- Member States are encouraged to establish effective and open communication programmes with all stakeholders to enable informed decision-making. These may include improving coordination and consultation among industry, local government, and citizens in the planning process for ELF EMF-emitting facilities.
- When constructing new facilities and designing new equipment, including appliances, low-cost ways of reducing exposures may be explored. Appropriate exposure reduction measures will vary from one country to another. However, policies based on the adoption of arbitrary low exposure limits are not warranted.

Safety Guidelines for Rf Radiation

Safety guidelines for exposure of the public to the RF radiation from transmitting antennas are set by different organizations all over the world. The most widely accepted standards are those developed by the Institute of Electrical and

Electronics Engineers (IEEE) and the American National Standards Institute (ANSI), the International Commission on Non-Ionizing Radiation Protection (ICNIRP), and the National Council on Radiation Protection and Measurements (NCRP).

The Federal Communications Commission (FCC) guidelines include standards for mobile base stations antennas which are essentially the same as the (ANSI/IEEE). In the presence of multiple antennas, these standards apply to the total power produced by all antennas.

The measurement programs that were conducted in the United Kingdom and Canada near schools showed that the measurements were below the maximum limits set by the different standards. The maximum measured RF levels in the Canadian schools were between 0.00001 mW/cm^2 and 0.0026 mW/cm^2. the Canadian standard is less than 0.57 mW/cm^2.

In the UK, measurements were performed at 118 publicly accessible sites around 17 mobile phone base stations. The maximum exposure at any location was 0.00083 mW/cm^2. Typical power densities were less than 0.00001 mW/cm^2. This is less than 0.01% of the ICNIRP public exposure guidelines. When RF radiation from all sources was taken into account, the maximum power density at any site was less than 0.2% of the ICNIRP public exposure guidelines.

1.8 O`odua Infraco Resource Limited's Health, Safety and Environment (HSE) Strategy

➢ **Policy Statements and Objectives**

OIRL has indicated in the Company's Corporate Health, Safety, and Environmental Policy statement that it will conduct its operations in such a manner as to:

- Provide a safe working environment.
- Ensure the safety and health of the workforce and contractors working within the company's direct areas of operations.
- Protect the public from injury or ill health and prevent properties from loss or damage resulting from its activities.
- Safeguard the conservation of the environment.
- Comply with applicable environmental standards and legislation in Nigeria.

OIRL is also committed to reviewing at intervals, it's HSE policy to reflect the reality of the prevailing situations, and legislations.

➢ **Safety Health and Environmental Targets**

In taking steps to ensure a healthy and safe working environment, the Company, its contractors, and their employees aim at the following goals:

- no fatalities;
- prevention of lost time and any significant accidents;
- no major irradiation and radioactive emission; and
- prevention of occupational disease and environmental degradation.

➢ **Implementation Aspects**

The Corporate Environmental Policy is implemented with special attention to the following specific aspects:

- That the requirements of the relevant government legislation are followed.
- Company standards, specifications, procedures, and regulations are applied.
- Safety is accorded equal importance as productivity and project cost.
- Each employee is given specific procedures related to his work.
- Work instructions are clear and due regard paid to safety.
- Experience gained, lessons learned from accidents/incidents, and new technical developments are widely distributed amongst staff/contractors.
- Installations are designed, built, and operated in a way that work can be carried out safely and in an environmentally sound manner.
- Only materials, tools, and equipment which meet high safety standards are used;
- Safety aspects of installations, materials, and tools are reviewed continually.
- Contractors are required to adopt and maintain the same high standards as company employees.
- All work carried out, whether by the Company or its contractors are effectively monitored by Company Representatives.
- Safety meetings are held at all levels in the organization to ensure safety occupies an important place in work planning and execution.

Green Products

To ensure that our EHS objectives are met, we started a "Green Products" program that covers R&D, procurement, production and customer support. The program's execution is being overseen by a tri-level organization to guarantee its full support throughout the company. The top management team, which is made up of our Investment Review Board (IRB) members, decides the general direction that the company should take in terms of environment conservation. The middle management team comprises project managers who focus on business processes, R&D, procurement, production, IT and recycling. The third management team is responsible for the program's actual execution.

OIRL has been engaged in the research and development of environmental-friendly products such as Optic Fibre cables and Corrugate Optic Duct (COD for several years and emphasizes the importance of eco-design throughout the entire IPD process, from concept development to product launch. We aim to achieve three main goals through eco-design: environment conservation, quality enhancement and the rational and efficient usage of resources.

International Standards and Regulations

As a responsible global corporate citizen, OIRL complies with the most important international standards and environmental policies and regulations.

- OIRL complies with ISO 14001:2004 and OHSAS 18001:1999, the most widely-recognized standards on environmental management and occupational health and safety.

- OIRL's products and product components in the European market comply with RoHS (Restriction of the Use of Certain Hazardous Substances) and WEEE (Waste from Electric and Electronic Equipment), directives issued by the European Union aimed at recycling and restricting the use of certain hazardous substances in electrical and electronic equipment.

- OIRL is currently in the process of preparation to comply with the directive on the eco-design of Energy-using Products (EuP) by 2008, a new regulation that sets eco- design requirements for energy-using products. The impact on the environment will be considered at every stage of the product life cycle and assessed in terms of resource and energy consumption, waste, recycling, emission to air, land and water, noise, vibration, radiation, and EMI, thereby ensuring product quality and environmental protection.

- The basic engineering phase commenced with Engineering and design and will incorporate applicable Nigeria standards as well as specifications of the following internationally recognized standards.
- **Power Loss** - FOTP-171 / EIA-455-171 Attenuation by ubstitution Measurement for short length Multimode graded index and Single-mode optical fiber cable assemblies
- **Optical Return Loss (ORL)** - FOTP-107 / TIA/EIA-455-107A Return Loss for Fiber optic components
- **OTDR** - FOTP-59 / TIA/EIA-455-8 Measurement of Fiber Point Discontinuities Using an

OTDR and FOTP-8 TIA/EIA

- **PMD** - TIA-455-124 – FOTP124 – Polarization-mode Dispersion Measurement for Single- mode Optical Fibers by Interferometry Method
- **Chromatic Dispersion** - FOTP-175 / TIA-455-175-B Measurement Methods and Test Procedures- Chromatic Dispersion.

Energy Conservation

Energy conservation is a major aspect of sustainable development and it is crucial to ensure that future generations get to enjoy the natural resources we often take for granted today.

The ability of telecommunications equipment to improve our means of communication is particularly important because it reduces the need for transportation, and thus resources, especially in less developed countries

Moreover, OIRL Distributed Node B is dust-tight waterproof, small, and light, allowing it to be installed at minimal cost. It also complies with the IP65 standard and is suitable for use in harsh environmental conditions. Wireless technologies offer convenience and enjoyment in communication for billions of people around the world.

Electromagnetic waves are used in wireless communication equipment to send and receive speech, text messages, pictures, video clips, music tracks, data files, and so on. Research on the effect of electromagnetic waves on the human body dates back to the early twentieth century. With the popularity of wireless communication equipment such a mobile phones and base stations, people are showing growing concerns about electromagnetic exposure. These concerns have been duly addressed by health authorities around the world, including the World Health Organization (WHO), International Commission on Non-Ionizing Radiation Protection (ICNIRP), and Institute of Electrical and Electronics Engineers (IEEE). So far, no sufficient evidence can prove that radio waves have caused any adverse health consequence.

As a leading vendor of wireless communication equipment, OIRL places great importance on the effect of radio waves on environments and health. OIRL is dedicated to providing wireless communication products in compliance with electromagnetic exposure standards and regulations. In addition, OIRL cooperates with telecom operators to construct environmentally-friendly networks in compliance with local and national electromagnetic exposure standards.

1.9 Structure of the Report

The ESIA is structured following *the EIA Sectoral and Procedural Guidelines, 2016-*

2018 as presented below:

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CHAPTER TWO

PROJECT JUSTIFICATION

Internet usage in Nigeria has grown so exponentially that many of the services available for the people are internet based. There is a great potential for Internet bandwidth utilization in the country looking at the population of the country as the most populous Black Country in the world. The country presently has active submarine fibre optic cables connecting the country to the world through Europe deployed by different organizations with huge Internet broadband capacities. However, the Internet broadband penetration in the country is still very low with about 10% of the Oceanic Optical fibre capacities utilized and just 6% of fibre optic broadband penetration. Over 99% of the Internet broadband connection today in Nigeria is through the mobile wireless networks with less than 1% connection via the fixed wired/wireless.

Fibre optic networks for Internet broadband deployment in Nigeria can be categorized into three levels. The first level is referred to as the core network, the second level, the backhaul or backbone networks and the third level, the access or last mile networks which is an open access. The core fibre network connects the country to the world through the submarine fibre optic connection via Europe. The backbone or backhaul networks connect the backbone switches across the states in the country, Internet Service Providers (ISPs) and the central offices. Finally, the access or last-mile networks connect the Base Transmission Stations (BTS), cabinets, organizations, and to the homes.

The Internet broadband for open access deployment in Nigeria today is 99% through mobile wireless. Table 2.1 shows the detailed subscription of data reported by the Nigerian Communication Commission (NCC)

Table 2.1 Monthly Data Subscriber from December 2016 to March 2017

Operator	Mar-17	Feb-17	Jan-17	Dec-16
Mobile (GSM)	151,999,197	153,661,547	154,660,446	154,124,602
Mobile (CDMA)	217,566	217,566	217,566	217,566
Fixed Wired/Wireless	152,500	151,500	151,088	154,513
VoIP	97,935	89,871	84,447	33,099
Total	**152,467,198**	**154,120,484**	**155,113,547**	**154,529,780**
% of Mobile (GSM)	99.69	99.7	99.7	99.74
% of Mobile (CDMA)	0.14	0.14	0.14	0.14
% of Fixed/Fixed Wireless	0.10	0.10	0.10	0.10
% of VoIP	0.06	0.06	0.05	0.02

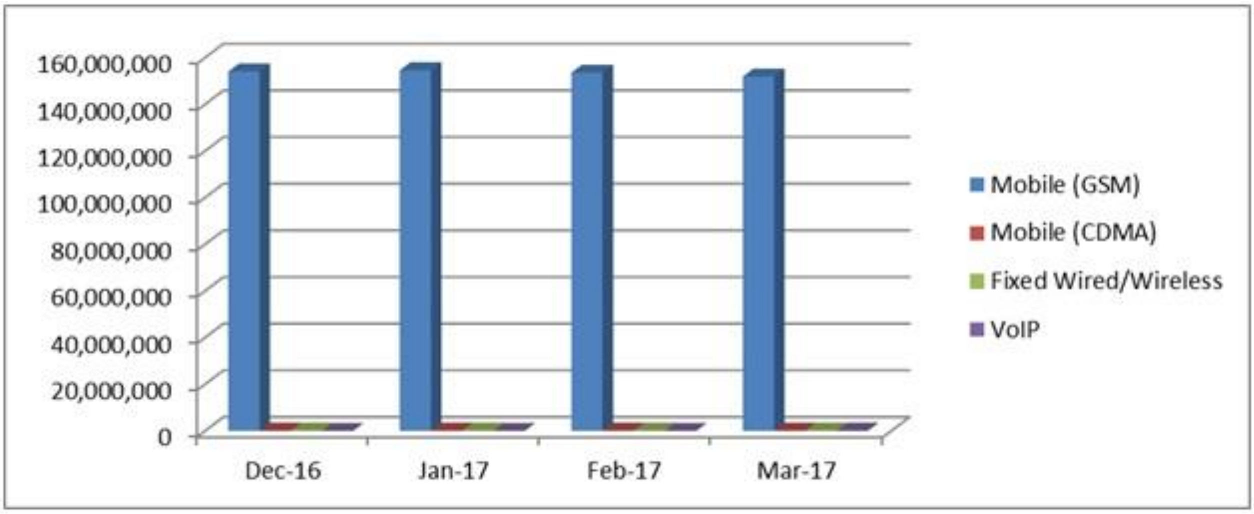


Figure 2.1: Internet broadband service subscriptions in Nigeria

From the information displayed in table 2.1 and figure 2.1, internet subscription in the country is almost through 100% Mobile (GSM). There are several limitations to these mobile technologies which range from coverage, volume of users per site, availability of devices for GSM 4GLTE deployment, etc. The fixed wired/wireless subscriptions captured in the graph in Figure 2.1 is a number of connections in which a connection may have multiple connections through Wi-Fi and Local Area Network (LAN) because most are connected to enterprise networks. The Internet society puts Nigeria at 128th for fixed broadband population penetration with 0.01% while the country was put at 101st in Internet user penetration globally with 38% penetration.

It is against this backdrop that the Nigerian Government instituted the Open Access

Metropolitan Fibre Network to raise the level of ICT in the rural and urban areas, attract the foreign investment, drive social & economic development and fulfil the Vision 2020 long-term development planning objective of Nigeria.

2.1 Value of the project

The Nigerian Communication Company (NCC) licensed O'odua Infraco Resources Ltd (OIRL) in 2018 to provide and operate on a wholesale basis an Open Access Metropolitan Fibre Network in the South West area of Nigeria including Kogi and Kwara states. This Project is part of President Buhari's Administration National Broadband Plan (2020 - 2025). The Federal Government will provide subsidy incentives for the project to the tune of N4,828,991,703.59 (Four Billion, Eight Hundred and Twenty-Eight Million, Nine Hundred and Ninety one Thousand, Seven hundred and three Naira, Fifty-nine kobo) while O'odua Infraco is spending Three (3) times more in the sum of N16, 509, 900, 000.00 (Sixteen Billion, Five Hundred and Nine Million, Nine Hundred Thousand Naira)

2.2 Need for the project

Nigeria has primary fiber optic backbone infrastructure presence in all the 36 state capitals and the Federal Capital Territory (FCT), with most fiber infrastructure concentrated in state capitals and a few urban centers. Of the 774 existing local government headquarters very few are connected on the route of the primary fiber backbone. Metropolitan networks only cover part of Lagos, Port Harcourt and Abuja. The National wholesale fiber optic networks that are operational are all owned by private investors in the countries. Some of these investors are, Globacom Limited, MTN Group, Multilinks, Etisalat, Phase 3/Dancom, Airtel and Main One. The optical fiber network of former National Carrier, Nigerian Telecommunication (NITEL) is not active. NITEL deployed large number of fiber optics across the nation, but presently not operational. Nigerian Communications Commission (NCC) 2014 year-end Report captures 80,938km length of fiber optics deployed by Mobile GSM/CDMA and Fixed operators as at December, 2014. The backhaul/backbone fiber optic networks are deployed by the telecommunication companies to enhance their network performance.

Thus, the backhaul/backbone fiber optic connections are to their core switches and to service base transmission stations not for open access to enhance last mile fiber optic connection. The NCC, through the Universal Service Provision Fund (USPF) started a project called Backbone Transmission Infrastructure Network (BTRAIN) which was aimed at facilitating the connection of the rural and semi urban areas to the core fiber optic network. So far, BTRAIN project has delivered 283km backbone fiber optic network to some villages in the Northern part of the country.

Hence, there is an urgent need to deploy open access last mile technologies that will maximize the available internet broadband capacity in the southern part of Nigeria including Kogi and Kwara states. To this end, the Nigerian Communication Company (NCC) licensed O'odua Infraco Resources Ltd (OIRL) in 2018 to provide and operate on a wholesale basis an Open Access Metropolitan Fibre Network in the South West area of Nigeria

Open Access Metropolitan Fibre Network or Fiber optic last mile technology is the best choice of internet broadband penetration in Nigeria because of the following reasons:

- It has very high capacity, light weight, small size and immunity to electromagnetic interference and cross talk;
- Emerging wide bandwidth can take applications like two-way video conferencing, video-on-demand (VOD), high-definition television and interactive gaming needs an uninterrupted high internet bandwidth powered by a communication medium like fiber optic to be able to enjoy these applications;
- Very fast and reliable internet usage can only be realized by a very high-speed connection using a medium like fiber optic;
- Fixed wired last mile technology deployment gives a more reliable and faster internet connection globally. The copper deployment as fixed wired technology is fading away in Nigeria hence the only available fixed cable last mile technology is fiber optic;
- Internet of Things (IoT), emerging technology globally can only be fully realized with a strong internet broadband accessibility which fiber optic last mile technology offers;
- Nigeria is already campaigning for moving the television transmission to full digital. With FTTH architecture using any of the PON technologies, digital television can easily be realized because fiber optic technology offers triple play solutions. That is, the voice (VoIP), the data and the video (IPTV):
- Presently, over 99% of the internet broadband penetration in Nigeria is through the wireless mobile. Congestion is experienced in accessing internet broadband in densely populated areas during the peak period with wireless mobile. With fiber optic last mile deployment, over reliant on mobile wireless will be drastically reduced hereby causing a more effective deployment of mobile wireless and maximization of the huge bandwidth the country has; and
- In the long run, fiber optic last mile deployment is cost efficient and effective.
- On completion, the project will greatly improve the modernization of ICT facilities of the Nigerian government, and strengthen the control capability of the

central government of Nigeria over the politics, economy and society of the whole country. It will also create a nice investment environment for foreign investment and create the advantageous macro environment for the political stability and economic growth of the country.

2.3 Benefits of the Project

This proposed project which is to construct an Open Metropolitan Fibre Network will positively enhance the performance of the telecommunication industry in satisfying the expectations and demand of both the private and public sectors of the economy. This will undoubtedly increase returns on the investment. The benefits of the project include:

Technical Benefits

1. The Open Metropolitan Fibre Network will provide reliable infrastructure for telecommunication operation.
2. The project will promote technology upgrade and provide dependable performance and superb reliability under high traffic load.
3. It has the ability to increase the businesses in the telecommunication industry.

Commercial and Economic Benefits

1. The project will improve the quality and efficiency of digital economy, data center enables organizations to conduct business around the clock and round the world.
2. It will ensure continuous business operations in the country.
3. Indirect economic benefits due to increased activities in the Information and Communication Technology (ICT) sector.
4. Provide employment opportunities and encourage foreign investment in the telecommunication industry.

Social Benefits

1. Facilitate crime abatement through improved communication and timely access to emergency response services.
2. Also, from the social perspective, modern and prospering cultures are characterized by well-functioning communication network.

2.4 Envisaged sustainability

The proposed project shall be undertaken using the Best Available Technology Not Entailing Excessive Cost (BATNEEC) and processes in the industry. To ensure technical, economic and environmental sustainability of the project, the specific measures to be taken shall include but not necessarily limited to the following:

Economic Sustainability

This project will be beneficial to the nation in so many ways. The project shall provide employment opportunities; support the local community and the nation economy as a whole. For example, during the construction phase of the object, indirect and direct job opportunities will be provided for skilled and semi-skilled labour force.

Apart from offering employment to our teaming population, it will improve the efficiency, performance and capacity of business accomplishment. It is the vehicle to realize sustainable development as it would bridge the digital divide between the rural and urban areas. According to a report issued by World Bank, taking Singapore as the example, via the online processing system in e-government, the cost saved during the establishment of one new company taking the mode of attracting foreign investment is between 700 and 20,000 USD, and the time required is shortened from 2 days to 2 hours.

The Nigerian government having fully recognized the importance of e-government, taking cognizance of the fact that e-government infrastructure is the basic drive to realizing long-term planning, has worked out an e-government development strategy. This involves the construction of unified platforms for the national e-government via various modes, plans and projects. This investment no will undoubtedly contribute to increased revenue to oureconomy.

Technical Sustainability

The development of an Open Metropolitan Fibre Network for the country is technically sustainable because it shall strictly adhere to internationally and nationally accepted engineering design and construction standard. In addition, innovative technologies that are economically viable and having minimal environmental, social and health impacts shall be utilized in the execution of the proposed project. The best available technology (BAT) in the telecommunication industry shall be deployed and in strict compliance with national and national and international engineering design codes and construction standards.

The Open Metropolitan Fibre Network provides abundant and flexible access for citizens to use government service anywhere anytime. Open Metropolitan Fibre Network is a unified network that features horizontal physical network and vertical virtual network with MPLS VPN technology. Each department can keep its own independence. To ensure technical sustainability, the following principles shall be enshrined in the project:

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

Environmental Sustainability

The project construction, installation and commissioning activities techniques vary according to the environment, and we are guided by Regulatory and Engineering Design standards. Working in marshy/swampy areas and water crossing would be approached using appropriate technologies to reduce risk levels. The regulatory requirements involving FMEnv, State and Local Government Councils environmental laws, regulations, standards and edits, and ratified international conventions as well as OIRL HSE policy, shall be adopted and implemented to sustain the project environmentally throughout the project's life span. Good housekeeping and waste management practices shall be adopted. There shall be continuous consultations with the host communities. There shall be strict adherence to the implementation of the Environmental and Social Management Plan (ESMP) to ensure sustainability of the project.

Also, the following guidelines shall be adopted to make the proposed project environmentally sustainable.

- ISO 14064-1:2006 *Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*: it specifies principles and requirements for the design, development, management, reporting, and verification of an organization's GHG inventory.
- ISO 14064-2:2006 *Greenhouse gases - Part 2: Specification with guidance at the project level for quantification, monitoring, and reporting of greenhouse gas emission reductions or removal enhancements*: it specifies principles and requirements and provides guidance at the project level for quantification, monitoring, and reporting of activities intended to cause GHG emission reductions. It includes requirements for planning a GHG project, for identifying and selecting GHG sources, for monitoring, quantifying, documenting, and reporting GHG project performances, and for managing data quality.
- ISO 14064-3:2006 *Greenhouse gases - Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions* specifies requirements for selecting GHG validators/verifiers, establishing the level of assurance, objectives, criteria, and scope, determining the validation

approach, assessing GHG data, information, information systems and controls, and preparing validation statements. It can be applied to organizational or GHG project quantification, including GHG quantification, monitoring and reporting carried out following ISO 14064-1 or ISO 14064-2.

- ISO 14040:2006 *Environmental management - Life cycle assessment -- Principles and framework* describes criteria and framework for life cycle assessment (LCA) and includes the definition of the goal and scope of each LCA phase, as well as the relationship between the LCA phases, reporting, critical review and limitations of the LCA, and conditions for use of value choices. ISO 14040:2006 covers life cycle assessment and life cycle inventory studies, but it does not describe the technique, nor specify methods for each phase. The application of LCA results is considered during the definition of the goal (and the scope), but the application itself is beyond the scope of this International Standard.
- ISO 14044:2006 *Environmental management - Life cycle assessment - Requirements and guidelines* specify requirements and provide guidelines for life cycle assessment following principles and framework of ISO 14040:2006. It covers life cycle assessment and life cycle inventory studies

Social Sustainability of the Project

To ensure the social sustainability of the project, the OIRL shall ensure:

a) ***Robust and sustained stakeholder engagement***: the OIRL shall ensure sustained and effective Stakeholder Engagement in a structured and culturally appropriate manner with affected states, LGAs and communities. The consultation process shall be tailored to the risks and impacts of the Project; the Project's phase of development; the language preferences of the affected communities; their decision-making processes; and the needs of disadvantaged and vulnerable groups. In the demonstration of OIRL's social policies, robust community engagement was instituted as part of the ESIA work (details are presented in Chapter Four).

b) ***Establish a grievance mechanism:*** This shall be designed to receive and facilitate the resolution of concerns and grievances about the project's environmental and social performance as part of its Environmental and Social Management System (ESMS). Potential sources of grievances and acts of sabotage could include community youth groups, tribal conflicts, etc.

c) ***Security Surveillance of the Backbone and Metro:*** Encroachment, breach of security and vandalism by a third party that can typically cause safety and environment incidents shall be monitored. Monitoring will include

i. Human tampering;
ii. Acts of terrorism and vandalism

2.5 Project Options and Alternatives

Established ESIA processes including the requirements of Nigerian regulations call for an analysis of reasonable alternatives to various elements of the proposed project. To align with the Federal Ministry of Environment's (FMEnv) *National Environmental Protection Regulation of 1991* which mandates early selection of best engineering and operational options for new point sources, a range of alternatives and options were evaluated to facilitate identification of the most appropriate means of meeting the project's environmental objective.

Project alternatives analysis in environmental assessment is designed to bring environmental and social considerations into project selection as well as the early stages of project planning, and the later stages of site selection, design, and implementation. The benefits of evaluating alternatives are for the selection of the best project design, selection of the best project location, and most efficient use of resources which will aid avoidance of adverse impacts and achievement of sustainable development goals. Therefore, the following options and alternatives were appraised:

- Project options: No project options; Delayed project options; and Go-ahead option;
- Project alternatives: Route alternatives and Transmission Technology Alternatives

Project Options

- ***Option One: No Project Option***

This option assumes that the project will not take place which means that no further development will take place in all the 8 states because of the non-viability of the feasibility studies. The No Project option will harm the local and national economies. The significant socio-economic and industrial development benefits associated with the proposed development such as increased business opportunities increased revenue to the government, increased foreign exchange earnings, employment opportunities, etc. will be forfeited. As a result, the 'No Project option' was not considered to be a viable or acceptable option for the proposed project.

- ***Option Two: Delayed Project Option***

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

- ***Option Three: Go-Ahead Option***

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

Project Alternatives

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

Alternatives can typically be identified according to:

a) Route alternatives
b) Transmission Technology Alternatives
c) Fibre Cable Type Alternatives
d) Duct Alternatives

For any alternative to be considered feasible such an alternative must meet the need and purpose of the development proposal without presenting significantly high associated impacts. The alternatives are described and the advantages and disadvantages are presented. It is further indicated which alternatives are considered feasible from a technical as well as environmental perspective.

Incremental alternatives typically arise during the ESIA process and are usually suggested as a means of addressing identified impacts. These alternatives are closely linked to the identification of mitigation measures and are not specifically identified as distinct alternatives. This section provides information on the development of footprint alternatives, as well as the type of activity, activity layout, technological and operational aspects of the activity.

Route Alternatives

Using Acquired ROWs

The acquired RoWs were chosen as the preferred location for the Open Metropolitan Fibre Network based on the following criteria (amongst others);

a) Sensitive area (Many of the existing environmental resources/values are not of prime importance) The project site: (1) does not contain any valuable ecological resources (either terrestrial or aquatic), (2) does not contain any items of archaeological significance or historical importance, (3) is not subject to floods or seismic disturbances and (4) is not the location of significant mineral resources or mining activities.
b) Availability of already acquired land: Taking the proposed development to another location will mean that a new land will have to be acquired. Shifting the project to another location will incur additional cost on investment because new land has to be purchased, a new business strategy needs to be adopted, etc. This action plan will also result in a loss of time. The necessary approval for the current site has been obtained and all required fees have been paid by OIRL.

Other route alternatives that were considered included a network with a different (i.e. smaller) scale, a network using a different configuration or underground and aerial installation, and a wireless network.

Different Scale Alternative

The proposed network is designed to meet the project purpose and need by optimizing the use of available infrastructure and adding new fiber only where necessary. Although a less extensive network could be implemented, that alternative would fail to address all three critical components of the Proposed Action. Consequently, this alternative was eliminated from further consideration due to its inability to meet the purpose and need.

Wireless Network Alternative

A wireless network alternative could address some elements of the project purpose and need but would be unable to provide the capacity or speed needed to fully meet the purpose and need. In addition, the installation of wireless infrastructure would require ground disturbance. Unlike the Preferred Alternative, which uses acquired ROWs, development of a wireless network typically requires disturbance of undeveloped areas for necessary site improvements and construction of access roads. Consequently, a wireless network was eliminated from further consideration due to its inability to fully meet the purpose and need and its greater potential for ground disturbance and associated environmental impacts.

Transmission Technology Alternatives

Usually, a fiber optic communication system consists of three main components: optical transmitter, fiber optic cable and an optical receiver. The optical transmitter converts the electrical signal to the optical signal; the fiber optic cable carries the optical signal from the optical transmitter to the optical receiver, and the optical receiver reconverts the optical signal to electrical signal. The most commonly used optical transmitter is semiconductor devices like LEDs (light-emitting diodes) and laser diodes. Photodetector is the key part of an optical receiver. It converts light into electricity using photodetector effect. As for the fiber optic cable, there is too much to say. As the use and demand for speed and bandwidth, the development of optical cables is amazing. Now in the optical cable market, there are OS2 fiber, OM1 fiber, OM2 fiber, OM3 fiber, OM4 fiber and OM5 fiber cable for different optical applications. Optical fibers are used as a medium for telecommunication and networking because it is flexible and can be bundled as cables. It is especially advantageous because of the following:

- **Extremely High Bandwidth**: No other cable-based data transmission medium offers the bandwidth that fiber does. The volume of data that fiber optic cables transmit per unit time is far greater than copper cables.
- **Longer Distance**: in fiber optic transmission, optical cables are capable of providing low power loss, which enables signals can be transmitted to a longer distance than copper cables.
- **Resistance to Electromagnetic Interference**: in practical cable deployment, it's inevitable to meet environments like power substations, heating, ventilating and other industrial sources of interference. However, fiber has a very low rate of bit error (10 EXP-13), as a result of fiber being so resistant to electromagnetic interference. Fiber optic transmission is virtually noise free.
- **Low Security Risk**: the growth of the fiber optic communication market is mainly driven by increasing awareness about data security concerns and use of the alternative raw material. Data or signals are transmitted via light in fiber optic transmission. Therefore, there is no way to detect the data being transmitted by "listening in" to the electromagnetic energy "leaking" through the cable, which ensures the absolute security of information.
- **Small Size**: fiber optic cable has a very small diameter. For instance, the cable diameter of a single OM3 multimode fiber is about 2mm, which is smaller than that of coaxial copper cable. Small size saves more space in fiber optic transmission.
- **Light Weight**: fiber optic cables are made of glass or plastic, and they are thinner than copper cables. These make them lighter and easy to install. Easy to Accommodate Increasing Bandwidth: with the use of fiber optic

cable, new equipment can be added to existing cable infrastructure. Because optical cable can provide vastly expanded capacity over the originally laid cable. And WDM (wavelength division multiplexing) technology, including CWDM and DWDM, enables fiber cables the ability to accommodate more bandwidth.

Fibre Cable Type Alternatives

Multi-Mode Fiber (MMF)

Multimode fiber, the first to be manufactured and commercialized, simply refers to the fact that numerous modes or light rays are carried simultaneously through the waveguide. Modes result from the fact that light will only propagate in the fiber core at discrete angles within the cone of acceptance. This fiber type has a much larger core diameter, compared to single- mode fiber, allowing for the larger number of modes. Multimode fiber is easier to couple than single- mode optical fiber and may be categorized as step-index or graded-index fiber. However, Multimode fiber is best designed for short transmission distances.

Single-Mode Fiber (SMF)

Single- mode fiber allows for a higher capacity to transmit information because it can retain the fidelity of each light pulse over longer distances. It exhibits no dispersion caused by multiple modes. Single-mode fiber also enjoys lower fiber attenuation than multimode fiber. Thus, more information can be transmitted per unit of time. Like multimode fiber, early single- mode fiber was generally characterized as step-index fiber meaning the refractive index of the fiber core is a step above that of the cladding rather than graduated as it is in graded-index fiber. Modern single- mode fibers have evolved into more complex designs such as matched clad, depressed clad and other exotic structures. Single- mode fiber is best designed for longer transmission distances, making it suitable for long-distance telephony and multi-channel television broadcast systems**. For this this proposed project, *Single-Mode Fiber (SMF)* shall be adopted.**

Duct Alternatives

Corrugate Optic Ducts (CODs): This type of duct has the following characteristics:

- Stand good against impaction damage and no damage risk from freezing temperature.
- Strong Concavo-convex shape provides good strength and stays same shape against ground compressive load.
- Stays stable from thermal expansion & contraction of duct during or after installation
- No duct connections in-between two manholes up to 500 meters or more.
- Single installation process: No need to go through complicated inner duct

insertion process owing to readily built-in both outer and inner ducts.
- To by-pass minor hurdles and skips unnecessary construction of manhole to diverse direction of line within the radiation of curbing angle.
- Increase of duct efficiency by increase of numbers of inner ducts to be inserted up to 5 ducts at approx. same price.
- Light weight allows easy handling and transportation
- Economic construction cost and time saving

Polyvinyl chloride (PVC): This type of duct has the following characteristics:
- Vulnerable to impaction damage
- Disconnection: Possibility of disconnection of connected points of outer duct due to ground compressive load.
- Thermal expansion & contraction during the installation period and in service Many individual connections: maximum length is 6 meters.
- To construct manhole to diverse direction of the line. - Complicated installation work as the insertion of inner ducts is in the second stage after the installation of outer duct.
- Causes traffic troubles (jamming) in case of urban installation.
- Inner duct may twist in the course of insertion.
- Maximum number of inner duct is limited to 3 ducts.
- High construction cost

For this this proposed project, Corrugate Optic Duct (COD) shall be adopted.

2.7 Summary

Given the abovementioned considerations, the preferred option (Go ahead option) is the optimal one, which combines efficient technology with cost minimization and environmental friendliness. The option to go ahead as planned does outweigh the other options of no project and delay project. The project shall serve to strengthen the economic base of Nigeria, improve ICT sector; and enhance Foreign Investment and everyday communication. The environmental sustainability of the project shall be ensured through the application of Best Available Technology.

Thus, it is envisaged that the proposed project can proceed while ensuring that adequate and appropriate measures are in place to mitigate any identified potential negative impacts of the project on the social, cultural and biophysical environment of the project area.

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Background Information

This chapter provides details on the proposed Open Metropolitan Fibre Network construction, installation, and operational processes. The details cover the nature of the key project activities, facilities, equipment, operations, personnel, and the implementation schedule. The aim is to enable the scope and extent of the project to be understood, and for all potential sources of impacts to be identified. It is also to facilitate the selection of best available techniques (BAT) as required by the National Environmental Protection of 1991. O`odua Infraco Resource Limited (OIRL) intends to design, install, and operate the project in line with the best international standards.

3.2 About the Project

In a bid to expand the networks infrastructure across the country and to provide more efficient services to the local consumers and government agencies, Nigeria Communication Company (NCC) through O`odua Infraco Resource Limited wishes to embark on an Open Access Metropolitan Fibre Network (laying of Fibre Optic backbone and Metro in the rural and urban areas) in Lagos, Ogun, Oyo, Osun, Ondo, Ekiti, Kwara and Kogi States. This project is part of government National Broadband Plan (2020-2025) that we lead to digital economy achievement, jobs and livelihood enhancement, e-learning, e-government, e-medicine, e-judiciary.

3.3 Project Location

The 7,500km of Backbone and metro network shall be constructed from with the starting point from Lekki Lagos to Ogun, Ogun to Oyo, Oyo to Osun, Osun to Ondo, Ondo to Ekiti, Oyo to Kwara and Ekiti to Kogi where it will be terminated at Lokoja. The Data Center will be setup in Lagos, and some Metro access system located in cities like Ibadan. Akure, Ado Ekiti, Osogbo, Abeokuta Ilorin and Lokoja. A Point of Access (POA) shall be setup in all the 117Local government Areas and viable locations in the southwest region including Kwara and Kogi States. The total land take shall be 0.0053km by 7,500km all through the 8 states.

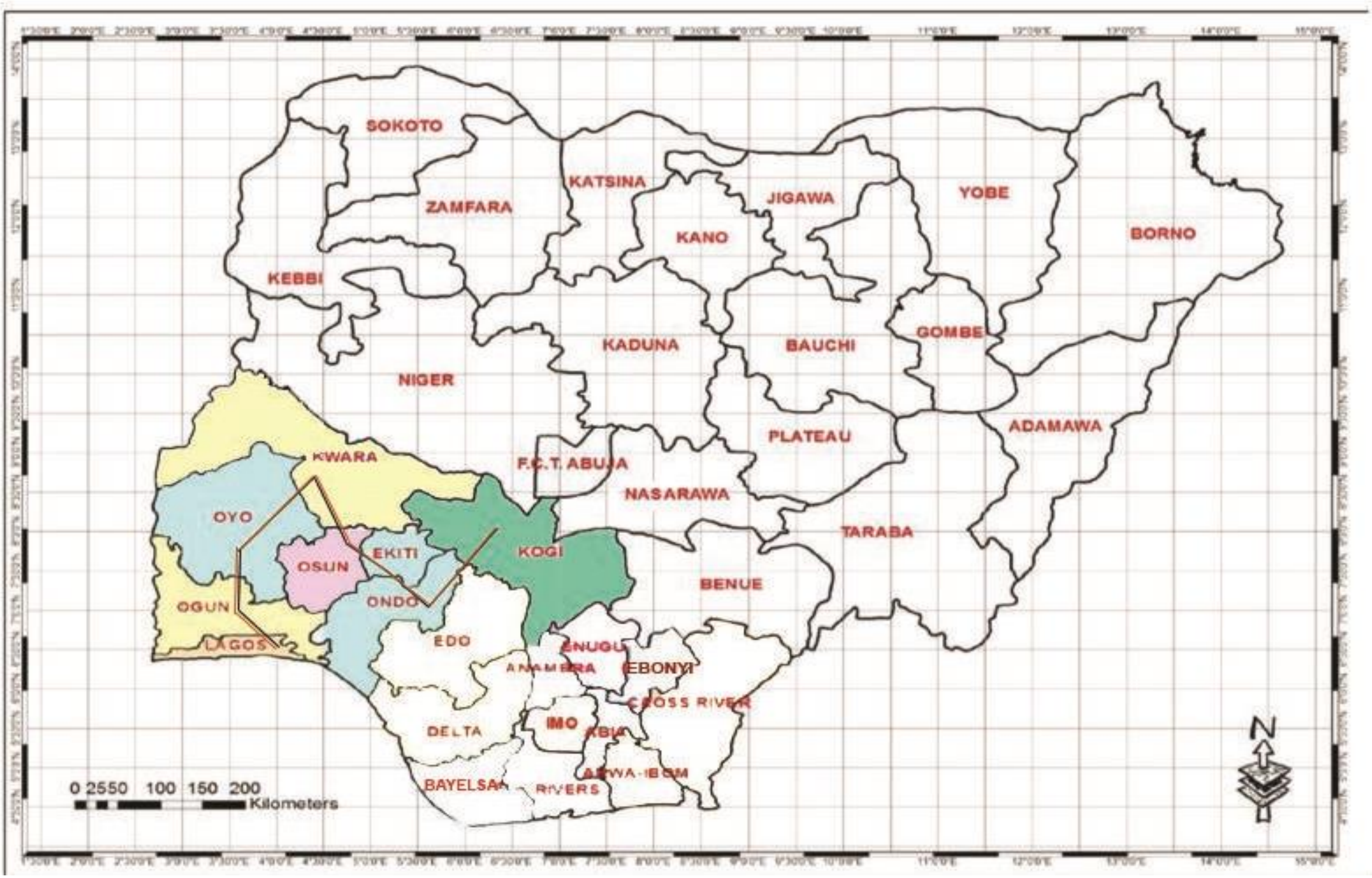


Figure 3.1: Map of Nigeria showing the proposed project route highlighted in colour (Source-GIS Map)

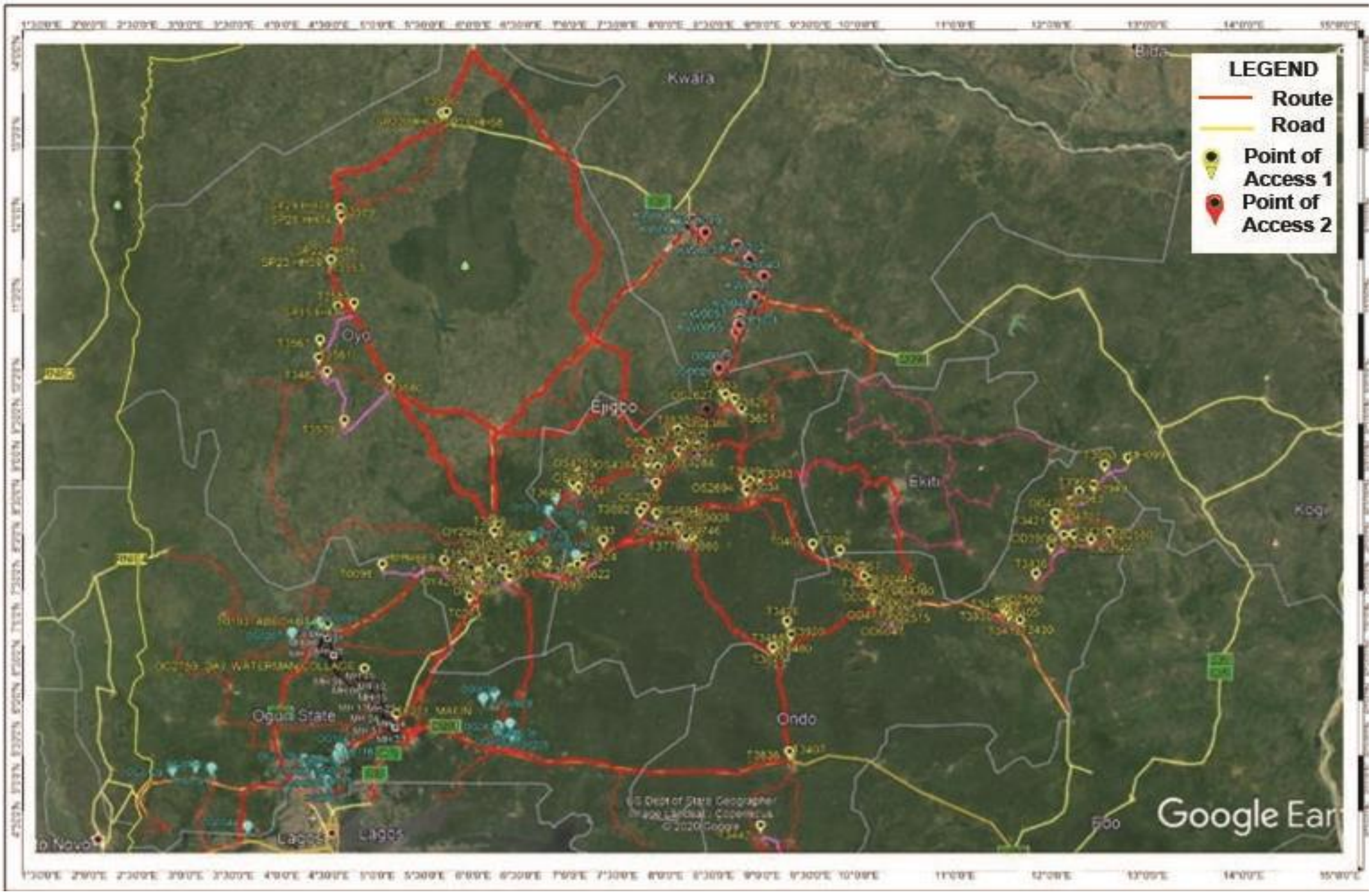


Figure 3.2: Satellite Imagery of Fibre Route across the 8 states (Lagos, Ogun, Oyo, Osun Ondo, Ekiti, Kogi and Kwara) Source: Google Earth Map

Table 3.1: Point of Access (POA)

	OGUN STATE			
	SCHEDULE OF DISTANCES			
	POA OF INTEREST	**COORDINATES**	**DISTANCE**	**Milestone Distance in (M)**
MILESTONE 1	ABEOKUTA SOUTH LGEA-ABEOKUTA SOUTH LG HQ	N7 08 42.1 / E3 21 42.5	2,648.00	**230,084.00**
	ABEOKUTA NORTH LG - ABEOKUTA SOUTH LG HQ	N7 11 14.2 / E3 20 22.6	3,852.00	
	ABEOKUTA SOUTH LG HQ - ILUGUN LCDA	N7 09 48.8 / E3 21 17.3	22,428.00	
	ABEOKUTA N.W. LCDA-ABEOKUTA N. EAST LCDA	N7 09 56.6 / E3 19 32.8	5,255.00	
	ABEOKUTA N. EAST LCDA- ABEOKUTA S.E LCDA	N7 08 33.4 / E3 19 27.7	1,847.00	
	ABEOKUTA S.E LCDA -ABEOKUTA SOUTH LGEA	N7 08 33.4 / E3 19 27.8	6,458.00	
	ABEOKUTA NORTH WEST LCDA-YEWA NORTH LG	N7 09 56.6 / E3 19 32.8	26,268.00	
	YEWA NORTH LG -IMEKO AFON LCDA	N7 14 27.2 / E3 03 10.7	37,210.00	
	IMEKO AFON LG SEC - IMEKO AFON LCDA	N7 26 05.8 / E7 26 05.8	13,376.00	
	IMEKO AFON LCDA	N7 25 42.4 / E2 55 52.4	-	
	ABEOKUTA NORTH WEST LCDA - IJU LCDA	N7 09 56.6 / E3 19 32.8	9,261.00	
	IJU LCDA - YEWA SOUTH LG	N7 05 18.4 / E3 05 11.6	25,571.00	
	YEWA SOUTH LG - COKER IBOGUN LCDA	N6 53 40.4 / E3 01 17.7	18,908.00	
	COKER IBOGUN LCDA - IFO LG	N6 49 56.0 / E3 07 22.7	13,803.00	
	IFO LG - EWEKORO, ITORI LG SEC	N6 49 57.9 / E3 11 36.1	13,483.00	
	EWEKORO, ITORI LG SEC - EWEKORO NORTH LCDA	N6 56 01.3 / E3 13 28.3	7,614.00	
	EWEKORO NORTH LCDA -ABEOKUTA S.E LCDA	N6 59 54.5 / E3 13 36.2	22,102.00	
MILESTONE 2	OFADA LCDA - IFO LG, OJODU ABIODUN	N6 49 12.2/ E3 26 33.2	24,231.00	**228,370.00**
	IFO LG, OJODU ABIODUN - AGADO OKE-ARO LCDA	N6 38 44.1 / E3 22 04.3	15,306.00	
	AGADO OKE-ARO LCDA - SANGO IJOKO LCDA	N6 40 58.3 / E3 17 58.0	13,693.00	
	SANGO IJOKO LCDA-ADO ODO, OTTA LG SEC	N6 43 55.1 / E3 15 24.2	5,400.00	
	ADO ODO, OTTA LG SEC - IFO LG	N6 41 25.3 / E3 14 13.4	18,455.00	
	IFO LG - COKER IBOGUN LCDA	N6 49 56.0 / E3 07 22.7	13,832.00	
	ADO ODO, OTTA LG SEC-IJU, ATAN, ILOGBO LCDA	N6 41 25.3 / E3 14 13.4	17,304.00	
	IJU, ATAN, ILOGBO LCDA - IFEKOWAJO LCDA	N6 39 51.7 / E3 05 40.6	24,105.00	
	IFEKOWAJO LCDA - IDIROKO LCDA	N6 41 59.0 / E2 53 39.0	12,640.00	
	IDIROKO LCDA - IKPOKIA LG SEC	N6 41 50.3 / E2 47 29.0	25,865.00	
	IKPOKIA LG SEC - IKPOKIA WEST LCDA	N6 32 11.0 / E2 50 08.2	12,519.00	
	IKPOKIA WEST LCDA	N6 31 01.7 / E2 44 43.2	-	

	IJU, ATAN, ILOGBO LCDA - AGBARA / IGBESA LCDA	N6 39 51.7 / E3 05 40.6	17,962.00	
	AGBARA / IGBESA LCDA - ADO ODO LCDA	N6 31 43.5 / E3 08 00.6	27,058.00	
MILESTONE 3	IKENNE LG - SAGAMU LG SEC	N6 52 07.9 / E3 41 29.4	8,477.00	**229,193.00**
	SAGAMU WEST LCDA - SAGAMU LG SEC	N6 50 57.9 / E3 37 50.6	5,145.00	
	SAGAMU SOUTH LCDA - SAGAMU LG SEC	N6 48 23.9 / E3 35 05.9	6,360.00	
	SAGAMU LG SEC - REMO CENTRAL LCDA	N6 50 06.2 / E3 39 37.1	10,231.00	
	REMO CENTRAL LCDA - REMO NORTH EAST LCDA	N6 54 38.7 / E3 40 38.8	9,523.00	
	REMO NORTH EAST LCDA - REMO NORTH LG	N6 57 29.1/ E3 41 29.7	7,333.00	
	REMO NORTH LG	N7 00 16.3/ E3 41 46.8	-	
	Ofada Lcda /Ibadan Exp - Sagamu W. Lcda / Benin Exp	N6 49 12.2/ E3 26 33.1	27,750.00	
	OBA EERIN LCDA - ABEOKUTA SOUTH LG ED.AUTH.	N7 02 21.5 / E3 21 29.8	29,850.00	
	ILUGUN LCDA - OPEJI LCDA	N7 22 59.1 / E3 40 39.9	41,058.00	
	OPEJI LCDA - ABEOKUTA NORTH WEST LCDA	N7 09 56.6 / E3 19 32.8	31,940.00	
	OFADA LCDA - OBAFEMI OWODE LCDA	N6 49 12.2/ E3 26 33.2	20,290.00	
	OBAFEMI OWODE LCDA - OBA EERIN LCDA	N6 57 11.5 / E3 30 15.8	31,236.00	
MILESTONE4	LEGURU LCDA - IJEBU ODE LG HQ	N6 44 56.4 /E3 52 36.7	9,538.00	**191,041.00**
	IFESOWAPO LCDA - IJEBU ODE LG HQ	N6 51 56.6 /E3 53 09.3	7,273.00	
	IJEBU ODE LG HQ - IJEBU ODE SOUTH LCDA	N6 49 06.8 /E3 54 58.9	2,475.00	
	IJEB ODE SOUTH LCDA - YEMOJI ILESE LCDA	N6 49 00.1 /E3 55 54.7	13,212.00	
	YEMOJI ILESE LCDA - IJEBU NORTH EAST LG	N6 49 52.3 /E3 59 07.0	10,461.00	
	IJEBU NORTH EAST LG - IJEBU NORTH LG	N6 53 48.2 /E4 00 31.1	9,542.00	
	IJEBU IGBO LCDA - IJEBU NORTH LG	N6 59 17.0 /E3 59 30.6	3,511.00	
	IJEBU NORTH LG - IJEBU NORTH CENTRAL LCDA	N6 57 44.2 / E3 59 25.7	6,170.00	
	IJEBU NORTH CENTRAL LCDA - AGO IWOYE LCDA	N6 57 17.2 / E3 56 26.3	10,504.00	
	AGO IWOYE LCDA	N6 56 53.6 / E3 54 36.3	-	
	Lagos-Benin Express/Ijebu Ode-Ogbere Junctions	N6 47 55.5 / E3 53 48.6	27,099.00	
	Lagos-Benin Express-IJEBU EAST LG HQ	N6 45 51.4 / E4 08 04.7	5,005.00	
	IJEBU EAST LG HQ	N6 44 19.7 / E4 09 57.2		
	Lagos-Benin Express Water Side Junction	N6 43 53.5 / E4 19 15.9	21,463.00	
	EXPRESS - OGUN WATER SIDE LG	N6 29 18.9 / E4 23 50.6	36,048.00	
	OGUN WATER SIDE LG-East Bolorunduro LCDA	N6 29 18.9 / E4 23 50.6	2,910.00	
	EAST LCDA BOLORUNDURO LCDA	N6 29 19.2 / E4 25 01.5	-	
	Lagos-Benin Express/Ijebu Ode-Odogbolu Junctions	N6 47 55.5 / E3 53 48.6	13,950.00	

	ODOGBOLU JUNCTION - ODOGBOLU LG	N6 51 12.9 / E3 47 14.3	2,423.00	
	ODOGBOLU LG - IKENNE LG	N6 50 49.8 / E3 46 01.7	9,457.00	
		Total Distance	**878,688.00**	**878,688.00**

	OYO STATE			
	OYO STATE BACKBONE DISTANCE BACKBONE DEPLOYMENT			
Milestones	**POA OF INTEREST**	**COORDINATES**	**DISTANCE(M)**	**Total Per Milestone**
Milestone 1	AKINYELE - IBADAN NORTH	N7 31 49.5/E3 54 37.3	16,662.00	126,686.00
	IBADAN NORTH - IBADAN SOUTH EAST	N7 23 46.1/E3 55 06.7	3,762.00	
	IBADAN SOUTH EAST - IBADAN SOUTH WEST	N7 22 32.6/E3 53 50.7	7,395.00	
	IBADAN SOUTH WEST - IBADAN NORTH WEST	N7 22 10.9/E3 51 34.3	4,080.00	
	ANA ARA - IBADAN SOUTH EAST	N7 16 14.5/E4 01 34.7	20,021.00	
	IBADAN NORTH EAST - IBADAN NORTH	N7 23 46.1 /E3 55 06.7	2,241.00	
	EGBEDA -IBADAN NORTH EAST	N7 22 44.8 /E4 02 45.0	14,283.00	
	LAGELU - IBADAN NORTH	N 29 57.5 / E4 04 53.4	21,743.00	
	OLUYOLE - IBADAN SOUTH WEST	N7 13 53.2 /E3 51 29.8	17,962.00	
	OLUYOLE - IBADAN SOUTH EAST	N7 13 53.2 /E3 51 29.8	18,537.00	
Milestone 2	SURULERE-OGBOMOSHO NORTH	N8 05 05.1/E4 23 01.1	20,464.00	123,667.00
	OGBOMOSHO SOUTH - OGO OLUWA	N8 06 51.4/E4 14 09.5	27,508.00	
	OGO OLUWA – ATIBA	N7 55 42.1/E4 08 02.3	28,934.00	
	ATIBA - OYO EAST	N7 50 16.9/E3 56 26.1	3,026.00	
	OYO EAST - OYO WEST	N7 50 59.0/E3 54 35.9	4,827.00	
	OYO WEST –AFIGIO	N7 45 38.9/E3 55 07.6	11,707.00	
	AFIGIO-AKINYELE	N7 31 49.5/E3 54 37.2	27,201.00	
Milestone 3	ITESIWAJU – ATISBO	N8 12 37.3 /E3 24 35.7	39,616.00	290,711.00
	ATISBO - SAKI WEST	N8 32 40.0 /E3 26 29.3	23,686.00	
	SAKI WEST - SAKI EAST	N8 40 05.5 /E3 23 50.1	29,601.00	
	SAKI EAST – OREROPE	N8 37 56.4/E3 36 42.9	30,983.00	
	OREROPE –IREPO	N8 49 32.1 /E3 45 21.4	30,124.00	
	IREPO – OLORUNSOGO	N8 43 34.7 /E4 09 38.3	55,642.00	
	OLORUNSOGO - ORI ILE	N8 43 34.7 /E4 09 38.3	64,278.00	

	ORI ILE-OGBOMOSHO NORTH	N8 09 28.0 /E4 15 27.8	16,781.00	
Milestone 4	IBADAN SOUTH WEST – IDO	N7 22 10.9 /E3 51 34.3	23,872.00	273,724.00
	IDO - IBARAPA EAST	N7 28 23.8 /E3 45 48.7	45,982.00	
	IBARAPA EAST -IBARAPA CENTRAL	N7 31 54.9 /E3 25 35.3	24,163.00	
	IBARAPA CENTRAL - IBARAPA NORTH	N7 26 56.0 /E3 16 31.1	1,304.00	
	IBARAPA NORTH – IWAJOWA	N7 32 08.1 /E3 13 08.2	68,577.00	
	IWAJOWA – KAJOLA	N7 59 57.0 /E3 06 22.2	46,780.00	
	KAJOLA – ISEYIN	N8 02 48.6 /E3 22 37.5	25,567.00	
	ISEYIN – ITESIWAJU	N7 58 40.2 /E3 35 13.3	37,479.00	
	TOTAL		**814,788.00**	**814,788.00**

OSUN STATE				
	SCHEDULE OF DISTANCES			
	POA OF INNTEREST	**COORDINATES**	**NNED DISTANC**	**one Distance DeployE**
MILESTONE 1	OROLU – IREPODUN	N7 52 31.0/E4 28 04.2	4566	**145317**
	IREPODUN – OSHOGBO	N7 50 23.9/E4 28 44.9	17316	
	OSHOGBO – OBOKUN	N7 46 04.6/E4 34 26.8	17073	
	OBOKUN – BORIPE	N7 47 06.7/E4 42 50.3	18767	
	BORIPE – IFELODUN	N7 54 44.3/E4 41 33.8	6528	
	IFELODUN ODO OTIN	N7 54 34.8/E4 39 15.2	14317	
	ODO OTIN – ILA	N8 01 34.7/E4 40 40.8	30690	
	ILA – IFEDAYO	N8 00 39.8/E4 54 48.9	20606	
	ILA – BOLUWADURO	N8 00 39.8/E4 54 48.10	15454	
MILESTONE 2	BOLUWADURO – OBOKUN	N7 56 52.6/E4 48 27.5	33711	**151120**
	OBOKUN - ILESHA WEST	N7 47 06.7/E4 42 50.3	19799	

	ILESHA WEST – ORIADE	N7 39 24.0/E4 43 29.2	13059	
	ILESHA WEST - ATAKUNMOSA EAST	N7 39 24.0/E4 43 29.3	32269	
	ATAKUNMOSA EAST -ATAKUNMOSA WEST	N7 30 11.9/E4 49 44.7	32079	
	ATAKUNMOSA WEST- IFE CENTRAL	N7 35 10.2/E4 37 39.7	20203	
	IFE CENTRAL - IFE EAST	N7 29 46.2/E4 30 58.8	8776	
	IFE CENTRAL - IFE SOUTH	N7 29 46.2/E4 30 58.9	43714	**104147**
	IFE CENTRAL – MODAKEKE	N7 29 46.2/E4 30 58.9	6137	
	IFE CENTRAL - IFE NORTH	N7 29 46.2/E4 30 58.9	9909	
	IFE NORTH – AYEDAADE	N7 30 22.4/E4 26 38.8	14436	
	AYEDAADE – IREWOLE	N7 28 03.3/E4 19 42.8	21175	
	ISOKAN –IREWOLE	N20 20.2 /E4 11 59.7	6967	
	IREWOLE – IWO	N7 22 29.1 /E4 10 30.9	33082	**135892**
	IWO – AYEDIRE	N7 38 47.6 /E4 11 14.6	8667	
	AYEDIRE - EDE NORTH	N7 37 53.6 /E4 14 38.4	31618	
	EDE NORTH - EDE SOUTH	N7 42 21.4/E4 26 55.9	4046	
	EDE NORTH – EGBEDORE	N7 44 14.2/E4 26 04.2	6667	
	EGBEDORE – EJIGBO	N7 46 03.9/E4 23 55.3	20500	
	EJIGBO – OROLU	N7 54 50.6/E4 18 56.9	24345	
	TOTAL		536476	**536476**

	Ekiti State		
	SCHEDULE OF DISTANCES		

	BACK BONE	DISTANCE	Milestone Distance
MILESTONE 1	IKERE EKITI - ADO EKITI	18,600.00	62,953.00
	ADO EKITI – GBOYIN	44,353.00	
MILESTONE 2	ILEJEMEJI – OYE	25,134.00	105,174.00
	OYE – IREPODUN	20,215.00	
	GBOYIN - ISE EKITI	47,511.00	
	ISE EKITI – EMURE	8,573.00	
	EMURE - IKERE EKITI	3,741.00	
MILESTONE 3	IREPODUN - EKITI SOUTH WEST	13,306.00	61,613.00
	IREPODUN - EKITI WEST	14,951.00	
	EKITI WEST – EFON	33,356.00	
MILESTONE 4	EKITI EAST - IKOLE EKITI	29,482.00	134,994.00
	IKOLE EKITI – OYE	21,479.00	
	OYE - IDO/OSI	24,064.00	
	IDO/OSI – IJERO	14,292.00	
	IJERO – MOBA	27,486.00	
	MOBA – ILEJEMEJI	18,191.00	
	TOTAL	364,734.00	

	ONDO STATE			
	SCHEDULE OF DISTANCES			
	POA OF INTEREST	**COORDINATES**	**DISTANCE**	**MILESTONE DISTANCE**
MILESOTNE 1	ONDO WEST - ILE OLUJI	N7 06 48.2 / E4 48 23.2	20,082	**120,975**
	ILE OLUJI - ONDO EAST	N7 13 31.7 / E4 51 59.0	26,076	
	ONDO EAST – IDANRE	N7 09 38.1 / E4 57 49.1	4,266	
	IDANRE - AKURE SOUTH	N7 11 25.8 / E5 01 40.8	25,484	
	AKURE SOUTH - IFEDORE	N7 16 50.1 / E5 09 48.7	18,946	
	AKURE SOUTH - AKURE NORTH	N7 16 50.1 /E 5 09 48.7	26,121	
MILESTONE 2	LAGOS/BENIN EXPRESS/ORE-OKITIPUPA	N6 45 41.7/E4 52 34.4	40,099	**207,304**
	OKITIPUPA – ILAJE	N6 30 00.2 / E4 46 19.4	24,161	
	OKITIPUPA-IRELE	N6 30 00.2 / E4 46 19.4	19,159	
	IRELE -ESE ODO	N6 28 54.4 / E4 52 02.7	22,432	
	ESE ODO -LAGOS/BENIN EXPRESS	N6 27 30.5 /E 4 51 52.7	57,476	
	LAGOS/BENIN EXPRESS - ODIGBO	N6 45 41.7/E4 52 34.4	2,265	
	ODIGBO - ONDO WEST	N6 46 53.0 /E4 52 23.7	41,712	
MILESTONE 3	AKURE NORTH – OWO	N7 22 31.3 / E5 15 06.9	57,719	**195,762**

	OWO - OSE	N7 13 26.4 / E 5 36 27.0	40,418	
	OWO - AKOKO SOUTH WEST	N7 13 26.4 / E 5 36 27.0	41,642	
	AKOKO SOUTH WEST - AKOKO SOUTH EAST	N7 27 27.5 / E5 47 36.0	15,610	
	AKOKO SOUTH EAST - AKOKO NORTH EAST	N7 26 53.1 /E5 54 24.6	25,606	
	AKOKO NORTH EAST - AKOKO NORTH WEST	N7 31 32.7 / E 5 46 09.7	14,767	
		TOTAL	**524,041**	**524,041**

LAGOS STATE			
	SCHEDULE OF DISTANCES		
	BACK BONE	**DISTANCE**	**Milestone Distance**
MILESTONE 2	IBEJU LEKKI - LAGOS ISLAND	26,000.00	
	LAGOS ISLAND - KOSOFE	23,000.00	
	KOSOFE - BADAGRY	73,000.00	
	TOTAL	122,000.00	122,000.00

KWARA STATE			
	SCHEDULE OF DISTANCES		
	BACK BONE	**DISTANCE**	**Milestone Distance**
MILESTONE 2	ILORIN SOUTH - ILORIN WEST	30,500.00	
	OFFA - MORO	87,600.00	
	MORO - ILORIN WEST	43,300.00	
	ILORIN WEST - IREPODUN	66,900.00	
	TOTAL	228,300.00	228,300.00

KOGI STATE			
	SCHEDULE OF DISTANCES		
	BACK BONE	**DISTANCE**	**Milestone Distance**
MILESTONE 2	KABBA - OKENE	38,300.00	
	OKENE - ADAVI	27,200.00	
	ADAVI - IDAH	47,600.00	
	TOTAL	113,100.00	113,100.00

3.4 Project Description

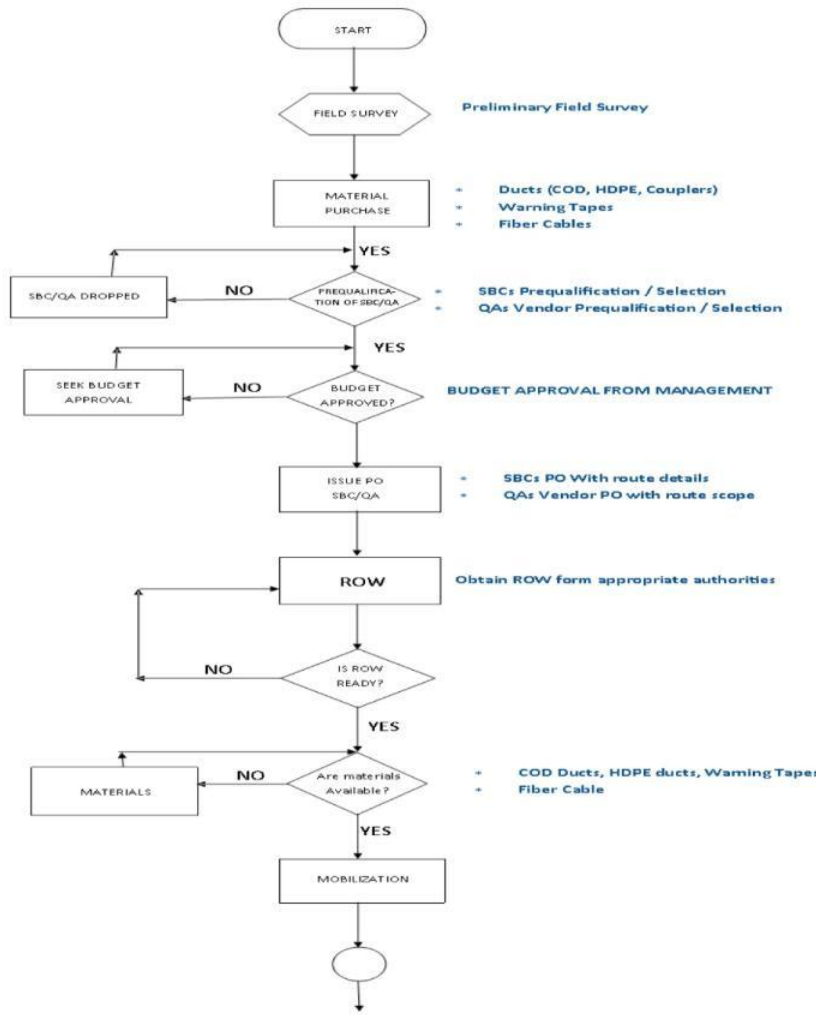
3.4.1 The Project Activities

The project activities will broadly cover the following areas:

- **Pre-construction activities include**
  - Acquiring of Right of Way (Row)
  - Site Preparation (Vegetation and Land Clearing)
  - Mobilisation (Transport) to the Site (Equipment, Personnel and Construction Modules)
  - (Provision of Energy for Construction)
- **Construction activities include**
  - Trenching of Fibre Optic route
  - Laying of Fibre cables
  - installation of various equipment, power generation equipment, etc.
  - Civil works
  - Activities relating to the construction of Data centres (electrical/ mechanical)
  - Backfilling
  - Manhole construction
  - Commissioning of Optic Fibre
  - Demobilization
- **Operational activities include**
  - Operation of the Open Access Metropolitan Fibre Network
  - Maintenance or inspection of fibre cable along the RoW
  - Maintenance of data center and Metro access system locations
- **The decommissioning activities include**
  - Removal of Open Access Metropolitan Fibre Network for relocation or sale

Workflow Processes

FIBER DEPLOYMENT WORK FLOW CHART



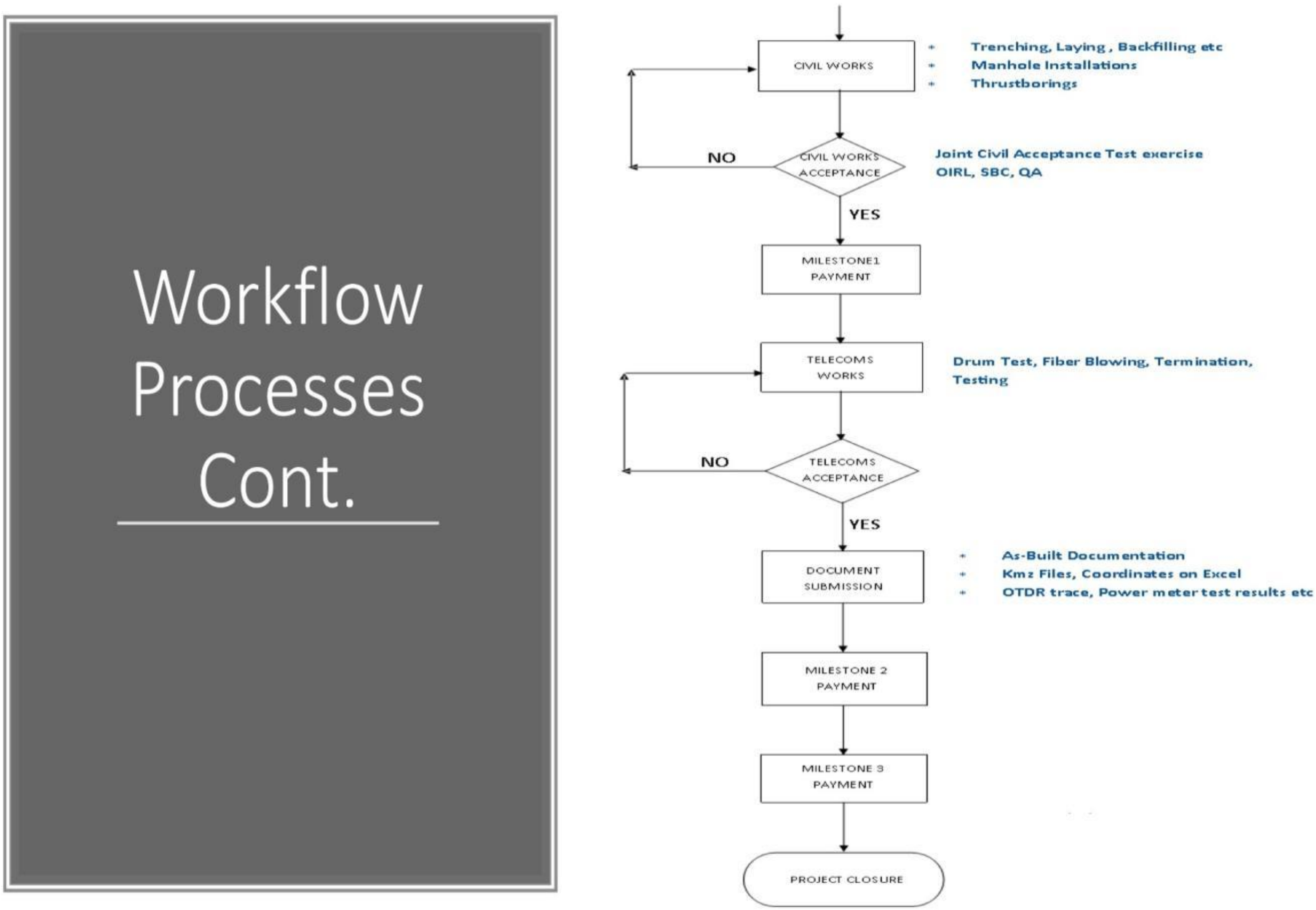


Figure 3.3: Fibre Deployment work flow chart

3.5 Project Description

The optical fiber is made up of two concentric cylindrical strands of silica surrounded by a plastic coating. The center most silica strand is the cone of the fiber with a refractive index1 of approximately 1.48. The core of the fiber physically transports most of the optical power. The core is surrounded by another strand of silica called the cladding. The cladding has a slightly lower refractive index, 1.46 and provides the interface that confines the optical signal to the core. The outermost layer of the optical fiber is the buffer coating. This thin plastic covering protects the glass from mechanical and environmental damage. A pictorial representation of the components that makeup an optical fiber is shown in figure 3.4

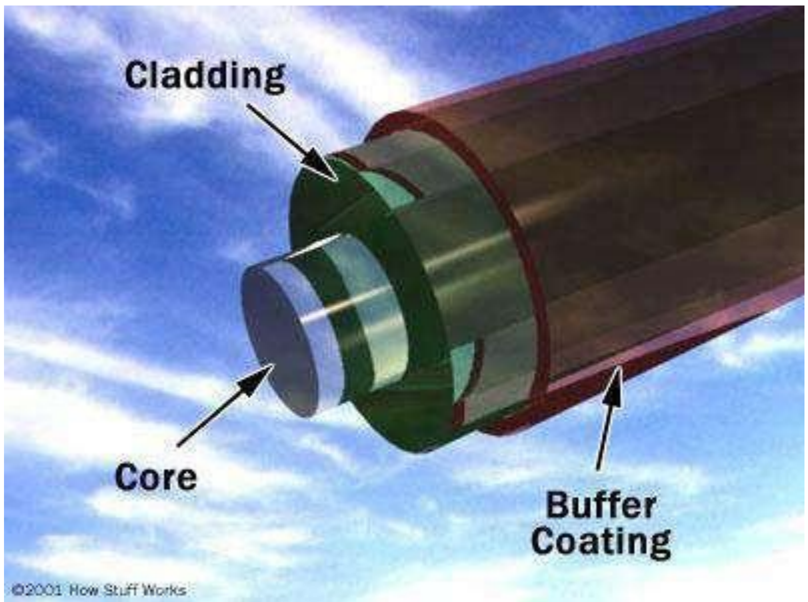


Figure 3.4: Components that makeup an optical fiber

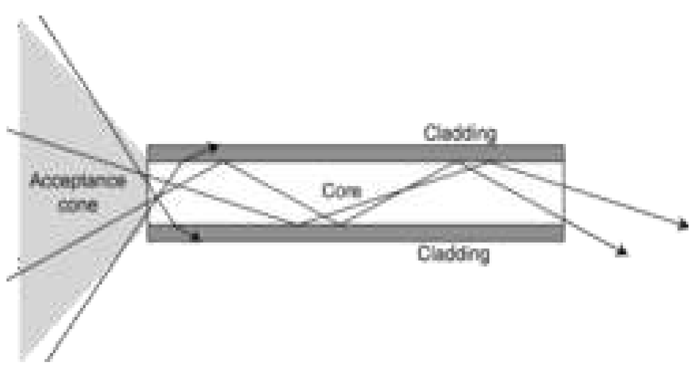


Figure 3.5a A diagram which illustrates the propagation of light through a multi- mode optical fiber.

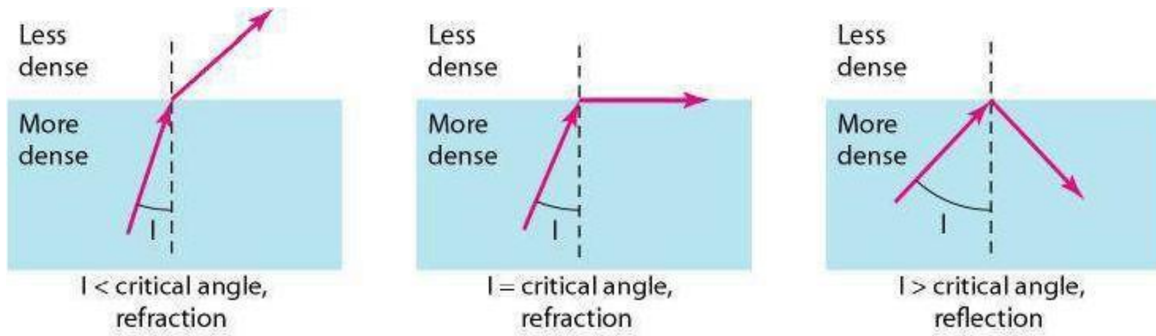


Figure 3.5b A diagram which illustrates the propagation of light through a multi- mode optical fiber.

Fiber with large (greater than 10 μm) core diameter may be analyzed by geometric optics. Such fiber is called *multi-mode fiber*, from the electromagnetic analysis. In a step-index fiber, rays of light are guided along the fiber core by total internal reflection. Rays that meet the core-cladding boundary at a high angle (measured relative to a line normal to the boundary) are completely reflected. The minimum angle for total internal reflection is determined by the difference in index of refraction between the core and cladding materials. Rays that meet the boundary at a low angle are refracted from the core into the cladding, where they are not useful for conveying light along the fiber. In this way, the minimum angle for total internal reflection determines the *acceptance angle* of the fiber, often reported as a numerical aperture. A high numerical aperture makes it easier to efficiently couple a transmitter or receiver to the fiber.

However, by allowing light to propagate down the fiber in rays both close to the axis and at various angles, a high numerical aperture also increases the amount of multi-path spreading, or *dispersion*, that affects light pulses in the fiber. In graded-index fiber, the index of refraction in the core decreases continuously between the axis and the cladding. This causes light rays to bend smoothly as they approach the cladding, rather than reflect abruptly from the core-cladding boundary. The resulting curved paths reduce multi- path dispersion because high angle rays pass more through the lower-index periphery of the core, rather than the high- index center. The index profile is chosen to minimize the difference in axial propagation speeds of the various rays in the fiber. This ideal index profile is very close to a parabolic relationship between the index and the distance from the axis.

Fiber with a core diameter narrower than a few wavelengths of the light carried, is analyzed as an electromagnetic structure, by solution of Maxwell's equations, as reduced to the electromagnetic wave equation. The electromagnetic analysis may also be required to understand behaviors such as speckle that occur when coherent light propagates in multi-mode fiber. As an optical waveguide, the fiber supports one or more confined transverse modes by which light can propagate along its axis. Fiber supporting only one mode is called single- mode or *mono-mode* fiber, while fiber that supports more than one mode is called multi- mode fiber. By the waveguide analysis, it is seen that the light energy in the fiber is not completely confined in the core, but especially in single-mode fibers, a significant fraction of the energy in the bound mode travels in the cladding as an evanescent wave.

3.5.1 Types of Fiber Optics

Understanding the characteristics of different fiber types helps to understand the applications for which they are used. Operating a fiber optic system properly relies on knowing what type of fiber is being used and why. There are two basic types of fiber: multimode fiber and single- mode fiber.

Multi-Mode Fiber (MMF)

Multimode fiber, the first to be manufactured and commercialized, simply refers to the fact that numerous modes or light rays are carried simultaneously through the waveguide. Modes result from the fact that light will only propagate in the fiber core at discrete angles within the cone of acceptance. This fiber type has a much larger core diameter, compared to single- mode fiber, allowing for the larger number of modes. Multimode fiber is easier to couple than single- mode optical fiber and may be categorized as step-index or graded-index fiber. However, Multimode fiber is best designed for short transmission distances.

Single-Mode Fiber (SMF)

Single- mode fiber allows for a higher capacity to transmit information because it can retain the fidelity of each light pulse over longer distances. It exhibits no dispersion caused by multiple modes. Single-mode fiber also enjoys lower fiber attenuation than multimode fiber. Thus, more information can be transmitted per unit of time. Like multimode fiber, early single-mode fiber was generally characterized as step-index fiber meaning the refractive index of the fiber core is a step above that of the cladding rather than graduated as it is in graded-index fiber. Modern single- mode fibers have evolved into more complex designs such as matched clad, depressed clad and other exotic structures. Single- mode fiber is best designed for longer transmission distances, making it suitable for long-distance telephony and multi-channel television broadcast systems. For this this proposed project, *Single-Mode Fiber (SMF)* shall be adopted.

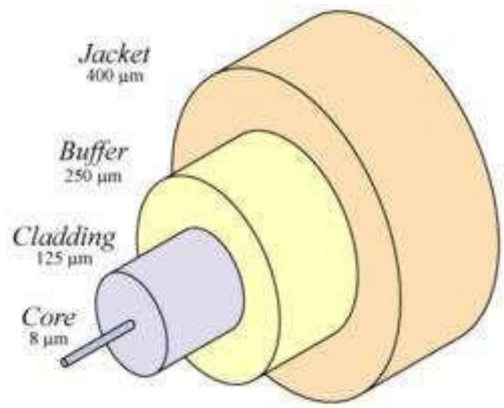


Figure 3.6: A typical single- mode optical fiber, showing diameters of the component layers.

The common type of single- mode fiber has a core diameter of 8 to 10 µm. It is notable that the mode structure depends on the wavelength of the light used, so that this fiber actually supports a small number of additional modes at visible wavelengths. Multi-mode fiber, by comparison, is manufactured with a core diameter of 50 µm, 62.5 µm, or larger.

Some special-purpose optical fiber is constructed with a non-cylindrical core and/or cladding layer, usually with an elliptical or rectangular cross-section. These include polarization- maintaining fiber and fiber designed to suppress whispering gallery mode propagation. At high optical powers, above one watt, when a fiber is subjected to a shock or is otherwise suddenly damaged, a *fiber fuse* can occur. The reflection from the damage vaporizes the fiber immediately before the break, and this new defect remains reflective so that the damage propagates back toward the transmitter at 1–3 meters per second. The open fiber control system, which ensures laser eye safety in the event of a broken fiber, can also effectively halt propagation of the fiber fuse. In situations, such as undersea cables, where high power levels might be used without the need for open fiber control, a "fiber fuse" protection device at the transmitter can break the circuit to prevent damage.

Cable Manufacturer Name – Iteco

Specification

Attenuation coefficient in dB/km	-	0.22 - 0.25 dB/km
L Length of section to be measured in	-	km Length
Oe Maximum splice loss	-	0.10 dB
Ne Total number of splices in the section	-	Number
Oc Maximum loss of a connector + a splice	-	0.50 dB
Average attenuation coefficient between two splices	-	0.22 dB/km
Average attenuation coefficient between two sites	-	0.25 dB/km
Life expectant of the Fiber	-	50 years

Date Manufactured - The fiber cable is manufactured in Batches, no specific date for manufacturing the whole fiber.

Cable handling: This shall be through cable blowing to reduce tension on the cable which increase the attenuation on the link. Bending loss shall be introduced in a fiber when there is a sharp bend in the optical cable. Bends introduce an interruption in the path of light causing some of the optical power to leak into the cladding where it is lost. There shall be a minimum-bending radius of 5cm on fiber pigtail. When bundling fibers together with tie wraps or twist ties, tying these fibers too tight shall be avoided so as not to introduce micro bending into the fiber because it can affect the fibre system. Cable shall be uncoiled in figure 8 to reduce bend radius of the Fiber cable.

Path of flow and Transmission

To send information over a fiber, bits of information are successively encoded and represented digitally by pulses of light. The more rapidly a laser pulses on and off the higher the bit rate and the closer encoded bits of information are spaced temporally. As these pulses of light propagate through a fiber, they tend to lose their shape and spread out eventually over lapping each other causing inter-symbol interference. The higher the data rate of the channel the more sensitive the overall system is to the effects of dispersion. Hence dispersion limits the information carrying capacity of a fiber.

Fiber Optic Datalink

Fiber optic transmission systems all use data links that work similar to the diagram shown below. Each fiber link consists of a transmitter on one end of a fiber and a receiver on the other end. Most systems operate by transmitting in one direction on one fiber and in the reverse direction on another fiber for full duplex operation. It's possible to transmit both directions on one fiber but it requires couplers to do so and fiber is less expensive than couplers. A FTTH passive optical network (PON) is one of the only systems using bidirectional transmission over a single fiber because its network architecture is based around couplers already.

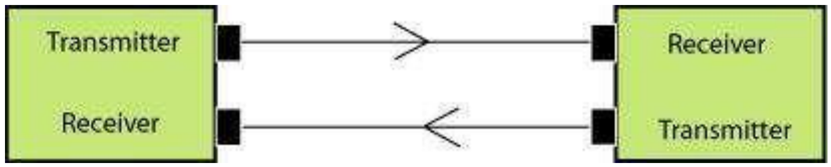


Figure 3.7: Fiber Optic Datalink process

Fiber Optic Transceiver

Most systems use a "transceiver" which includes both transmission and receiver in a single module. The transmitter takes an electrical input and converts it to an optical output from a laser diode or LED. The light from the transmitter is coupled into the fiber with a connector and is transmitted through the fiber optic cable plant. The light from the end of the fiber is coupled to a receiver where a detector converts the light into an electrical signal which is then conditioned properly for use by the receiving equipment.

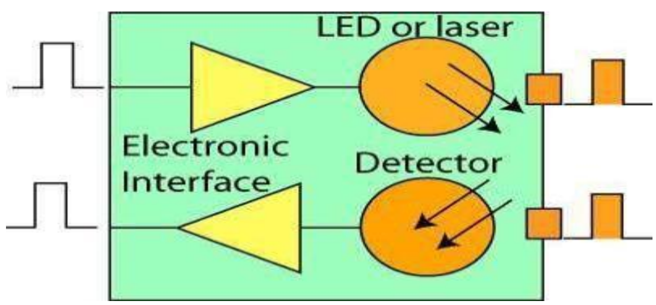


Figure 3.8: Fiber Optic Transceiver process

Analog or Digital

Analog signals are continuously variable signals where the information in the signal is contained in the amplitude of the signal over time. Digital signals are sampled at regular time intervals and the amplitude converted to digital bytes so the information is a digital number. Analog signals are the natural form of most data, but are subject to degradation by noise in the transmission system. As an analog signal is attenuated in a cable, the signal to noise ratio becomes worse so the quality of the signal degrades. Digital signals can be transmitted long distances without degradation as the signal is less sensitive to noise.

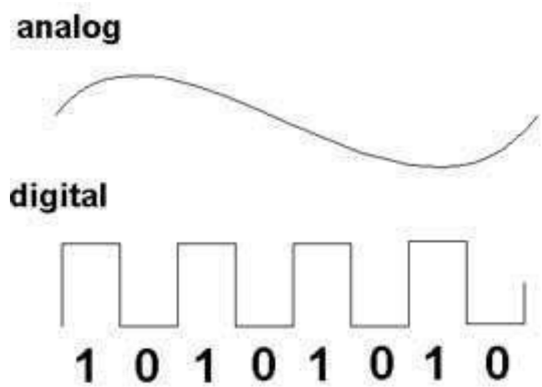


Figure 3.9: Analog or Digital Signals

Fiber optic datalinks can be either analog or digital in nature, although most are digital. Both have some common critical parameters and some major differences. For both, the optical loss margin or power budget is most important. This is determined by connecting the link up with an adjustable attenuator in the cable plant and varying the loss between transmitter and receiver until one can generate the curve shown above. Analog datalinks shall be tested for signal to noise ratio to determine link margin, while digital links use bit error rate as a measure of performance. Both links require testing over the full bandwidth specified for operation, but most data links are now specified for a specific network application, like AM CATV or RG color monitors for analog links and SONET, Ethernet or Fibre Channel for digital links.

3.5.2 New Generation Green Data center

Data Center is the heart of the platform. It shall be located at Lekki in Lagos State and will have a network equipment area to provide centralized maintenance for network equipment such as the service access switch, service convergence router, firewall, and egress router. It provides high-speed and convenient service for public. The land take of the data centre shall be 100meter square.

The Cloud Computing System includes following aspects:

1) Automated Operations Portal

- Cloud computing service application can be submitted to the system administrator in a variety of ways.
- The administrator of service application has the permissions to apply and redistribute resources, and other administrative permissions.

- End users can directly access Web-based interface, using the services provided by the cloud computing platform.
- A simple interface of resources application realizes the virtualization of IT resources, and rapid deployment.

2) Real-time Monitoring & System Self-healing

- Real-time monitoring: For all hardware devices, virtual resources running in real-time monitoring, while for business load to monitor and manage. When a fault occurs, operation and management platform can detect the fault timely.
- Fault isolation: The system restarts faulty equipment automatically. The faulty equipment will be isolated if it is still unable to recover.
- System self-healing: The system automatically assigns a new, alternative resource and loads the backup image to run.

3) Cloud storage

- Abundant storage business: Net disk, data sharing and synchronization, online storage, online backup, etc.
- High available: File sensitive optimization and multiple RAID technologies will improve performance and reliability.
- Easy management: Full open system, support of union management, and reduced maintenance costs.
- Scalability: Dynamic expansion of the storage server and storage space.
- Energy saving: Idle/standby technology will reduce storage unit power cost.

4) Service operation and manager system of New Generation Green Data center (NGDC)

Operations Management System consists of:

- Multi-dimensional monitoring system
- Safety management system
- Information security system
- 3 layers maintenance system
- Customer service system
- Failure process
- Configuration change management process
- Grade hardware and service level

5) Unattended network management

- An accurate picture of network topology
- Accurate early warning, targeting network equipment failure

- Real-time control network equipment/server-status
- Network/equipment/server traffic management
- DC hosting server and application management
- Provision of various reports of equipment/server/application
- Switches
- Routers
- Servers and racks

6) Visualization of business management

- To provide integrated management of customer data
- To provide flexible management of the prices of DC products and services
- To provide comprehensive unified resource management of DC
- To provide definable management of DC business process
- To provide standard management and interface support of DC accounting
- To provide DC analysis reports and decision support
- 7-Inch Full Touch screen
- Digital Cordless Phone
- 3-Megapixel HD Camera
- Abundant Interfaces： Dual Network Interfaces, Video Output Interface, Audio Output Interface, USB Ports and so on.

3.5.2.1 Document Security Exchange

The e-Document Exchange system is set up to replace the traditional manual transfer mode, implementing the digital and network orientation of such main office services as the confidential document, information, meeting and supervision and e-transmission of the document and information. This system is based on the WEB interface and cross platform. The standard confidential document template can be customized to provide the ID recognizing, compressing for transmission, decompressing for reception, management of received and sent documents and the urging for handling and replying functions. Each network access unit can set up an internal document operation and querying system according to its actual conditions.

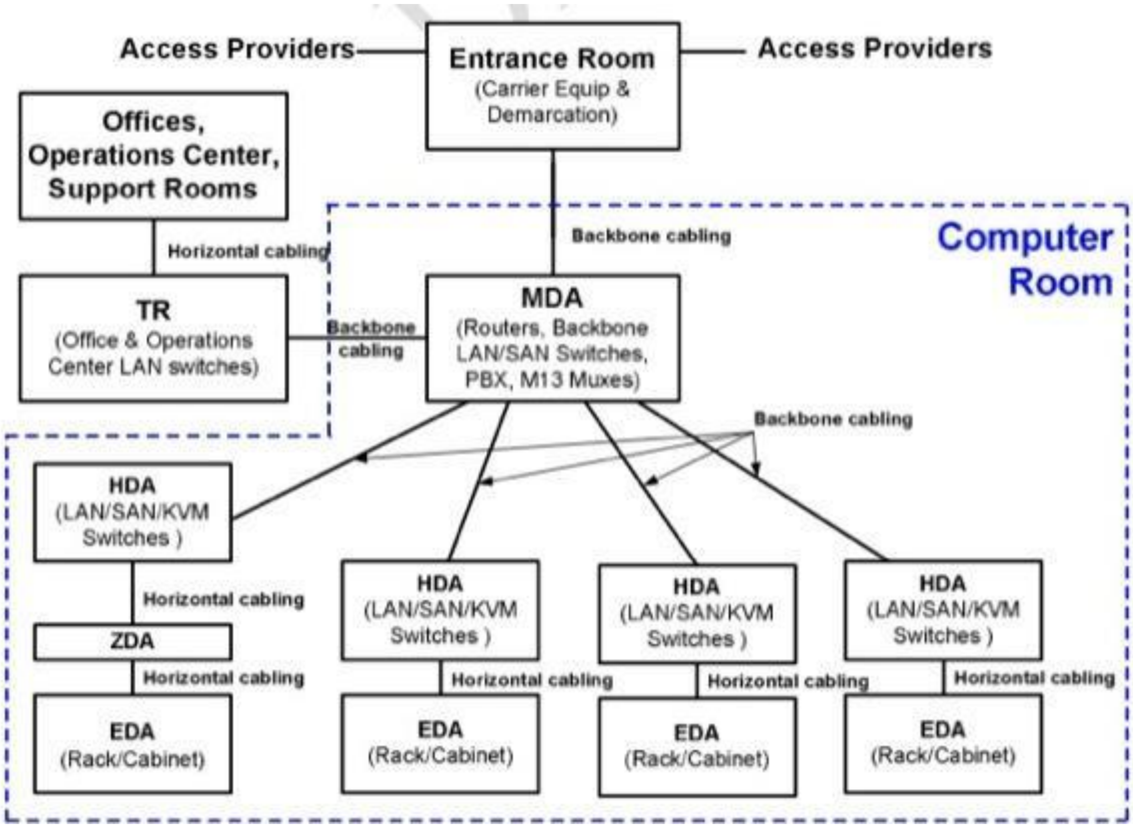


Figure 3.10: Typical basic Data Centre Topology

3.5.2.2 Security and Alarm Systems

The following sensors summarised below shall be installed.

Table 3.2: Security and Alarm Systems

Sensor Type	DESCRIPTION	OUTPUT	DF Position
Door Sensor	INTRUSION	N/O	1
Smoke Detector	SMOKE / FIRE	N/O	2
A/C System	A/C SYSTEMS FAULT	N/O	3
Temp Sensor	OVER TEMP	N/O	4
Gate Sensor	GATE CONTACT	N/O	5
Relay	ELECTRIC FENCE	N/O	6
Relay	RECTIFIER CRITICAL	N/O	7
Relay	RECTIFIER WARNING	N/O	8
Relay	MAINS FAILURE	N/O	9
Relay	GEN 1 FAILURE	N/O	10

Relay	GEN 2 FAILURE	N/O	11
Relay	LOW FUEL GENSET 1& 2	N/O	12
Relay	AVIATION LIGHT FAILURE	N/O	13
Relay	CONTROLLER FAILURE	N/O	14

The position and numbering will remain the same and be made on the Krone blocks inside the transmission cabinet.

3.5.2.3 Fire Extinguishers

1. Fire extinguishers will be provided at all Point of Access (POA) and Data Centre. Data Center and POA shall be supplied with a 4.5kg CO_2 fire extinguisher.
2. The fire extinguisher shall be mounted on the inside of the equipment room door.
3. The unit shall be installed so that it is supported by the mounting bracket, and not suspended from it.

3.5.2.4 Generator /Hybrid General Specifications

- All generators shall be housed in an outdoor steel canopy housing the generator, fuel tank, amf panel etc. or mounted on a slab at the discretion of the Country Build Team. No additional housing is required.
- All generators to be 3-phase as well as be able to work on single phase
- Euro Silent type – 70dba or below @ 7 meters.
- 2 Generators shall be installed at the data centre (500KVA each) and 20KVA at each POA
- Eye lift on top of the enclosure fixed to the skid.
- Fully weather proof sound attenuated enclosure. Sound foam acoustical sound treatment.
- High corrosion resistance. Electrozinc coated before painting with a polyester powder rust inhibiting coat.
- Stainless steel bolts and rivets, anodized aluminium alloy hinges.
- Flexible seals between body sections.
- Rectifier and back up batteries to be installed
- Battery strings in total using 12v blocks hawkers 6VE 155
- Inverter System
- The DC system enables the data centre to work on hybrid mode, hence generator run hour can be reduced to an average of 10-12hours a day.

- **Engine**

- Diesel Engine
- Rated RPM 1,500. With possibility to accelerate.
- Frequency regulated +/- 2.5%.
- Coolant system Water or Oil– tropicalised radiator with engine driven blower type fan and Coolant Pump. Require Low Water Level Captor.
- Lubrication - oil. Visual Oil Pressure Meter.
- Controlled Emissions.
- Manual start panel.
- Change over panel. Adjustable Delay Timer incorporated.
- Emergency stop button.
- Automatic emergency shutdown – low oil temperature, high water temperature, Under / Over speed.
- Water separator fuel filter.
- Anti-vibration mountings.
- The exhaust system of the generator must not be positioned so as to make any marks on the fence, containers or tower.
- All Generators need to be able to start automatically (Automatic Start)
- Gazole Circuit need to have : électrovanne d'arrêt moteur, d'un préfiltre avec décanteur. Visual Gazole Level.
- Air Filter Easily Accessible for Maintenance.

- **Alternator**
  - Compliance with NEMA MG21, UTE NFC51.111, VDE0530, BS4999, CSA Standards.
  - Tri Phases (220/380V) Sinusoidal, Frequency 50 HZ
  - Power factor – 0.8
  - Brushless type.
  - Single bearing IP 53.
  - Coupling – direct.
  - IP 21 drip proof.
  - Isolation Class H and Temperature Class F
  - Alternator need to have double tropicalisation

- **Command Board**
  - Phase Invertion Detection
  - AMF panel
  - 12V Relays

- Light Protection
- Battery Charger (To be confirmed)
- Voltmeter
- Amps Meter of Current on each Phase
- Emergency Stop Button
- Clock Programmer

Generators must be able to repatriate critical and non-critical alarms from the generator to the switch (MSC) for maintenance purposes. They should be as follows:

- **Alarms**
  - Low Fuel
  - Mains Failure
  - Charge alternator failure.
  - Low oil pressure.
  - High water temperature.
  - Low Water Level
  - Generator start failure
  - Emergency stop engaged.
  - High/Low Voltage
  - High/Low Frequency
  - Fail Start
  - (Those alarms that affect the normal working conditions of the generator)

- **Documentation**
  - One set of engine-e and alternator handbooks.
  - One panel – wiring diagram.
  - One factory test certificate.
  - All generators must have English as well as French documentation
  - Maintenance recommendations & procedures by Remote Monitoring:
  - Maintenance Intervals
  - Generator Running hours
  - (Those alarms that do not affect the normal working conditions of the generator)
    - ✓ Three-phase 400/230 V, +10%, -15%, 5-wire supply (3 Phases plus neutral plus earth).
    - ✓ Frequency protection @ 7%, 20 KVA.

- ✓ The generator and diesel tank must be free of oil and diesel leaks.
- ✓ Only qualified persons are to connect the generator cable to the DB.

3.5.3 Point of Access (POA): These are the locations where fibre active equipment shall be located. It shall be secured and have uninterrupted power supply to the equipment. Point of Access routes shall be either Metro (within the city) or backbone (through interstate)

3.5.4 Corrugate Optic Duct (COD)

C.O.D. stands for Corrugated Optic Duct, with built-in multiple cable ducts inside of outer duct as an integrated single body. COD has very distinctive differences from the conventional telecommunication PVC ducting System.

C.O.D. opens new era of telecommunication backbone with its built-in multiple inner ducts (3 to 5) inside of the outer duct by means of assembling cable ducts in the course of production. Both inner and outer ducts are made of HDPE (High Density Polyethylene) having high flexibility enabling rolled-on spool regardless of numbers of inner ducts built-in. COD is safe against Earthquakes and Land Subsidence due to its strong compressive load strength and its inherent flexibility. The readily built-in sub ducts perfectly eliminate any loose space inside of the spiral-corrugated duct, allowing COD to offer considerable advantage in terms of compressive load.

Coiling Length of C.O.D. is unlimited, however depending on the numbers of inner ducts and diameters thereof; each reel may practically coiled up to 500 meters, however, coiling even 1,000 meters of small dimension model is also available. Owing to such a flexible and lengthy product of COD, it enables quick installation reducing considerable consecutive work quantities such as trench excavation, inner duct insertion (no need as it is readily built-in), inner duct related works (such as cleaning of duct line upon completion of outer duct connection and inspection thereof) and installation time. Owing to such benefits, great savings of project cost as well as traffic trouble are anticipated contributing to the construction of telecommunication infrastructure.

Table 3.3: Corrugate Optic Duct Specification

Name of model		Duct	Sub duct			
Standard	Code No.	O.D (mm)	O.D (mm)	THK (mm)	I.D (mm)	No. Sub
28mm × 3 lines	283000	90.0	33.0	2.5	28.0	3
28mm × 4 lines	284000	100.0	33.0	2.5	28.0	4
32mm × 3 lines	323000		38.0	3.0	32.0	3
25mm × 7 lines	257000	110.0	29.0	2.0	25.0	7
36mm × 3 lines	363000		42.0	3.0	36.0	3
32mm × 4 lines	324000		38.0	3.0	32.0	4
28mm × 5 lines	285000		33.0	2.5	28.0	5
28mm × 6 lines	286000	120.0	33.0	2.5	28.0	6
36mm × 4 lines	364000		42.0	3.0	36.0	4
34mm × 7 lines	347000	160.0	40.0	3.0	34.0	7
50mm × 3 lines	503000		59.0	4.0	50.0	3

Source: OIRL

Plate 3.1Pictures of Corrugate Optic Duct (COD) in different forms

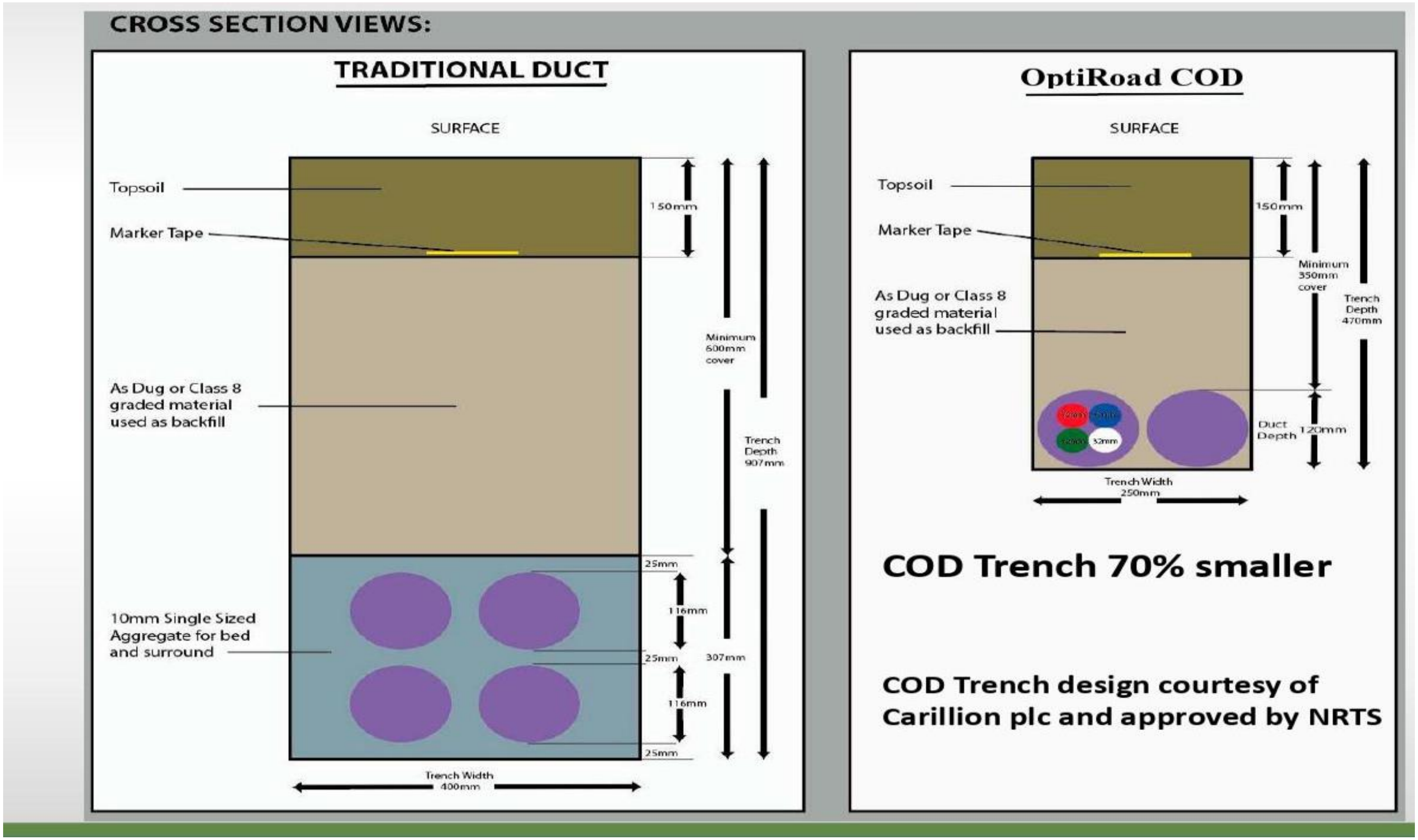


Figure 3.11 Installation Comparison of COD with Traditional Duct

3.5.5 Fiber Laying Techniques

Fibers are not only extremely brittle, but also elastic to an extent. Fibers must be protected from tensile forces (axial), compressive forces and **bending**. The long-term transmission characteristics of optical fiber depends on the installation procedures used. Fiber laying is a specialized discipline that has to be performed by trained and experience personnel.

Ducting & Trenching

The traditional method of laying optical fibers still used in most developing countries is Ducting and Trenching. This involves creating a trench through manual or mechanized soil excavation. The trenching process shall be carried out with needed careful control to make sure the trench floor does not have any kinks and is uniform, and trenches do not have major bends. This shall be done at about 10m after drainages or power poles with a dept of 120cm.

Ducts shall be placed in the trenches and fiber is then blown through the ducts with specialized fiber blowers, using water or air. In Air Assisted Fiber Blowing, the blowers shall use compressed air to push fiber through ducts. The fiber cables shall never use more than 70% of the available duct space. When 1-inch fiber cables are used, they occupy 64% of a 1.25-inch duct. Ducts are manufactured from High Density Polyethylene (HDPE). HDPE is hard, can withstand temperatures up to 120°C and have excellent resistance to alcohols, concentrated acids and bases.

If there are functional existing ducting infrastructure, we shall go through it otherwise liaise with relevant authorities on how to construct a ducting channel before passage. Also, there are possibilities that some routes have existing fiber routes, before proposed project implementation, all maintenance teams shall be duly informed through the coordination of the ministry of works before project execution.

Plate 3.2: Typical Cable ducts in open trench

Horizontal Directional Drilling

Horizontal Directional Drilling (HDD) is also referred to as Directional boring, and is a trenchless technique used for installing conduits, underground pipes and cables. This shall be used in the case of road crossing without causing much damage to existing roads.

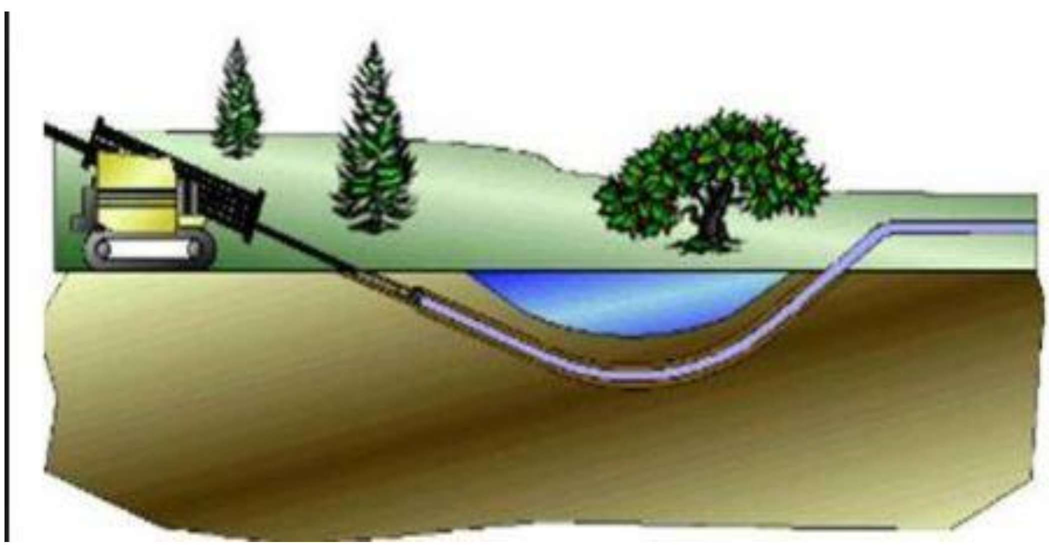


Figure 3.12: Principle of Horizontal Directional Drilling (HDD)

For this type of installation, a drilling rig that is launched from the surface shall be used to create a shallow arc along a predefined path. The impact on surrounding areas using this method is minimal and it is therefore preferred. It can be used for numerous soil conditions and jobs including landscape, road and river crossings. Right-of-Way (ROW) permissions for HDD based cable laying has been obtained from the authority.

The process is multi staged and the first step involves creating an entrance pit with a receiving hole. A pilot hole is then drilled through the designed path, after which the hole is enlarged (reamed) with a larger cutting tool known as the back reamer. The diameter of the reamer is determined by the size of the pipe to be pulled back through the hole. In the next stage, a casing pipe is placed in the enlarged hole by using the drill stem. A fully automatic gyro-based drilling mechanism is used by advanced HDD machines.

Crossings: ROW permission has been obtained from the appropriate quarters before crossing Road, Railway and River Bridge. This shall be done through the use of a specialized machine called Horizontal Directional Drilling machines (HDD). With this technology, ducts are laid without affecting the original composition of the soil.

Road Crossing – This shall be through trust boring after ROW is obtained.

Railway Crossing - This shall be through trust boring after ROW is obtained.

River Bridge Crossing – This shall be through bridge attachment after ROW is obtained

Swamps and Critical Ecosystems Crossing - In swamp areas adequate protection shall be provided to the ducting infrastructure to prevent exposure.

Splicing

The splicing is done using Enclosure with airtight and use silica gel to seal it from blocking water entering the enclosure. The cable comes in 6km drum, no splicing is done within this 6km, splicing is done at every 6km. Splicing shall be done so as to have continuity on the cable, it is necessary because the cable comes in 6km drum. For this proposed project, Fusion splicing shall be adopted. Fusion slicing is more expensive but has a longer life than mechanical splicing. Fusion method fuses the fibre cores together with less attenuation. In the fusion splicing process a specialized fusion splicer machine shall be used to precisely align the two fibre ends then the glass ends are “fused” or “welded” together using electric arc or some type of heat. This produces a transparent, non-reflective and continuous connection between the fibres enabling very low loss light transmission.

The fusion splicer performs optical fibre fusion splicing in two steps.

1. Precisely align the two fibres
2. Generate a small electric arc to melt the fibres and weld them together

With proper training, a fibre splicing technician can routinely achieve less than 0.1dB insertion loss splicing for both single mode and multimode fibre cables. In addition to lower splicing loss at 0.1dB typical, advantages of fusion splicing include less back reflection. The common application for splicing is jointing cables in long outside plant cable runs. This is where a length of a run requires more than one cable. Splicing is generally used to terminate single mode fibres (by splicing pre-terminated pigtails onto each fibre) but there are other uses. It is important to note that slicing can be used to mix different types of fibre cables like connecting 48 fibre cables to six 8 fibre cables going to different places.

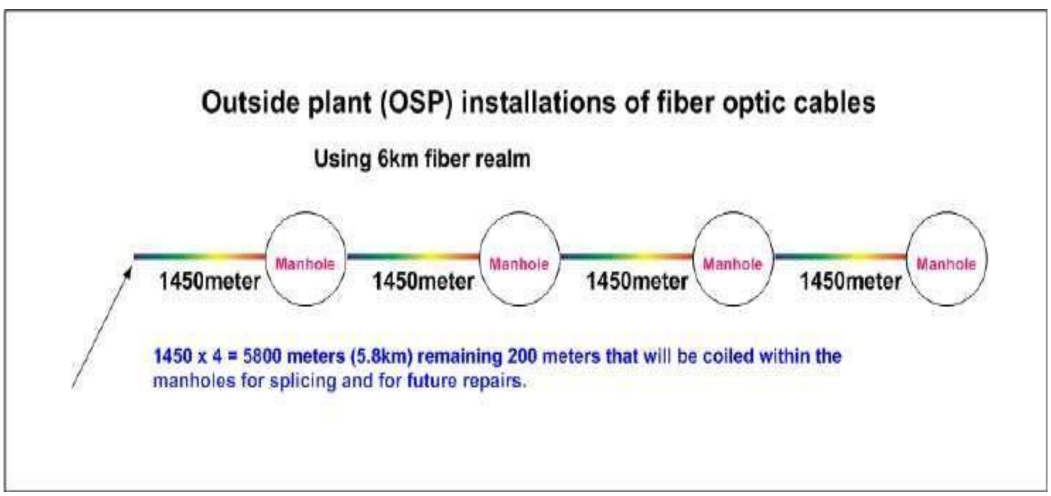


Fig. 3.13 Splicing is done using Fusion splicing Machine due to low attenuation

The following pictures show optic fibre laying at different locations

Plate 3.3: Laying of Optic Fibre along highway

Plate 3.4: Laying of Optic Fibre across the bridge

Plate 3.5: Laying of Optic Fibre along Mountain area

Manholes

Manholes shall be constructed of polymer concrete or similar material with cast iron frame and covers. Structure shall be rated for continuous highway truck loading. Minimum inside dimensions shall be 36 inches by 60 inches and 36 inches deep. Manhole access shall have a minimum opening of 30 inches.

Manholes shall be constructed at a depth so that the top of the manhole cover without grade rings is at no higher an elevation than twelve (12) inches below the nearest lip of gutter. Appropriate grade rings shall be used to raise the manhole frame and cover to the appropriate pavement elevation.

Plate 3.6: Installation of Optic Fibre Manhole

Plate 3.7: Installation of Curved Manhole for Optic Fibre

Optical Connector Structure

Fiber optic connectors have traditionally been the biggest concern in using fiber optic systems. While connectors were once unwieldy and difficult to use, connector manufacturers have standardized and simplified connectors greatly. This increasing user-friendliness has contributed to the increase in the use of fiber optic systems. It has also taken the emphasis of the proper care and handling of optical connectors.

Fiber-to-fiber interconnection can consist of a splice, a permanent connection, or a connector, which differs from the splice in its ability to be disconnected and reconnected. Fiber optic connector types are as various as the applications for which they were developed. All connectors have the following four basic components:

The Ferrule: The fiber is mounted in a long, thin cylinder, the ferrule, which acts as a fiber alignment mechanism. The ferrule is bored through the center at a diameter that is slightly larger than the diameter of the fiber cladding. Th end of the fiber is located at the end of the ferrule. Ferrules are typically made of metal or ceramic, but they may also be constructed of plastic.

The Connector Body: Also called the connector housing, the connector body holds the ferrule. It is usually constructed of metal or plastic and includes one or more assembled pieces which hold the fiber in place. The details of these connector body assemblies vary among connectors, but bonding and/or crimping is commonly used to attach strength members and cable jackets to the connector body. The ferrule extends past the connector body to slip into the coupling device.

The Cable: The cable is attached to the connector body. It acts as the point of entry for the fiber. Typically, a strain-relief boot is added over the junction between the cable and the connector body, providing extra strength to the junction.

The Coupling Device: Most fiber optic connectors do not use the male-female configuration common to electronic connectors. Instead, a coupling device such as an alignment sleeve is used to mate the connectors. Similar devices may be installed in fiber optic transmitters and receivers to allow these devices to be mated via a connector. These devices are also known as feed-through bulkhead adapters.

The following figures show different optical connectors for the proposed project.

1. Line Connector

For the Air Blowing Installation

Raw Materials

- Inner duct socket : PC or HDPE
- Outer duct fixing cover : EPDM or PC
- Bolt/nut/washer : Cast iron or SUS

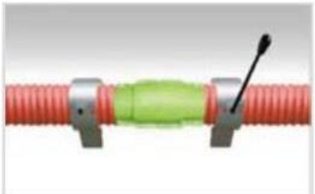
1. Peel off COD outer cover about pitches and arrange on the connecting jig

2. Fitting the inner duct socket one side each inner duct

3. Using connecting jig insert the socket in the both side inner duct

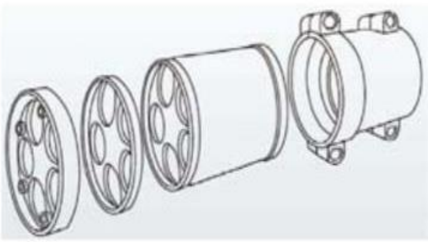
4. After finishing the socket coupling, cover the outer fixing cover

5. Tighten the bolt & nut



6. Complete

2. Various Manhole Connector



Material of COD Manhole Connector

- Body of Manhole connector : EPDM or PE
- Cap : PP(PP 90% + PE 10%)
- Fixing cover : PP(PP 90% + PE 10%)
- Rubber gasket : NBR

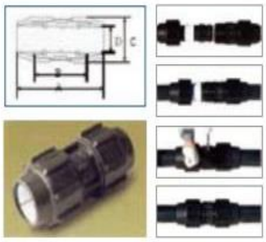
Connecting Method

1. Remove outer layer : use the outer layer remover to remove about 50cm of outer layer.
2. Insert Body of Manhole Connector jointing : Place the Body in the correct position.
3. Attach body with fixing cover : use bolts and nuts to connect the body with the upper and lower fixing covers
4. Complete

3. Coupler Set

INNER DUCT END CAP

OUTER END CAP



INNER DUCT SOCKET

MICRO COD INNER COUPLER

4. Connecting Tool

For the connecting

CONNECTING JIG

CUTTER

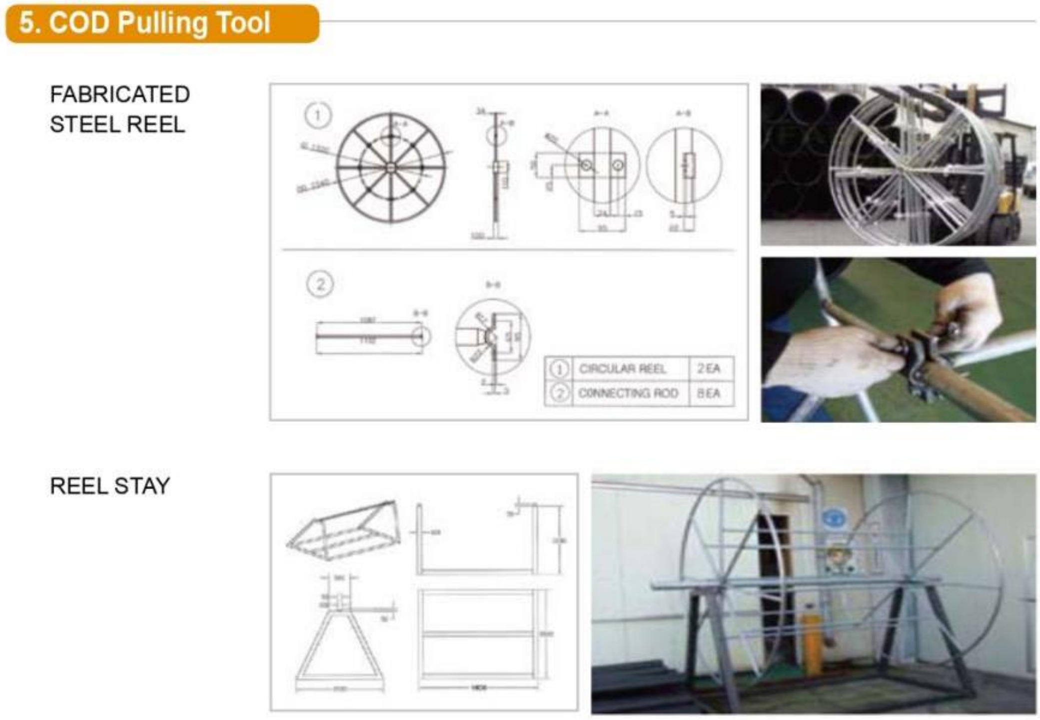


Figure 3.14: Optical connectors

3.6 Project operation/maintenance

3.6.1 Situation of maintenance

1) Elements of operation: Task

Operation proceeds between customers and network elements (NEs). Optical fibre cable operation is classified into two operations: a customer service operation and NE operation (refer to Figure 3.10). The former consists of tasks, such as reception of service order, billing information inquiry, and reception of trouble report. The latter also consists of tasks, such as provision, construction, installation, maintenance and administration. These tasks are closely related.

2) Elements of maintenance: Activities

Maintenance consists of three activities: surveillance, testing and control of NE. These are described below:

Surveillance – to monitor the condition of NE. Surveillance has two functions: to inform of NE degradation before trouble occurs, and to inform of NE abnormality when trouble occurs.

Testing – to measure characteristics of NE and to check whether the characteristics satisfy a required level or not.

Control – to restore NE to normal or to take action to maintain service quality.

Generally, the type of maintenance involving such works as monitoring NE degradation, testing and NE control before trouble occurs is considered to be preventive maintenance.

On the other hand, the type of maintenance involving such works as reception of an alarm or a trouble report, testing and NE controlling after a fault has occurred is considered as post-fault maintenance.

From the standpoint of preventive maintenance, optical fibre cable maintenance is composed of three activities such as periodic testing, fibre degradation testing and network element control.

- Periodic testing – to periodically detect fibre loss increase, fibre deterioration and water penetration.
- Fibre degradation testing– to perform measurement on fibre loss increase, fibre strain distribution and water location after receiving information from periodic testing.
- Network element control – to identify fibre, transfer and splice fibre – synchronously, if necessary.

In preventive maintenance, all activities shall be performed using spare (inactive) fibres or working (active) fibres that are multiplexed with the transmission signals without interfering with the transmission signals.

On the other hand, from the standpoint of post-fault maintenance, optical fibre cable maintenance involves reception of a transmission system alarm or trouble report from a customer, fibre fault testing, and cable repair/cable removal (that is, cable re-routing).

Therefore, optical fibre cable maintenance can be composed of the following:

– surveillance;
– testing; and
– control.

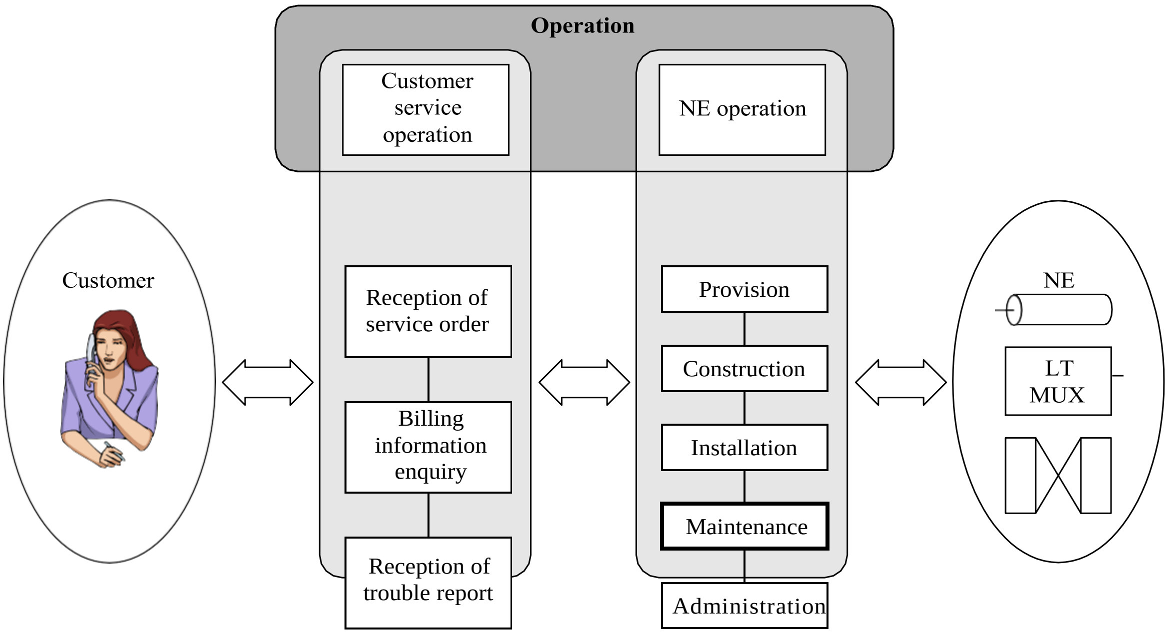


Figure 3.15 – Situation of maintenance

3.6.2 Fibre faults and their origins

Fibre faults may be classified into three types: fibre failure, fibre loss increase and fibre connector abnormality.

Fibre failure may be caused by:

– tensile strain and bending strain in a cable;
– bending strain and torsion strain in a cable closure;
– lateral stress in a crushed cable conduit.

Fibre loss increase may be caused by:

– micro bending loss increase due to fibre axial strain in a cable;
– fibre (macro) bending loss increase in a cable closure;
– hydrogen absorption loss increases in cable or a cable closure. Fibre

connector abnormality may be caused by:

– tensile strain and a change in the fibre alignment.

Optical fibres in an installed cable have residual strains from tension, torsion and bending. Bent fibres in a closure suffer larger strains than those in a cable and the fibre strength decreases accordingly. Furthermore, the fibre strength deteriorates more rapidly if water penetrates the cable and the closure.

Two major origins, fibre residual strain and bending loss in the cable and the closure induce most of the fibre faults. Water penetration is believed to accelerate the possibility of fibre failure and fibre loss increase.

Therefore, appropriate actions in optical fibre cable maintenance are desired before fibre faults occurs by the two major origins.

3.6.3 Preventive maintenance

Conventional optical fibre cable maintenance has followed the concept of metallic cable maintenance, which is, if anything, neither effective nor efficient because the knowledge about the bit-error rate is insufficient to determine whether the trouble is occurring in the transmission equipment or in the optical fibre network. Consequently, a lot of time is taken in the series of work starting from reception of the trouble report to a return to normality.

Compared with conventional cable maintenance which is activated after a trouble occurs, optical fibre cable maintenance shall take action before a fibre fault occurs to ensure high reliability of the optical fibre cable network and therefore reduces the number of customer complaints and trouble reports. It also allows maintenance departments to plan works and reduces operation costs. The procedures for preventive maintenance are shown below:

- periodic testing.

When an abnormality is found, the procedures continue as follows:

- fibre degradation testing;
- network element control;
- return to normal operation.

3.6.4 Post-fault maintenance

Post-fault maintenance such as reception of a trouble report, fault testing, cable repair and cable removal has been the main part of conventional cable maintenance.

In a trunk/long-distance plant, when the optical fibre cable is damaged or an optical fibre is broken, action is taken immediately in response to an alarm from a transmission system or a customer complaint. In this case, the possibility of optical fibre cable maintenance is to re-route traffic to an alternate path, to perform testing to find the fibre fault location, and to utilize a restoration cable kit to make a temporary path across the damaged portion of the cable. The restoration cable is prepared in advance for rapid repair. The procedures for post-fault maintenance in the trunk/long distance plant are as follows:

- reception of transmission system alarm;
- re-routing;
- fault distinction between fibre line and transmission equipment;
- fibre fault testing;
- craft dispatch;
- cable repair;
- repair verification;
- return to normal operation.

In a local distribution plant, after reception of a trouble report from a customer and testing for the cable/fibre fault, repair is done by a restoration cable kit or transferring fibre. The procedures for post- fault maintenance in the local distribution plant is as follows:

- reception of trouble report from a customer;
- fault distinction between fibre line and transmission equipment;
- fibre fault testing;
- craft dispatch;
- cable repair;
- repair verification;
- return to normal operation.

Cable removal is in fact cable re-routing work due to a claim from a road administrator or a customer. When cable removal work is to be done, fibre transfer control to another fibre circuit, in a point-to- point system, is necessary. Fibre transfer control has an advantage that it can transfer in parts of cables. In cable removal work, path transfer is done at both ends of all paths in the fibre cable, so the work area for path transfer is much more widely expanded than that for fibre transfer.

The process of cable removal is as follows:

- preparation of a newly installed fibre to be transferred to;
- transfer from the active fibre to a spare fibre;
- identification of the fibre to be transferred;
- cutting the fibre and splicing with newly installed fibre;
- testing of the spliced fibre;
- transfer from the spare fibre to the spliced fibre.

3.6.5 Functions required for optical fibre cable network maintenance

3.6.5.1 Surveillance

Functions required for preventive maintenance

1) **Detection of fibre loss increase**

In a trunk/long-distance plant, the condition of the optical fibre network shall be monitored using (an) active fibre(s) or (a) spare fibre(s) periodically. A light source and an optical power meter shall be used for monitoring purposes to detect automatically fibre loss increase caused by microbending, macrobending or hydrogen absorption. In the case of (an) active fibre(s) the transmission signal as well as a monitoring signal exist on a single-mode (SM) fibre using wavelength division multiplexing (WDM) components. The monitor wavelength is different from the transmission wavelength to prevent transmission from being interrupted.

In a local distribution plant, the condition of the optical fibre network is monitored using (an) active fibre(s) or (a) spare fibre(s) periodically. An optical time domain reflectometer (OTDR) and reflection waveform analysis are used to detect automatically fibre loss increase. Reflection waveform analysis allows the maintenance centre to compare the monitoring trace with the reference trace such as the initial installation trace. In the case of (an) active fibre(s), the OTDR wavelength is different from the transmission wavelength to prevent service interruption.

2) **Detection of fibre deterioration**

Optical fibres in an installed cable have residual strains from tension, torsion and bending. Fibre deterioration means a decrease in the fibre strength from such strains. Therefore, functions are required to detect the condition of fibre deterioration.

3) **Detection of water penetration**

When a cable sheath and/or a cable closure are damaged, water penetration may occur. Such water may generate hydrogen which may lead to a hydrogen loss increase. In order to prevent water penetration into the cable itself, various cable structures shall be used. The cable might be jelly-filled or contain water-blocking materials. In the former case, the jelly blocks water from penetrating into the sheath at a cut or hole, and minimizes the incidence of faults capable of being caused through water penetration. In the latter case, a water-blocking tape is used to prevent water penetration. If water penetrates the sheath at a cut or hole, the water blocking material swells and blocks further penetration of water.

A water sensor which shall be installed in an unfilled closure can detect water penetration. If water penetrates the closure, the water-absorbent material in the sensor expands and causes the fibre bender in the water sensor to bend the spare fibre; the macrobending loss of the fibre loss increases. This loss increase is detectable when the fibre is monitored.

Functions required for post-fault maintenance

The bit-error rate is monitored in trunk/long-distance transmission systems. If the bit-error rate exceeds the threshold level of an alarm, the alarm sends a signal through the interface along the path (transmission) operation system to the fibre cable maintenance centre. In a local distribution system, trouble reports mainly from customers are sent over to the fibre cable maintenance centre.

3.6.5.2 Testing

Functions required for Preventive Maintenance

1) **Measurement of fibre fault location**

The standard testing tool for fault locating is the OTDR. The OTDR has enough resolution to measure backscatter over even the longest fibre. A fault point caused by loss increase is easy to locate using a testing light wave on an active fibre, as a remote unit to the fibre cable maintenance centre.

2) **Measurement of fibre strain distribution**

Fibre axial strain induces a change in the Brillouin frequency shift in fibres; functions are required to measure this change. Fibre strain distributions, especially tensile strain distributions, in fibres can be measured by Brillouin optical fibre time domain analysis (B-OTDA). Ways of measuring of other fibre strain distributions such as bending and torsion are under consideration.

3) **Measurement of water location**

The water-absorbent material in the sensor expands and causes a loss in the spare fibre due to macrobending. If the water sensor is identified beforehand, the location where water was penetrated shall be measured the moment the fibre loss is monitored.

Functions required for Post-fault maintenance

1) **Fault distinction between transmission equipment and fibre line**

When a system trouble occurs, action is taken in response to a customer complaint or an alarm from a transmission system. The monitoring system has the responsibility of determining whether the trouble is occurring in the transmission equipment or in the fibre line. Because the function of monitoring the fibre network quality is independent of the transmission equipment, it is possible to make this distinction.

2) **Measurement of fibre fault location**

The standard testing tool for fault locating is the OTDR. The fault point is located using a transmission signal wave and/or a testing light wave on a faulty fibre. The OTDR is operated independently with its own software. Some OTDRs are now portable enough to be carried in the palm of the hand.

3.6.5.2 Control

Cable control is performed when faulty fibres are found when cables are damaged and fibres are broken, or when cable re-routing or replacement is required.

For preventive maintenance in a trunk/long-distance plant, functions are required to identify fibres to be transferred to, to splice fibres and to transfer from spare fibres to spliced fibres synchronously between cable splice points. In a local distribution plant, fibre transfer splicing in the fibre cable maintenance centre is under consideration.

For post-fault maintenance, the functions of cable repairing, fibre identification and fibre transfer splicing in the field, are required for both the trunk/long-distance plant and for the local distribution plant.

There are two types of cable removal: one is the use of automatic switching to standby transmission equipment and fibres, between both ends of the path or cable splicing points, especially in a trunk/long-distance plant, and the other is the adoption of automatic fibre transfer splicing in the local distribution plant.

3.6.5.3 Monitoring System during Operation Phase

Noise

The focus on noise as an air quality parameter is primarily with regard to its health implications. Unusually loud and uncontrolled noise levels may cause adverse effects to public health and welfare. The most obvious impact to human health is in the form of impaired hearing and eventual deafness in cases of prolonged exposure.

Scientific studies have shown that noise becomes offensive and unhealthy when it exceeds a certain limit -the mean tolerable noise exposure limit. In a bid to protect workers and other individuals who are exposed to loud noise, the Federal Ministry of Environment (FMEnv) under noise levels and exposure limits regulations has recommended that daily noise exposure for individuals (workers) should not exceed 90 decibels daily for an 8-hour working period.

The major source of noise are the generators, which are used to provide uninterrupted power supply at the Data Centre and POA. However, it is interesting to note that OIRL as part of its best operational practices ensures that all generators in its operational areas are equipped with sound attenuators. To this end, the maximum noise levels in these areas does not exceed 70dB (A) and it reduces with increase in distance from source. Also, Diesel Generator deployed to each POA shall work for 12hrs and shall be complemented with hybrid system which shall also work for 12hrs. Against this background, the likelihood of noise induced health problems on the workers and residents is very remote.

Exhaust Emissions

An average POA uses 20kVA diesel engine generator and it consumes 4 litres of diesel per hour i.e. 96 litres per day. OIRL shall quarterly monitor the temperature, humidity and air pollutants, namely; CO_2, SPM, VOC, NOx CO in and around each POA and Data centre.

Types of Maintenance

1. Predictive Maintenance: To analyse and forecast the eventual breakdown of a system
2. Preventive Maintenance: To forestall breakdown of equipment or site.
3. Corrective Maintenance: To correct or repair broken down equipment.

Mode of Maintenance

1. Generator Overhaul after 250hrs of usage
   - Changing of oil
   - Changing of brushes/slip ring

2. System Check (POA): Maintenance is carried out by site engineer on a periodic basis.

During the course of periodic maintenance check, the following aspects of the system are also monitored: frequency readings, input/output voltage readings, MDF terminal correction, system earthing, power cables for any loose contacts, battery voltage as well as electrolyte level in the cells and system & customer data configurations for any virus or default.

3. Cooling System (A/C): The maintenance is also carried out periodically by the site engineer.

The following component of the A/C system is monitored: The power plug/socket, the output voltage and the temperature.

3.7 Waste Management and Environmental Health and Safety

Wastes shall be generated during all the phases of the **proposed project** i.e, the preconstruction, construction and operation. **OIRL** through its **Contractor** shall engage government approved waste handlers in each State for management of hazardous and non-hazardous wastes.

OIRL waste management procedure describes details with respect to authority and responsibility, resources, standards and procedures, inspections, waste management, control and emergency procedures.

The waste management procedure specifies responsibilities of the MD/CEO with respect to provision of resources. The Environment unit is responsible for co-ordination of all activities, monitoring and ensuring compliance, documentation, and maintenance records amongst others. The Environment Specialist shall ensure effectiveness and success of the procedure, proper documentation of source, quantity, destination and proper tracking of all wastes till disposal/reuse/recycling and ensure that contractors comply with objective of this procedure.

RoW Supervisors monitors the **Contractors** who are responsible for the collection and segregation of all wastes in the site, storage of these wastes before their final disposal/reuse/recycling by the State approved waste handler and maintain records of waste materials generated from the site. All employees shall work strictly in accordance with laid down instructions and procedures to ensure minimal waste generation at source, proper disposal/reuse/recycling of all wastes and proper response in times of environmental emergencies.

The wastes shall immediately be removed from site and transferred through the engaged waste handlers. The 3R of (Re-use, Recycle and Reduce) principle of waste management shall be adopted in managing the waste that shall be generated during the implementation of the project. The waste segregation and receptacles are as shown in **Table 3.3**

Table 3.4: Site Waste Minimization and Management Plan-Site Maintenance

Type of waste generated	Estimate Volume (m^3) or Weight (Kg) of Reuse and specify method of reuse	Estimate volume (m^3) or Weight (Kg) of Recyclables	Phase	Estimate Volume (m^3) or Weight (Kg) disposed and specify landfill to be used	Roles & Responsibilities
Used Filters	NIL	NIL	Operation	NIL	Validated and disposed through approved State Waste Managers such as PSP approved by State Environmental Protection and Waste Management Agencies.
Used oil	Nil	Nil	Operation	Nil	Validated and disposed through approved State Waste Managers such as PSP approved by State Environmental Protection and Waste Management Agencies.
Sludge	Nil	Nil	Operation	Nil	Tank cleaning vendor to transfer sludge to any acceptable sludge recycler/reuse facility
Decommissioned Diesel Generators (DGs)	Nil	Nil	Operation	Nil	Validated and disposed through approved State Waste Managers such as PSP approved by State Environmental Protection and Waste Management

Type of waste generated	Estimate Volume (m^3) or Weight (Kg) of Reuse and specify method of reuse	Estimate volume (m^3) or Weight (Kg) of Recyclables	Phase	Estimate Volume (m^3) or Weight (Kg) disposed and specify landfill to be used	Roles & Responsibilities
					Agencies for recycling
Decommissioned Air Conditioners (ACs)	Nil	Nil	Operation	Nil	Validated and disposed through approved State Waste Managers such as PSP approved by State Environmental Protection and Waste Management Agencies for recycling
Used Batteries	NIL	Nil	Operation	NIL	Validated and disposed through approved State Waste Managers such as PSP approved by State Environmental Protection and Waste Management Agencies for recycling
Decommissioned ATS, ACDB & DCDB, Rectifier module etc.	NIL	Nil	Operation	NIL	Validated and disposed through approved State Waste Managers such as PSP approved by State Environmental Protection and Waste Management Agencies for recycling
Packaging (used pallets,	NIL	NIL	Construction/	Nil	Disposed through approved State

Type of waste generated	Estimate Volume (m^3) or Weight (Kg) of Reuse and specify method of reuse	Estimate volume (m^3) or Weight (Kg) of Recyclables	Phase	Estimate Volume (m^3) or Weight (Kg) disposed and specify landfill to be used	Roles & Responsibilities
pallet wrap)			Operation/Decommission		Waste Managers such as PSP approved by State Environmental Protection and Waste Management Agencies or State approved landfills
Brown waste – grass cuttings, dry leaves, twigs, paper, cardboard, cartons, etc.	NIL	NIL	Construction/ Operation/Decommission	Nil	Disposed through approved State Waste Managers such as PSP approved by State Environmental Protection and Waste Management Agencies or State approved landfills
Containers (cans, plastic, glass)	NIL	NIL	Construction/ Operation/Decommission	Nil	Disposed through approved State Waste Managers such as PSP approved by State Environmental Protection and Waste Management Agencies or State approved landfills

Type of waste generated	Estimate Volume (m^3) or Weight (Kg) of Reuse and specify method of reuse	Estimate volume (m^3) or Weight (Kg) of Recyclables	Phase	Estimate Volume (m^3) or Weight (Kg) disposed and specify landfill to be used	Roles & Responsibilities
Corrugate Optic Duct - Fibre Optic Cables	NIL	Nil	Construction	NIL	Validated and disposed through approved State Waste Managers such as PSP approved by State Environmental Protection and Waste Management Agencies for recycling

Safety Rules for Fiber Optics

- Keep all food and beverages out of the work area. If fiber particles are ingested they can cause internal hemorrhaging.
- Always wear safety glasses with side shields to protect your eyes from fiber shards or
- splinters. Treat fiber optic splinters the same as you would treat glass splinters.
- Keep track of all fiber and cable scraps and dispose of them properly. If available, work on black work mats and wear disposable lab aprons to minimize fiber particles on your clothing. Fiber particles on your clothing can later get into food, drinks, and/or be ingested by other means.
- Never look directly into the end of fiber cables – especially with a microscope - until you are positive that there is no light source at the other end – having tested it with a power meter.
- Use a fiber optic power meter to confirm that the fiber is dark. When using an optical tracer or continuity checker, look at the fiber from an angle at least 6 inches away from your eye to determine if the visible light is present.
- Contact lens wearers must not handle their lenses until they have thoroughly washed
- their hands.
- Do not touch your eyes while working with fiber optic systems until your hands have been thoroughly washed.
- Only work in well-ventilated areas.
- Keep all combustible materials safely away from the curing ovens and fusion splicers.
- When finished with the lab, dispose of all scraps properly. Put all fiber scraps in

properly marked container for disposal.
- Thoroughly clean your work area when you are done

OIRL not only believes in the need to stay at the forefront of technology, but also in the active promotion of environmental awareness and conservation. In order to lead by example, we have implemented the Environment, Health and Safety (EHS) management system based on international standards, which strives to provide a safe and healthy working environment for our employees, and aims to achieve the following objectives:

- Increase awareness of the importance of EHS in our design, production and operation processes.
- Systematically identify potential environmental risks and occupational hazards.
- Lay down specific EHS requirements for our purchasing strategy, and promote EHS throughout the whole supply chain.
- Encourage EHS awareness among our employees and cultivate a corporate culture that emphasizes the individual responsibility that each of us have towards the environment.
- Increase focus on sustainable development through the reduction of energy consumption and efficient usage of resources.
- Perform internal audit and management review of EHS on a regular basis.

3.8 EMPLOYMENT

An average of 10km of ducting infrastructure is expected to be laid on a daily basis with the use of 1,000 labors to achieve the milestone. So, there shall be 1000 site employees onsite per day during preconstruction, construction and 100 during operation phases. These shall include management staff, contractors, unskilled workers, skilled technicians, and drivers. 75% of these employees shall come from the host communities.

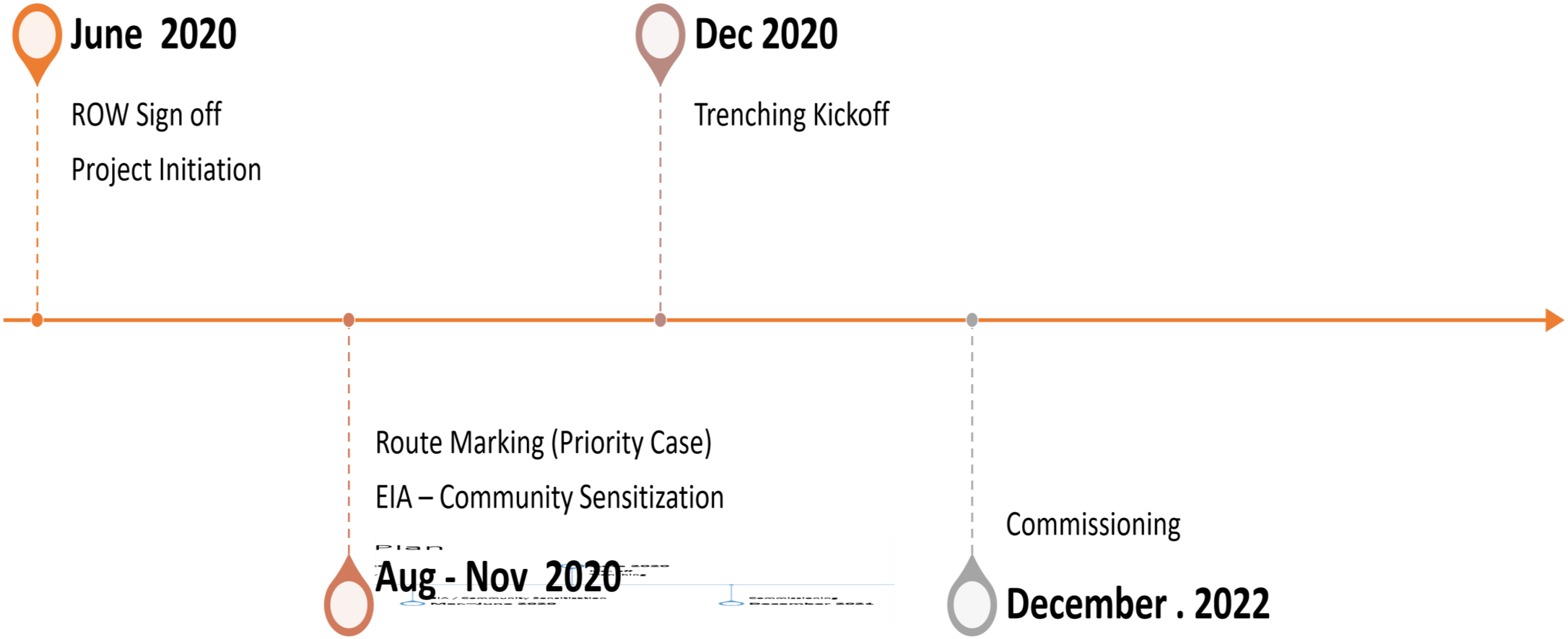
OIRL shall seek to promote the development of local skills and the transfer of international technologies and expertise to local manpower and local manufacturers. It shall also ensure that activities are fully compliant with the relevant (and evolving) ‘‘local content’’ provisions of Nigerian law and regulation.

3.9 Project Schedule

The overall conceptual project implementation schedule for the construction and commissioning of the Project is illustrated in table 3.5 below:

Table 3.5: The conceptual project schedule for the proposed Optic Fibre Project

S/N		Activity	2020		
			Q3	Q4	Q1
1		Appointment of Consultants to prepare ESIA			
2.		ESIA Preparation & Certification Process			
3		Preconstruction Phase: Mobilisation (transport) to the site (equipment, personnel, and construction modules), Energy requirements (provision of energy for pre-construction activities), Site Preparation and excavation of the land area			
4		Construction Phase: Trenching of Fibre Optic route, Laying of Fibre cables, installation of various equipment, power generation equipment, etc.) and civil works. Commissioning			
5		Operation and Maintenance Phase			


June 2020
ROW Sign off
Project Initiation
Dec 2020
Trenching Kickoff
Route Marking (Priority Case)
EIA – Community Sensitization
Aug - Nov 2020
Commissioning
December . 2022

CHAPTER FOUR

DESCRIPTION OF THE ENVIRONMENT

4.1 Background Information

The detail baseline environmental and social description of proposed Open Metropolitan Fibre Network project is presented in this chapter.

The baseline environmental and social characteristics of the proposed project area were established based on one (1) climatic season on-site field sampling carried out in the study area. The wet season field sampling exercise was conducted on Monday 15th through Saturday 26th September, 2020 while the secondary data for dry season was culled from phase 11 ATCN EMP report which was carried out between 6th and 15th March 2020.

4.1.1 Study Approach

A review of the relevant literature enabled the background information on the environmental characterization of the proposed project location (study area) to be obtained. The commencement of field work was preceded by a reconnaissance visit to the site. The proposed Open Metropolitan Fibre Network project locations are green field that cuts across eight states namely: Lagos, Ogun, Oyo, Osun, Ono, Ekiti, Kogi and Kwara States. There are rivers, streams and pond within the Area of Potential Project Influence (APPI).

A multidisciplinary team of experts in various areas was employed to undertake this study. The area of expertise includes; Ecology (Wildlife/Vegetation), Climatology, Air Quality, soil, Socio Economic etc. These experts were engaged with a view to developing the baseline conditions of the study area.

4.1.2 Field Data Acquisition Method

Preliminary investigations were made through field sampling surveys, questionnaires, interviews and review of existing reports, maps and literature. Information on the climate conditions of the project was collected from the Nigerian Meteorological Institute (NIMET) 1997-2019. For this purpose, information for a period of at least 22 years 1997-2019 was obtained. Specifics of data collection methods are presented in the following subsections.

4.2 Study Methodology

4.2.1 Sampling Design

The sampling was carried out in accordance with the requirements of *EIA Act CAP E12, LFN 2004***.** Grid and transect sampling approaches were adopted with respect to environmental components intended for sampling. A total of Seventy-Two (72) geo-referenced sampling stations and additional twenty-four (24) control points were established for air quality, noise, soil and vegetation (3 samples and 1 control for each senatorial district in each state) while twenty-four (24) geo-referenced sampling stations and additional 8 controls points were established for groundwater (1 sample and 1 control for each senatorial district in each state). For surface water and sediment, fifteen (15) geo-referenced sampling stations and additional 3 controls points were established in line with the FMEnv ESIA Terms of Reference (ToR). The sampling coordinate is attached in ***Appendices 4.1a-c. 'Figure 4.1*** shows the sampling maps.

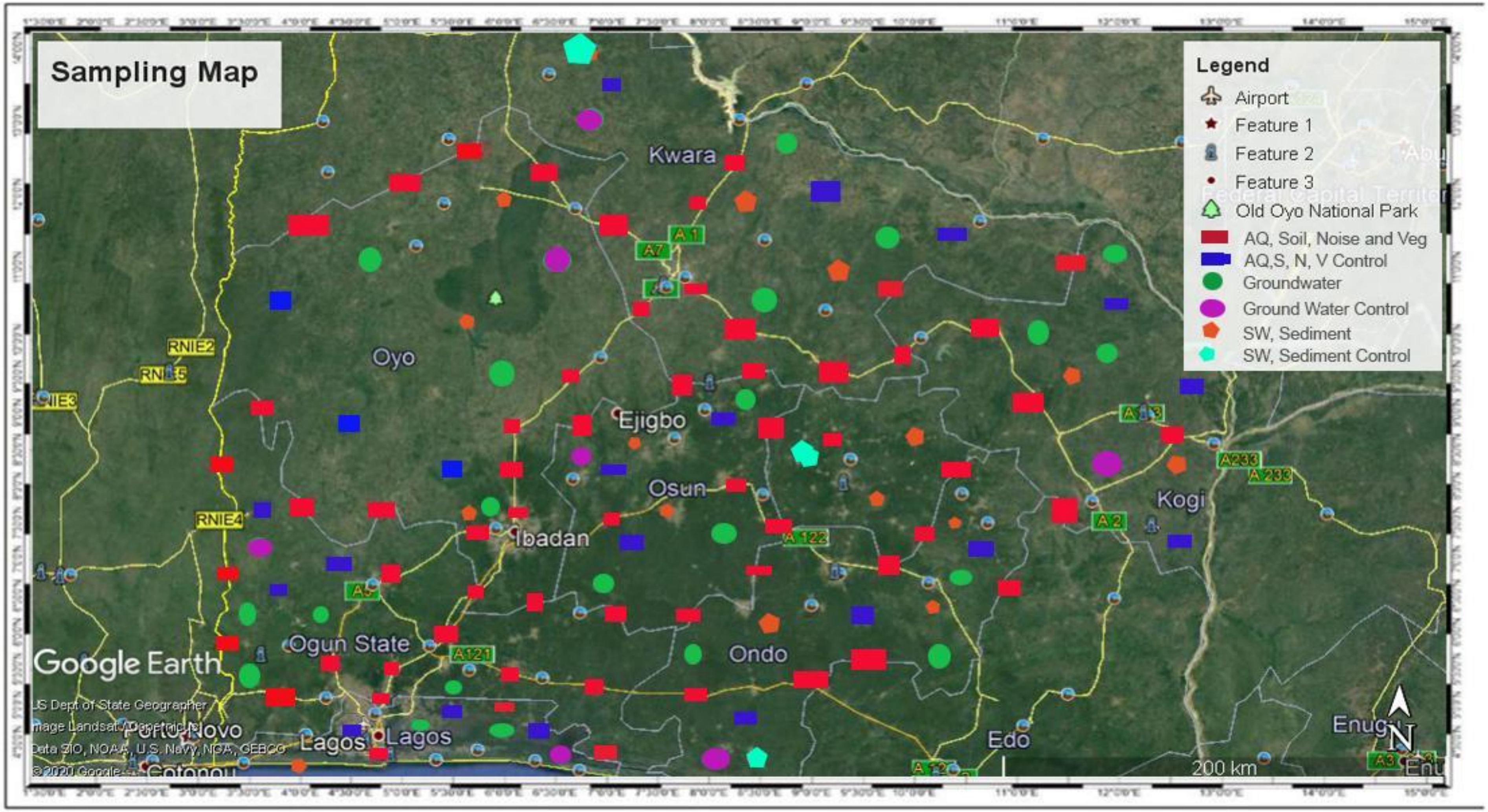


Figure 4.1: Map showing sampling stations for air quality, Noise Groundwater, Soil, Vegetation, Surface water and Sediment
Source: Google earth map

4.2.2 Sampling Equipment and Laboratory Technique

Sample collection, handling, storage, transfer, data coding and documentation followed the *EIA Act CAP E12, LFN 2004*. All the samples collected on the field which were witnessed by FMEnv representative were preserved with ice chests and immediately taken to Anila Resources Limited, Lagos for analysis. The samples were then stored adequately in designated freezers at <4°C prior to analysis. Laboratory analysis which was also witnessed by FMEnv staff was timely carried out in line with the samples' respective analytical times as recommended in FEPA (1991) *(**Table 4.1**)*

Table 4.1: Sampling and Laboratory Technique

Parameter	Symbol	Unit	Test method
Physico-chemistry			
Ph	pH		in situ
Temperature	T	°C	in situ
Conductivity	EC	S/cm	in situ
Dissolved oxygen	DO	mg/L	in situ
Salinity	S	‰	in situ
Turbidity	Turb	NTU	in situ
Total suspended solids	TSS	mg/L	APHA 2540D
Total dissolved solids	TDS	mg/L	APHA 2540C
Heavy metals			
Arsenic	As	mg/L	AAS
Cadmium	Cd	mg/L	AAS
Arsenic	As	mg/L	AAS
Chromium	Cr	mg/L	AAS
Copper	Cu	mg/L	AAS
Mercury	Hg	Mg/l	AAS
Ferric iron	Fe3+	mg/L	AAS
Ferro iron	Fe2+	mg/L	AAS
Lead	Pb	mg/L	AAS
Nickel	Ni	Mg/l	AAS
Manganese	Mn	Mg/l	AAS
Cations			
Magnesium	Mg	mg/L	AAS
Potassium	K	mg/L	AAS
Sodium	Na	mg/L	AAS
Zinc	Zn	mg/L	AAS
Aluminium	Al	mg/L	AAS
Anions			

Parameter	Symbol	Unit	Test method
Carbon dioxide	CO_2	mg/L	APHA 4500-CO2
Carbonate and bicarbonate	HCO_3	mg/L	APHA 2320B
Fluoride	F	mg/L	APHA 4500
Nitrate	NO_3	mg/L	APHA 4500
Nitrite	NO_2	mg/L	APHA 4500
Phosphorus total	P	mg/L	APHA 4500
Sulphate	SO_4	mg/L	APHA 4500
Sulphide	S^{2-}	mg/L	APHA 4500
Organics			
Total Organic Carbon (TOC)	TOC	mg/L	APHA 5310
Dissolved organic carbon	DOC	mg/L	APHA 5310
Total mineral oil		mg/L	EPA 8015
BTEX	BTEX	mg/L	EPA 8260
Phenol		mg/L	APHA 5330C
Chemical oxygen demand	COD	mg O_2/l	APHA 5220B
Biological oxygen demand	BOD	mg O_2/l	APHA 5210B
Polycyclic aromatic hydrocarbons	PAH	mg/L	EPA8260
Macro and Micro-biology			
Chlorophyll		mg/L	UV
Phytoplankton population density		number of cells / l	Coulter Counter
Bacteria count		(cfu/100ml x 103)	APHA 9215C

FEPA, 1991

4.2.3 Sampled Parameters

Abiotic and biotic components were studied; they include climate/meteorology, air quality and noise, soil, vegetation, wildlife, socio-economics and health status. During the field sampling, in situ measurement was done for parameters with short holding analytical time while other samples were collected for laboratory analysis.

4.2.3.1 Abiotic Component

a) Climate and meteorological studies

The purpose of the climatic and meteorological study is to establish meteorological conditions in-and-around the study area. The climatic characteristics of the study area relating to the following were extracted from historical and field sampling data. The following data were collected:

a) Temperature
b) Rainfall

c) Relative humidity
d) Wind patterns (speed and direction)
e) Sunshine (hours and intensity)

A hand-held battery powered high precision Spymaster (SM 28) pocket Weather Tracker, made in the USA was used for data collection for wind speed, humidity, temperature and wind direction (i.e. microclimatic data). Although the microclimatic data was acquired via field measurement, macroclimatic data (long term data) was acquired from the database of the Nigerian Meteorological Agency (NiMet).

A weather station was set up at the same sampling stations for soil sampling during the field survey. Sampling was allowed to run for a minimum of 30 minutes in order to establish a microclimatic data of that particular station. All precautions taken when setting up a weather station and during measurements were observed for the onsite measurements according to the World Meteorological Organization (WMO) standard. These include setting up the weather station away from obstacles like buildings and tall vegetation, using an instrument shelter to display all temperature sensitive instruments, orienting the instrument shelter so that the sun's radiation does not fall directly on the instrument during reading and setting up the weather station in an area representative of the study area's totality. ***Table 4.2*** below presents weather data acquisition techniques.

Table 4.2: Weather Study Equipment

Climatic Variable	**Instrumentation/Method**
Air temperature	Dry bulb thermometer
Relative humidity	Psychrometer/hygrometer
Wind speed	Anemometer
Wind direction	Wind vane
Cloud cover	Direct observation

b) Ambient air quality and air borne noise level investigations

Gases that are of environmental importance such as toxic gases, greenhouses gases and ozone depleting gases were examined. Portable AEROQUAL Air Quality Monitor (Series 300 Model) was used for air quality determination. Pollutant gases such as NOx, SOx, NH_3, H_2S, CO and VOC were determined. The analyser contains sensor for each gas and each sensor analyse the quality of the respective gases in the ambient air. It is a digital meter, which reads parameters at a time weighted average. An EXTECH instrument (USA), model 407730 Sound level meter with high sensitivity was used, the instrument can measure as low as 30 dB (A) and as high as 150 dB (A). The accuracy is ±1.5 dB (A).

The AeroQual multi-gas detector, Extech noise level meter, SKYMASTER Weather Tracker, and Met One Aero Track Handheld Airborne Particle Counter (manufactured in USA, Model 9303) used for the study are shown in **Plate 4.1a**. Air quality, Noise and Weather condition were determined in situ and recorded. Data collection was done from the hours of 10:00AM – 5:00PM. **Plate 4.1b** shows the data collection process.

Plate 4.1a: In Situ Meters - 1: Aeroqual multi gas meter, 2: GPS, Aero Track Handheld Airborne Particle Counter (SPM), 3: Noise Meter and Weather tracker and 4: SO_2 meter, NO_2 meter, H_2S meter etc.


Plate 4.1b: Air quality sampling activity

c) Water Quality Sampling Methodology *(Groundwater and Surface water)*

Groundwater samples were collected from 32 existing boreholes and well (24 samples and 8 control) while surface water samples were collected from 15 sampling stations and 3 control stations from Lagos Lagoon, Owena River (Ondo State), Ogbese River (Ondo State), Ose River (Ondo State), Oluwa River (Ondo State), Oba River (Oyo State), Otin River (Oyo State), Asejire River (Oyo State), Kara River (Ogun State), Ososa River (Ogun State), Oshun River (Osun State), Owena River (Osun State), Ogbese River (Ekiti State), Ose River (Ekiti State), Asa River (Kwara State), Alalubosa River (Kwara State), Osse River (Kogi) and River Obuburu (Kogi State). These samples were immediately analysed for parameters with short holding analytical time such as pH, dissolved oxygen (DO), electrical conductivity, salinity, temperature, and turbidity.

Samples were collected into sterilized and appropriate sampling containers. Samples for physico-chemical and heavy metals analyses were collected in plastic containers while those for hydrocarbons and were collected in glass bottles. Samples for microbiological analyses were collected in 15ml McCartney sample containers. Collected samples were properly labeled, preserved, stored in an ice chest thermos cooler and transported to the laboratory for analyses.

Parameters with short holding analytical time were analyzed in situ, while others were analyzed at the lab. A summary of the laboratory methods used for the various water quality analyses is presented in **Table 4.3**.

Table 4.3: Summary of Laboratory Methods for Water Analysis

Water Parameter	Analytical Method
Organics:	
Total Hydrocarbons (THC)	N-Hexane Extract using GC
Total Organic Carbon (TOC)	Dichromate Wet Oxidation (Walkley and Black, 1934)
Metals:	
Alkali Metals (Ca, Mg, Na and K)	Flame Photometry (Jone, 1988
Other Metals: (Cr, Cu, Fe, Ni, V, Pb, Zn, Cd, Hg, and Mn)	Atomic Absorption Spectrophotometry (AAS)
Physico-chemistry:	
TDS/TSS	TDS/TSS meter (APHA 209C)
BOD_5	Titrimetric (Winklers APHA 422)
TOC	Titrimetric, wet digestion (APHA 422)
Anions (SO42-, NO3-, PO43-, Cl-)	Colorimetric, autoanalyzer (ASTM 3867, APHA 427C)
Alkalinity	Titrimetric (APHA 427C)
Microbiology:	
Heterotrophic Bacteria	Plate count
Culturable Fungi	Plate count
Coliform Bacteria	Plate count, MPN (Crickshank, 1975)

Plate 4.2a: Sampling of Groundwater quality

Plate 4.2b: Sampling of surface water quality

d) Hydrobiology studies and Fisheries

- ***Planktons and Benthos***

Qualitative plankton samples were collected by towing a 55 μm mesh plankton net at a very slow speed just below the water surface for 5 min at each sampling station. The net was hauled in and the sample transferred into a 250 mL well labeled plastic container with screw cap. Each sample was preserved with 4% buffered formalin solution to prevent decay of the samples (Nwankwo, 2004) and transferred to the laboratory for microscopic analyses.

Sediment samples were collected with an Ekman-Birge Grab from the same location where surface water samples were collected. The sediment samples were placed in sampling bags after sieving to remove dirt and debris, labelled and stored in a coolant to prevent microbial degradation of the hydrocarbon ***Plate 4.43*** shows sediment sieving procedure.

Plate 4.3: Sampling of Sediment Plankton, Zooplankton and Benthic Macroinvertebrates

Plankton Analysis: The plankton samples were concentrated by allowing cells to settle for at 48 hours and thereafter decanted. The micro transects drop count method as described by Lackey (1938) was employed to investigate the plankton samples. One drop of each concentrated sample was thoroughly investigated five times by observing all fields within the cover slip border using a Wild II binocular microscope with calibrated eye piece at different magnifications (10× and 40×). The total number of plankton identified was recorded as number of cells per ml. Relevant texts were used to aid identifications (Patrick and Reimer, 1975; Wimpenny, 1966; Waife and Frid, 2001; Rosowski, 2003; Siver, 2003) in the Ecotoxicology Lab of Zoology Department University of Lagos.

Benthic Macroinvertebrates Analysis: Benthic macroinvertebrates were sorted in the laboratory using a hand lens of 500x magnification and an American optical dissecting microscope and stored in labelled specimen bottles containing 4% formalin for later examination. Benthic invertebrates were subsequently identified to their lowest generic level, using appropriate identification keys at the Zoology Department Laboratory, University of Lagos. The community structure of the planktons and benthos was done using the measures of biological diversity such as species richness index, Menhinick's Index, Shannon and Weiner diversity index, Species Equitability or Evenness index and Simpson's dominance index.

e) Soil quality investigation

To ensure a representative sampling, soil samples were collected from 3 cores from each sampling point at depths of 0-15cm and 15-30cm for top soil and sub soil respectively ***(Plate 4.4)*****.** Samples were collected with stainless screw type soil auger into plastic bags for physicochemical and microorganism analysis. Separate samples were also collected into aluminium foil hydrocarbon content determination.

Plate 4.4: Soil sampling activity at the proposed project site

4.2.3.2 Biotic Components

f) Vegetation and Wildlife Studies

⊙ ***Sampling Technique for Floristic and Faunal Data Collection***

Floristic data were collected using systematic sampling technique with 6 quadrats of one square meter each at each sampling location for assessment of herbaceous flora. Sampling for faunal species followed point sampling design, and walking along foot paths was used (Walsh and White, 1999). Data collected on faunal species included species composition of each sampling location.

⊙ ***Species Identification***

Identification of species was done using methodology provided by Akobundu and Agyakwa (1998); Johnson (1997) for herbaceous flora; and Dalziel and Hutchinson (1979) and Keay *et al.* (1967) for woody flora. Identification of faunal species was done using the methodology provided by Adeyanju *et al.* (2012)

⊙ ***Data Analyses***

All quantitative data were subjected to Relative Importance Values analysis following Kent and Coker (1992) and Olubode *et al* (2009). Multivariate analyses for ordination and phytosociology of species and stands describing the ecology of the sampling stations followed Hammer *et al.* (2001) using Paleontological Statistics (PAST) 2.14 version software for detrended correspondence and cluster analyses. Two-Way Indicator Species Analyses (TWINSPAN), 2012 version software was used for determination of phytosociology of the flora (Hill, 1994, 2012).

⊙ ***Statistical analyses***

Indices of species diversity and evenness were used to characterize the faunal community structure. The Margalef's index (d) of taxa richness, Shannon-Wienner index of general diversity (H) and Evenness (E) were used to express the descriptive properties.

Margalef's Index (d): d= $\frac{S-1}{3.322 \log N}$

Where,

S = number of taxa

N = total number of individuals

Shannon-Wienner Diversity Index (H): H = $3.322(\log N - \frac{\sum Ni \log Ni}{N})$

Where,

N = Total number individuals in all species

Ni = Number of individuals in each species

3.322= Conversion factor from base 10 to base 2

H' = Diversity (0-4)

The Evenness component of diversity expresses the degree of uniformity in the distribution of individuals of each taxon in the collections.

Species evenness (j): j = $\frac{H}{Hmax}$

where,

H= Shannon-Wienner Diversity Index

Hmax. = logarithm of the number of species in the population (Zar, 1983).

The Slack system was used in the determination of dominant, sub-dominant, common and rare groups of genera. Taxonomic groups or genera comprising:

15% or more of the total number of individuals collected = Dominant

5 - 14% = Sub-dominant

1 - 4% = common

<1% = Rare.

g) Microbiology

Surface and ground water, bottom sediments and soil samples were collected into sterile plastic bottles and polythene bags, kept at 2-6^{o}C and analysed for microbial contents.

⊙ ***Heterotrophic Bacterial Counts***

The total heterotrophic bacteria in both water and sediment were enumerated using modified yeast extract agar (Cruickshank *et al*, 1975). Bacteria isolates were identified according to the scheme for Buchanan and Gibbons (1974).

⊙ ***Determination of Fungal Content***

The total fungal counts in the water and sediment samples were determined using Emmons, Binford and Utz's modified Sabouraud Dextrose Agar (Cruickshank, *et al*, 1975). Isolated fungi were identified based on the associated spores and mycelia and their growth characteristic on the isolation medium.

⦿ ***Determination of Percentage Petroleum Degrading Bacteria and Fungi***

The petroleum degrading bacteria were enumerated on petroleum agar medium, while chloramphenicol was added to this medium for the selective isolation and enumeration of petroleum degrading fungi. Any bacteria or fungi growing on these media were regarded as petroleum utilizers or degraders. The percentage of these counts on the total heterotrophic bacteria or fungal counts were then calculated to obtain the percentage petroleum degrading bacteria and fungi respectively in each sample.

4.2.3.3 Laboratory Analysis Procedures

Sample collection, handling, storage, transfer to the laboratory, data coding and documentation followed the FMEnv's EIA procedural guidelines. All the samples collected on the field were preserved in ice chests and immediately taken to the laboratory. The samples were then stored adequately with the sediment samples stored in designated freezers at - 4°C and water samples stored in well cooled refrigerators prior to analysis. ***Table 4.4*** shows analysis procedures employed.

Table 4.4: Analytical procedure

Parameter	***Method/Instrument***
Temperature (°C)	Hanna portable digital meter
pH	Hanna portable digital meter
Conductivity (µS/cm)	Hanna portable digital meter
TDS (mg/L)	Hanna portable digital meter
TSS (mg/L)	Gravimetry
Turbidity (NTU)	Turbidity meter
DO (mg/L)	Hanna DO Meter and Test Kit
BOD_5 (mg/L)	DO measurement after 5 days
COD (mg/L)	Dichromate/titrimetry
Alkalinity ($mgCaCO_3/l$)	Titrimetry
Salinity as chloride (mg/L)	Titrimetry
Total hardness ($mgCaCO_3/l$)	Titrimetry using EDTA
Sulphate (mg/L)	Turbidimetry
Phosphate (mg/L)	Spectrophotometry
Nitrate (mg/L)	Spectrophotometry
Ammonia (mg/L)	Nesslerisation
Hydrogen sulphide (mg/L)	Titrimetry

Parameter	Method/Instrument
Oil and grease (mg/L)	Extraction / Spectrophotometry
Total hydrocarbon (mg/L)	Extraction / Gas chromatography
Calcium (mg/L)	Titrimetry using EDTA
Magnesium (mg/L)	Titrimetry using EDTA
Cadmium (mg/L)	Atomic Absorption Spectrophotometer (AAS)
Chromium (mg/L)	AAS
Copper (mg/L)	AAS
iron (mg/L)	AAS
Lead (mg/L)	AAS
Manganese (mg/L)	AAS
Nickel (mg/L)	AAS
Vanadium (mg/L)	AAS
Zinc (mg/L)	AAS

AAA: Atomic absorption spectrometry, GC, Gas chromatography Source: FEPA, 1991

The samples were analysed at Anila Resources Nigeria Limited, located at #5, Afisman Drive, off Awolowo Way, Ikeja Lagos, Nigeria. Laboratory analysis was timely carried out in line within the respective samples analytical time as recommended in FEPA (1991) and APHA *et al*, 1980; Golterman *et al*., 1978; and US EPA (1979).

4.2.3.4 Quality Control/Quality Assurance (QA/QC) Procedures

QA/QC procedures cover all aspects of the study, including sample collection and handling, laboratory analyses, generation of data and coding, data storage and treatment and report preparation. The quality assurance programme employed in the fieldwork and laboratory analyses were in accordance with *FEPA (1991)*.

- ***Sample Collection and Handling***

In preparation for fieldwork, glassware to be used were washed with detergent solutions, rinsed with tap water, then soaked in 1:3 nitric acid solutions for 24 hours to remove organic materials, washed again with tap water and rinsed with distilled water. Plastic containers were washed with detergents, rinsed with tap water, followed by distilled water. After drying, all the containers were rinsed with acetone to remove organic materials, and rinsed with distilled water. Aluminium foils were obtained for soil and sediment samples. Sampling equipment was rinsed with portions of the water to be sampled. Samples per sampling point were taken with thoroughly cleansed containers. Sterile wide-mouth polypropylene and Pyrex glass sample bottles were used. Samples for oil and grease were collected in clean and dry glass-stoppered bottles and were usually not completely filled to avoid losing oil when the stopper was inserted.

⊙ ***Sample Identification***

Specific details on sample identification were entered on a permanent label to reflect node, date, sample matrix, sampling point, sample number, depth etc.

⊙ ***Laboratory Analysis and Generation of Data***

Possible sources of error in laboratory analysis include contamination of reagents and materials, lack of sensitivity of equipment, lack of calibrations, poor data entry and interpretation. Glassware and other containers used for each analysis were thoroughly cleansed as appropriate for each parameter. All glassware used for oil and grease determination was pre-rinsed with Analar grade xylene. Glassware for determination of metals were pre-soaked in dilute nitric acid and then rinsed well with distilled water. All reagents and chemicals of high purity (mostly Analar grade) were used. Freshly distilled water prepared in our laboratory was used for all dilutions.

The various instruments and equipment for measuring physico-chemical parameters used were in good working condition. Periodic control checks were usually carried out on such instruments/equipment and the performance record maintained. The pH meters were calibrated using HACH commercial buffer standards. Appropriate colour standards of diluted potassium dichromate or potassium permanganate solutions are frequently used to check the wavelength settings and sensitivities of the absorption spectrophotometer.

For analytical determination requiring the use of calibration curves, such curves were plotted using standard solutions prepared from analytical grade reagents. Records of such calibration curves were maintained and frequent re-calibration checks were carried out. Analytical blanks were incorporated per specific batches of samples to compensate for the sample preparation and determination steps. All the analyses were replicated and the means reported.

⊙ ***Storage/Preservation***

Samples were analysed at minimum time after collection they could be subject to microbial degradation and transformation. Samples were stored in ice-chest as a cooling device and transported to the laboratory where they were refrigerated at 4°C or kept in a freezer as appropriate. Samples for heavy metal analyses were preserved with 1:1 nitric acid and oil and grease with 1 ml of 1:1 H_2SO_4 as soon as they were collected. Adherence to good preservation procedures ensured that errors were not introduced into the analytical process.

⊙ ***Chain of Samples Custody Procedure***

There is a Master Register for all samples brought into the laboratory. Following registration of the sample, a Sample Data Sheet containing pertinent information on the sample was opened for each sample. The information includes:

a) sample reference number;
b) nature or type of sample;
c) site of collection;
d) date and time of collection; and
e) Mode of preservation (depends on nature of material) and analytical data from the field and results of laboratory analyses of representative samples.

Appropriate methods were used in storing the remaining stock materials and sub samples. Samples for storage were kept in labelled compartments on shelves in a storage room. Samples sent to co-operating laboratories were recorded in the Master Register and accompanied by essential data pertaining to the sample material**.**

⊙ ***Evaluation of Results***

Raw data obtained from the instrumental measurements were used in calculating the concentrations of the various parameters, using standardized formulae. All such calculations were crosschecked. Outlying values were deleted from the replicate data before calculation of mean concentrations. A quick identification of results, which deviate from the normal trend, was usually done. The sum of the anion concentration in meq/l should be equal to the sum of the cation's concentration also in meq/l. Differences within 5% are acceptable.

$$\% \text{ Difference} = \frac{(\text{Cations}) \text{ minus } (\text{anions})}{(\text{Cations}) \text{ plus } (\text{anions})}$$

Also, calculated and observed conductivity measurements and IDS data were compared, to check reliability and accuracy of data. The laboratory analytical methods used were those recommended by FEPA, 1991.

⊙ ***Occupational Safety and Health (OSH) Program***

Safety measures were adopted for field samples and lab analysis in line with O'odua Infraco Resources Limited HSE policies. On arrival the entire team comprising of FMEnv, representative of O'odua Infraco Resources Limited and Spatial Ecosystemts Limited were briefed on safety on site to familiarize them with essential safety precautionary measures, emergency response procedures and hazards associated with each plant/facility. The safety briefing was corroborated with Safety pep-talk on each sampling day. Personal Protective Equipment (PPE) were worn in all situations involving handling of toxic/dangerous materials in line with the procedures provided in the Spatial Ecosystems Limited safe handling of chemical card (SHOC). A total of 250 man-hours was used for the sampling without Lost Time Injury (LTI).

4.2.4 Geology of the Study Areas

4.2.4.1 Geology of Oyo State

Oyo State is entirely underlain by Precambrian basement complex rocks. The basement complex is dominated by undifferentiated quartzo-feldspathicbiotite- and hornblende-bearing gneisses, schists and migmatites (Wright *et al*., 1985). Intercalated among the gneisses and migmatites are numerous supracrustal relics which are referred to as the "older metasediments" in Nigeria. They are structurally complex which helps to distinguish them from the "younger metasediments". Older metasediments occur as a northeast-north trending, discontinuous bands through the western and eastern parts of Oyo State (Geological Survey Division, 1974). They are composed of ridge forming quartzites (not prominent in Oyo State) that are often micaceous and sometimes silimanite- and kyanite-bearing. The quartzites grade into muscovite-quartz-schists (FORMECU, 1999).

4.2.4.2 Geology of Lagos State

The study area and its environs lie within the extensive Dahomey basin, containing Recent - Cretaceous sediment built-up. The basin extends from the eastern part of Ghana through Togo and Republic of Benin to the western margin of the Niger/Delta basin, just before the Mahin mud coast in Nigeria. The basin is separated from the Benue trough by a basement ridge, a paleographic highland. It is bounded in the east by Benin hinge line, a major regional fault structure marking the western limit of the delta basin (Adegoke, 1969).

The sedimentary succession consists of near surface Recent alluvial deposits. These deposits are underlain by the Coastal Plain Sands or the Benin Formation. The sediments of the Coastal Plain, deposited during the Late Tertiary - Early Quaternary (Jones and Hockey, 1964), consist of unconsolidated, coarse to medium sands (Okosun, 1998). The sands are generally moderately sorted and poorly cemented. The Benin Formation is underlain by the Paleocene Akinbo Formation. The formation is predominantly shally. The Akinbo shale is underlain by the continental Cretaceous sediments of the Abeokuta Group (Omatsola and Adegoke, 1981). The littoral and lagoon deposit of recent sediment underlies the area. The coastal belt varies from about 8km near the Republic of Benin border to 24 km towards the eastern end of the Lagos Lagoon (Nton, M.E, 2001).

4.2.4.3 Geology of Ondo State

There are two geological formations in Ondo state. These are

- Region of sedimentary rocks in the south-the sedimentary rocks are mainly of the PostCretaceous sediments and the cretaceous Abeokuta formation.
- The region of precambrian basement complex is mainly of the medium grained gneisses. These are strongly foliated rocks frequently occurring as outcrops. On the surface of these outcrops, severely contorted alternating

bands dark and light colored minerals can be seen. These bands of light colored minerals are essentially feldspar and quartz, while the dark colored bands contain abundant biotic mica. A small proportion of the state, especially to the north east overlies the coarse grained granites and gneisses, which are poor in dark ferromagnesian minerals. Some few kilometers north of Aaye occurs the basement complex: sedimentary rocks boundary.

4.2.4.4 Geology of Ogun State

The geology of the Project Area comprises sedimentary and basement complex rocks, which underlie the remaining surface area of the state. It also consists of intercalations of argillaceous sediment. The rock is soft and friable but in some places cement by ferruginous and siliceous materials. The sedimentary rock of consists of Abeokuta formation lying directly above the basement complex. This in turn is overlain by Ewekoro, Oshosun and Ilaro formations, which are all overlain by the coastal plain sands (Benin formation).

4.2.4.5 Geology of Ekiti State

Ekiti State is underlain by metamorphic rocks of the PreCambrian basement complex, the great majority of which are very ancient in age. These basement complex rocks show great variations in grain size and in mineral composition. The rocks are quartz gneisses and schists consisting essentially of quartz with small amounts of white micaceous minerals.

In grain size and structure, the rocks vary from very coarse-grained pegmatite to mediumgrained gneisses. The rocks are strongly foliated and they occur as outcrops especially in Efon-Alaaye and Ikere Ekiti areas (Smyth and Montgomery, 1962).

4.2.4.6 Geology of Osun State

Geology of the study area is covered by Iwo Sheet 60 on a scale of 1:250 000 with structural features exhibited by rocks including foliation in the gneisses, lineation, folds, faults and joints. Rocks found all over the study area are schists, associated with quartzite ridges of the type in Ilesa area. The basement rocks are categorized by Rahaman (1976) as migmatite gneiss, quartzite, politic schist, biotite granite, charnockite, granite, gneiss and porphyritic granite. The study area basement complex is of different groups. The first group consists of the migmatite complex, including banded magmatic, auguen gneisses and peg matites with outcrops in Ilesa and Ife Areas. Metasediments consisting of schiests and quartzites, calsilicates, meta conglomerates, amphibiolites and metamorphic iron beds make up the second group. They are found in Iwo and Ikire areas. Other parts of the State are underlain by undifferentiated metamorphic rocks.

4.2.4.7 Geology of Kogi State

The northern segment of the area falls within the southern middle Niger Embayment (Bida Basin) covering places like Lokoja, Obajana and Koton- Karfi. The zone comprises of the Agbaja Ironstone Formation (Jones, 1958), Lokoja Formation and Patti Formation, which are essentially made up of conglomerates, coarse to fine grained feldsparthic, sandstones, siltstones (Gegubeki) clay and oolitic, pisolitic and concretionary ironstone.

The first two layers are interpreted as possibly lateritic topsoil underlain by dry regolith of layers 3 and 4, which lie over wet weathered basement. The geoelectric substratum could possibly be of undifferentiated basement units. Sometimes, the top layer reflects a micaceous fine earthy material that is then underlain by regolith that makes up the geoelectric layers. These layers contain water with downward decreasing saturations and a characteristic clayey nature.

4.2.4.8 Geology of Kwara State

Kwara state is largely underlain by the Pre-Cambrian basement complex rocks hence the characteristic formation of inselberg landscape. This relief system is generally flat and marked by numerous domed-shaped hills and by occasional flat-topped ridges varying in height from 300m to 700-m. The northeastern part of Kwara State is referred to as the Yorubaland Plateau, beyond which the elevations begin to decrease towards the Niger River basin.

4.3 Socioeconomics and Stakeholder Consultation

4.3.1 Socioeconomics and Health Study Approach

These were a modification of focus Group Discussion (FGDs) aimed at involving the local people as part of consultation and community engagement. The groups were made up of village head, clerics, representatives of the youth, and some selected elders of the communities. The objective of the group discussions was to identify community's perception of the proposed project, the problems associated with it, and how such problems may be mitigated. Information from such discussions was used to confirm and cross check the veracity of some of the answers provided in the questionnaires. A well-structured questionnaire was designed, field tested for cultural acceptability, amended and adopted. Interviewers were trained to administer the questionnaire on community members. All comments and contributions from the respondents were noted.

Table 4.5: Administration of Questionnaires

S/no	Community	Questionnaire administered	Questionnaire retrieved
1	Oyo	150	100

2	Osun	150	115
3	Ekiti	150	145
4	Ondo	150	100
5	Lagos	150	80
6	Ogun	150	150
7	Kwara	150	70
8	Kogi	150	95
5	Total	1,200 (100%)	855(71.25%)

A total of One Thousand, Two Hundred (1,200) questionnaires based on 50 questionnaires per a senatorial district were administered as shown in Table 4.200 above and Eight Hundred and Fifty-five (855) were retrieved. (See sample questionnaire at appendix 4.9). The questionnaires were administered based on age, gender, occupation income, access to infrastructure in the project locations. The questionnaires were designed to provide the age, occupation, educational level, waste and sewage disposal method, common ailment of the residents in the past six months. Also, to know the perception of the residents along the optic fibre routes about the proposed project.

4.3.2 Socio-economic Data Analysis and Presentation

In analyzing the primary and secondary data, simple descriptive methods and summary statistics like mean, range, mode and percentage were used. Also, some of the data were presented in tables and graphs. These are national, regional, state, local government area, community, household and individual respondent. Meanwhile, the population of the host communities was projected using result of the 2006 national census released by the National Population Census (NPC).

The linear extrapolation and exponential growth model of population projection method are often used in estimating population. While the linear extrapolation model assumes population growth to occur in constant increment over time, the exponential model assumes rate of population growth as not constant but rather changes with time, growing faster as the population size increases. Put differently, population more often than not grows exponentially rather than linearly. However, the exponential growth model was used in estimating the population of the communities. Thus

Exponential Growth Model: $Pn = Po (1+r)^n$

Where:

Po = population in the base year

R = annual growth rate of the population

N = time lapse in years

4.4 Baseline Environmental Condition

4.4.1 Climate/Meteorology, Ambient Air Quality and Noise of the Study Area

4.4.1.1 Climate/Meteorology

Nigeria is located between latitudes 4 and 11 degrees north. The term "tropical" generally refers to any region falling between the Tropic of Cancer and the Tropic of Capricorn. Therefore, Nigeria's climate is basically tropical. The country enjoys a climate characterised by the hot and wet conditions associated with the movement of the Inter-Tropical Convergence Zone (ITCZ) north and south of the equator. ITCZ is the convergence of two air masses which are the Tropical maritime (Tm) and the Tropical continental (Tc). The former is associated with the moisture-laden south-west winds (south westerlies) which blow from the Atlantic Ocean, while the latter is the dry and dusty north-east winds (easterlies) which blow from the Sahara Desert. When the zone of convergence of the two air masses, is to the south of the equator, the north-east winds prevail over Nigeria, thus producing the dry-season conditions (November – March).

The weather elements that make up climate include rainfall, temperature, humidity, wind, cloud, solar radiation, dust and aerosol. Climate is not static and is often defined as "average weather" together with its variability from the average. Climate fluctuation or variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. The overall changes in temperature, rainfall and other meteorological parameters determine the annual changes in climate over a given region.

The study area which is located in South-western Nigeria. Southwestern Nigeria lies within longitude 2^0 48' - 6^0 0' E and latitude 5^05' - 9^0 12'N. Southwestern Nigeria has two distinct seasons; the dry season, from November to March and the raining season, which is from April to October. Southwestern Nigeria lies within what has been classified as warm humid climate.

Rainfall

The south Western region of Nigeria experiences a double rainfall maxima characterised by two high rainfall peaks, with a short dry season and a longer dry season falling between and after each peak. The first rainy season begins around March and last to the end of July with a peak in June, this rainy season is followed by a short dry break in August known as the August break which is a short dry season lasting for two to three weeks in August. This break is broken by the short rainy season starting around early September and lasting to mid-October with a peak period at the end of September. The ending of the short rainy season in

October is followed by long dry season. This period starts from late October and lasts until early March with peak dry conditions between early December and late February

The annual rainfall received in this region is very high, usually above the 2,000 mm (78.7 in) rainfall totals giving for tropical rainforest climates worldwide.

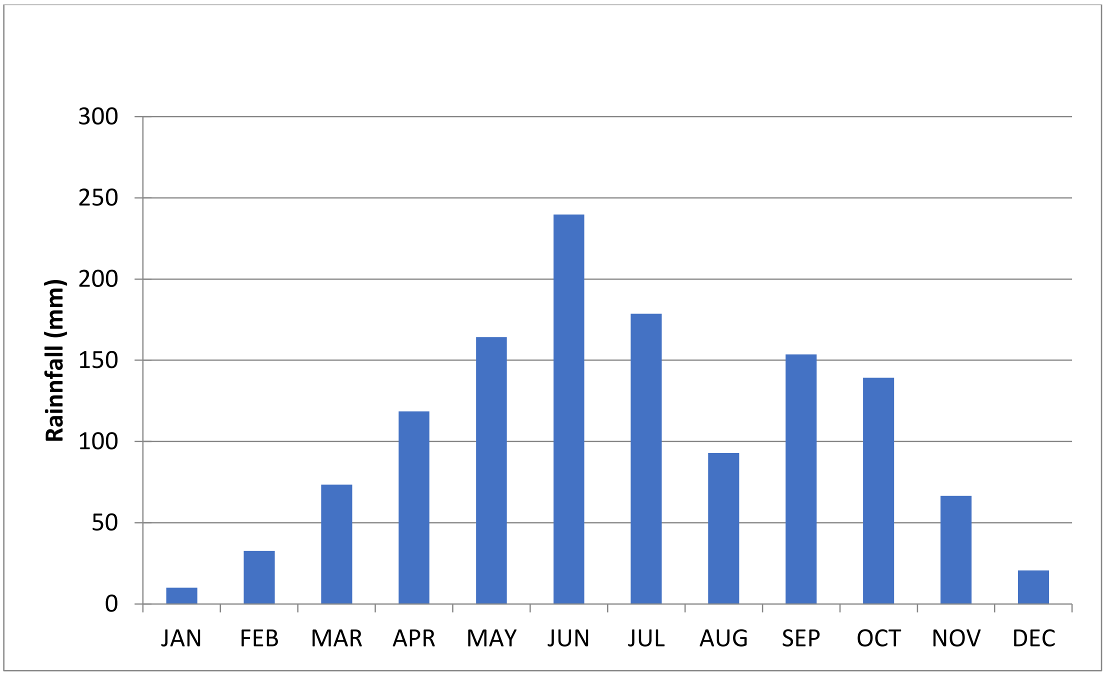


Figure 4.2: Average Rainfall Pattern in Lagos State (1997-2019)
Source: NIMET

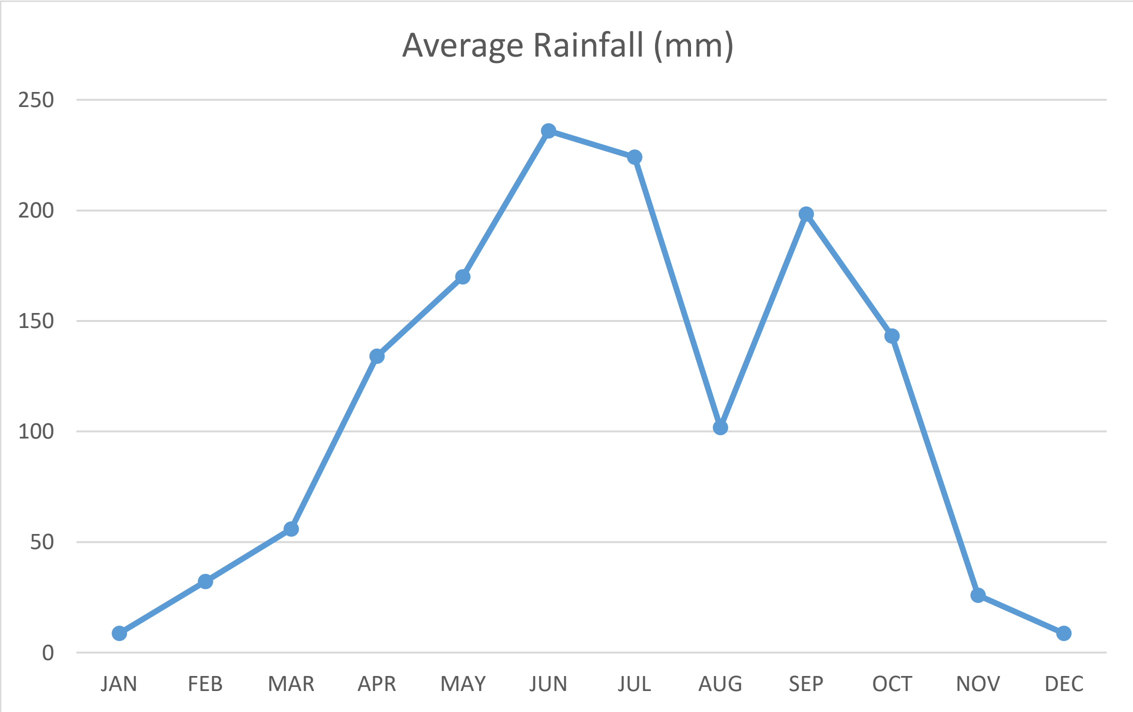


Figure 4.3: Average Rainfall Pattern in Ogun State (1997-2019)
Source: NIMET

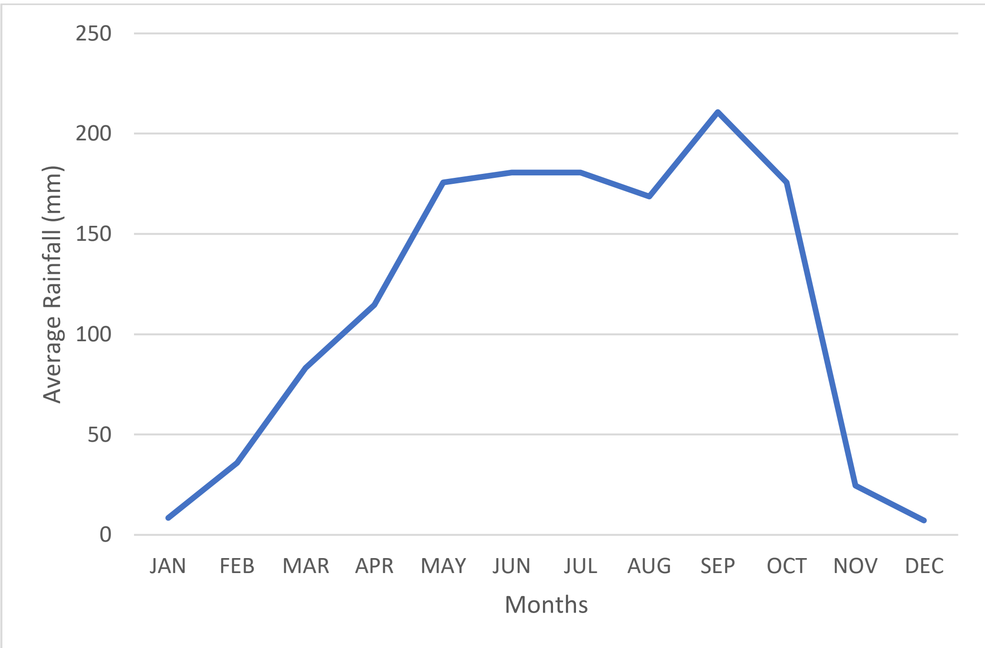


Figure 4.4: Rainfall pattern in Oyo state (1997-2019)
Source: NIMET

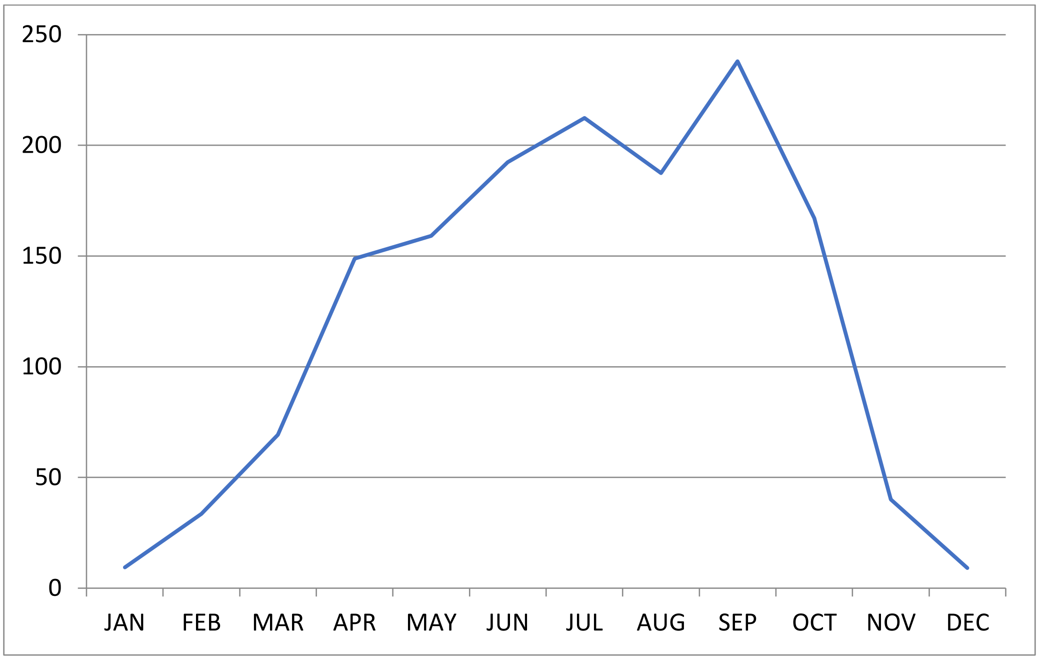


Figure 4.5: Average Rainfall Pattern in Ekiti State (1997-2019)
Source: NIMET

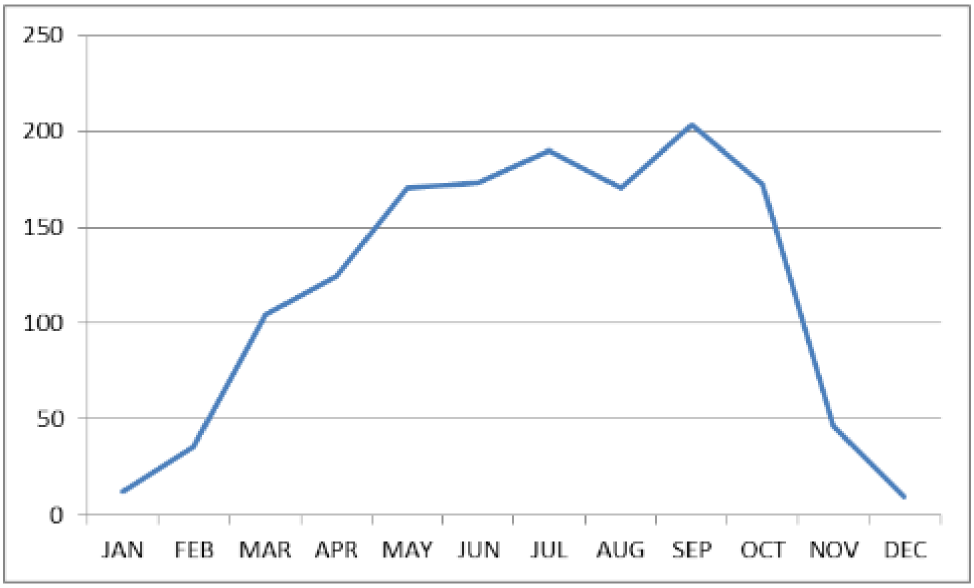


Figure 4.6: Average Rainfall Pattern in Ondo State (1997-2019)
Source: NIMET

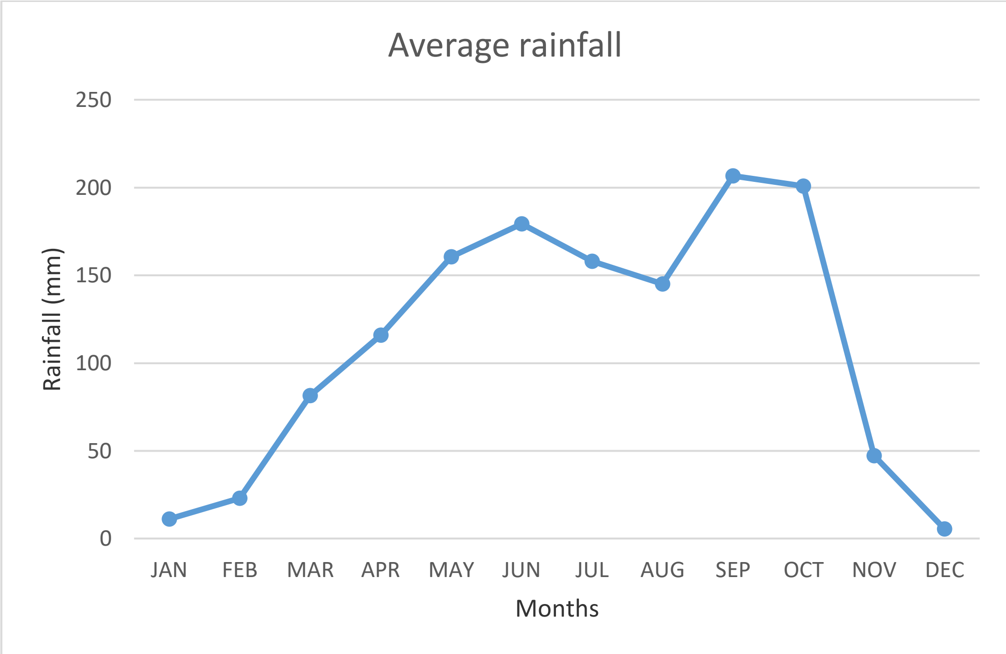


Figure 4.7: Average Rainfall Pattern in Osun State {1997-2019}
Source: NIMET

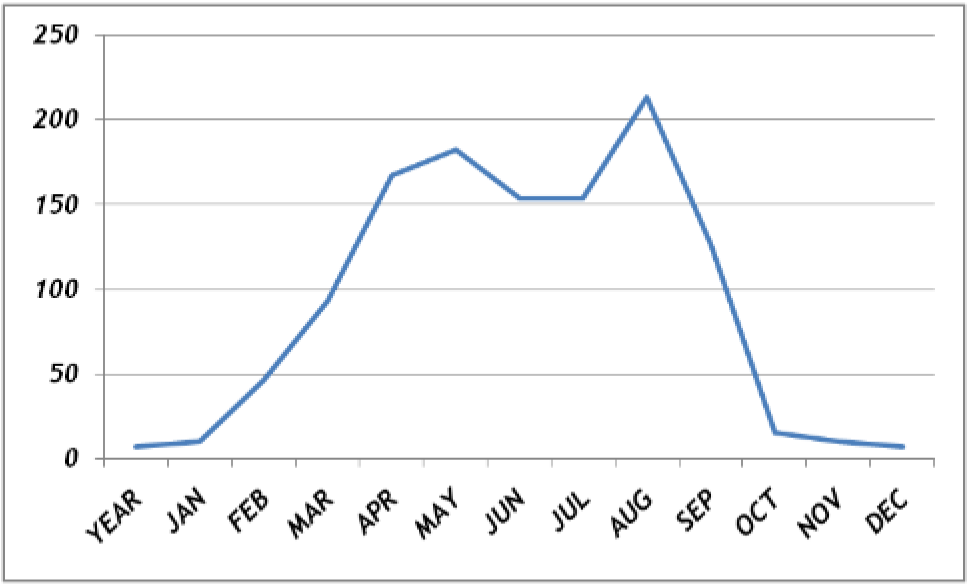


Figure 4.8: Average Rainfall Pattern in Kwara State {1997-2019}
Source: NIMET

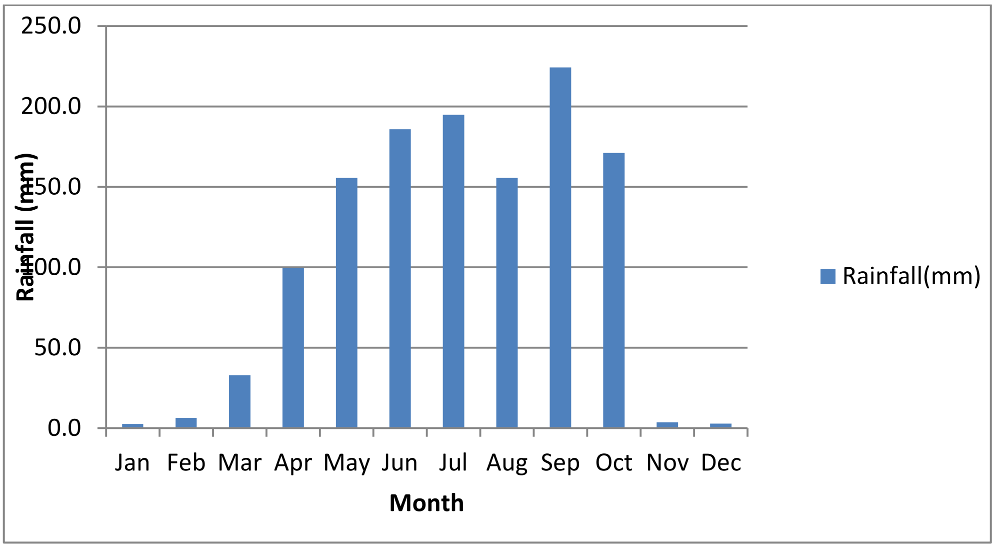


Figure 4.9: Average Rainfall Pattern in Kogi State (1997-2019)
Source: NIMET

Temperature

The temperature of the area is influenced primarily by the apparent movement of the sun, wind direction and speed as well as land configuration. The regional maximum and minimum temperature data obtained from NIMET as given in Figure 4.10 to Figure 4.11

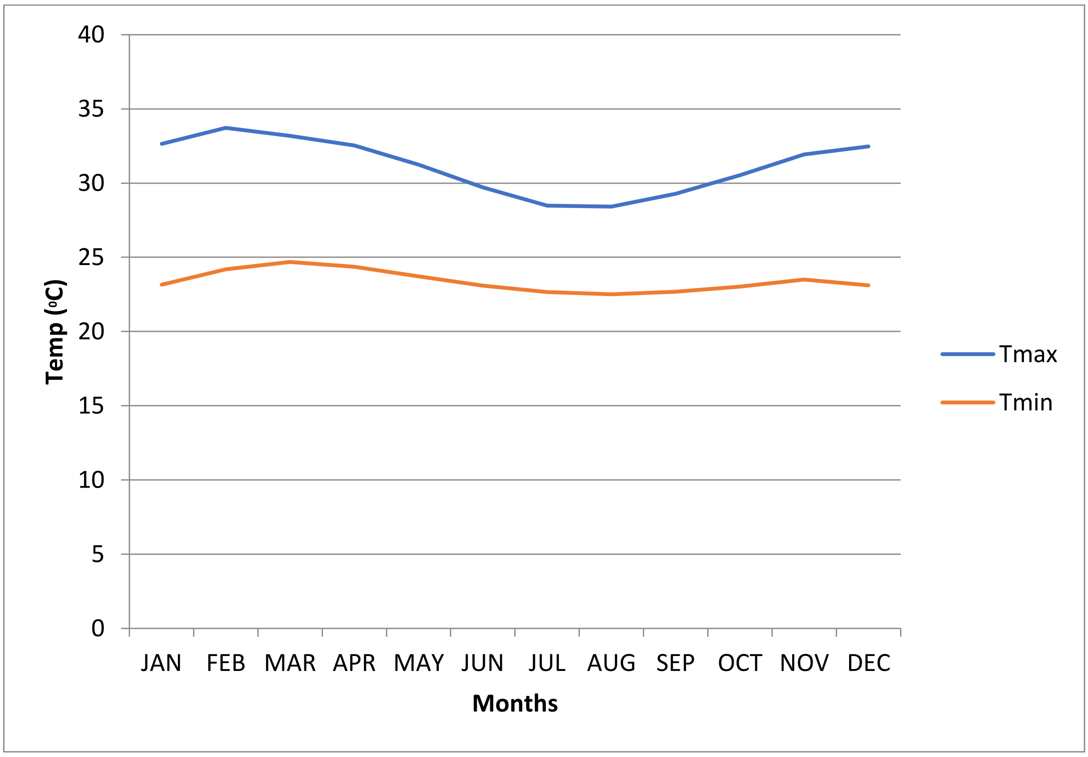


Figure 4.10: Maximum and Minimum temperature of Lagos State for the period of 1997-2019. Source: NIMET, Oshodi

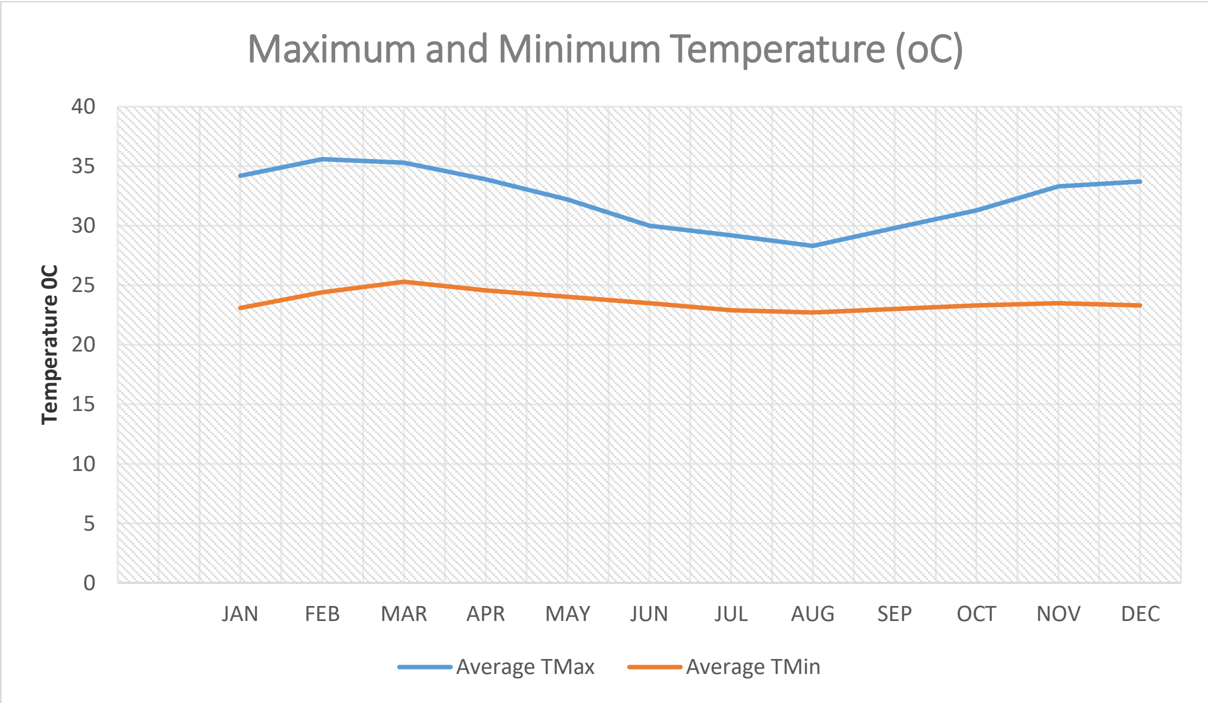


Figure 4.11: Maximum and Minimum temperature of Ogun State for the period of 1997-2019. Source: NIMET, Oshodi

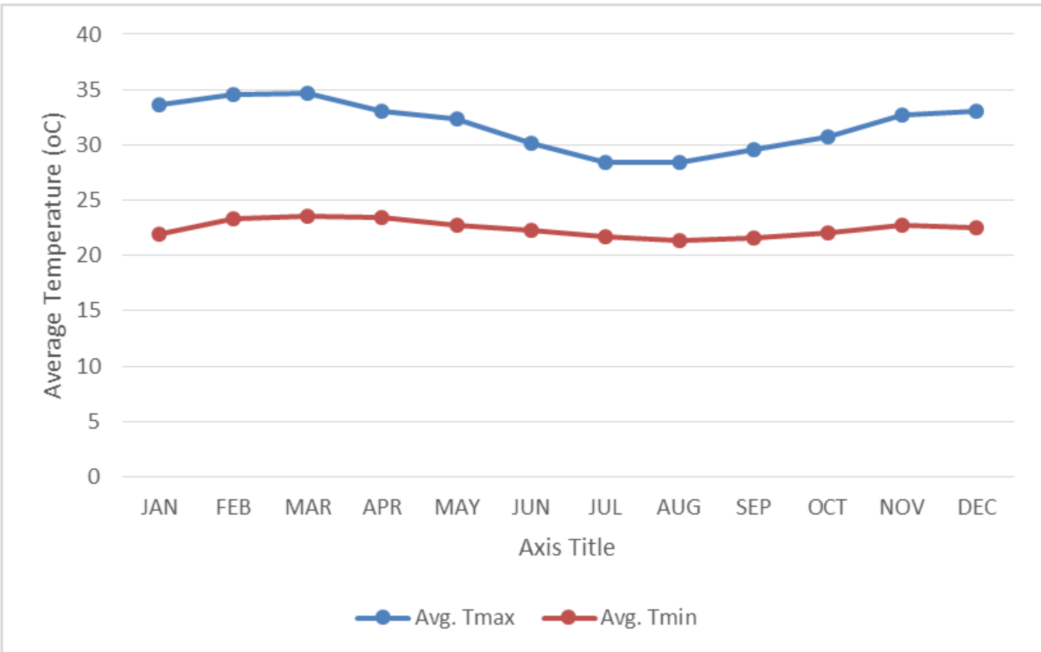


Figure 4.12: Maximum and Minimum temperature of Oyo State for the period of 1997-2019. Source: NIMET, Oshodi

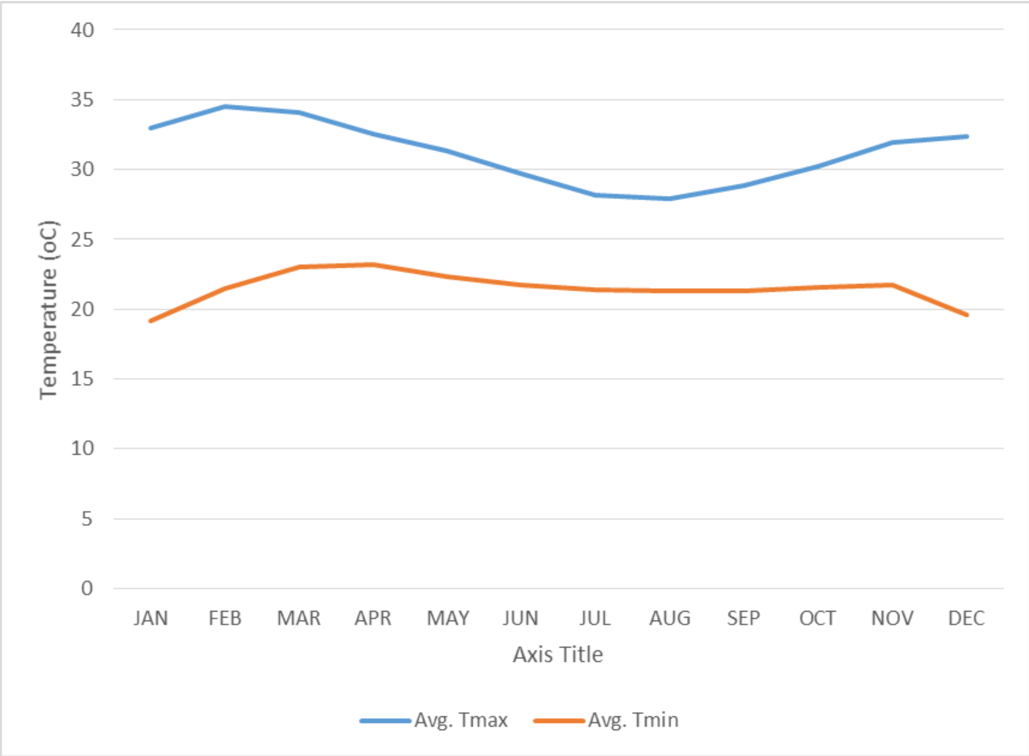


Figure 4.13: Maximum and Minimum temperature of Ekiti State for the period of 1997-2019. Source: NIMET, Oshodi

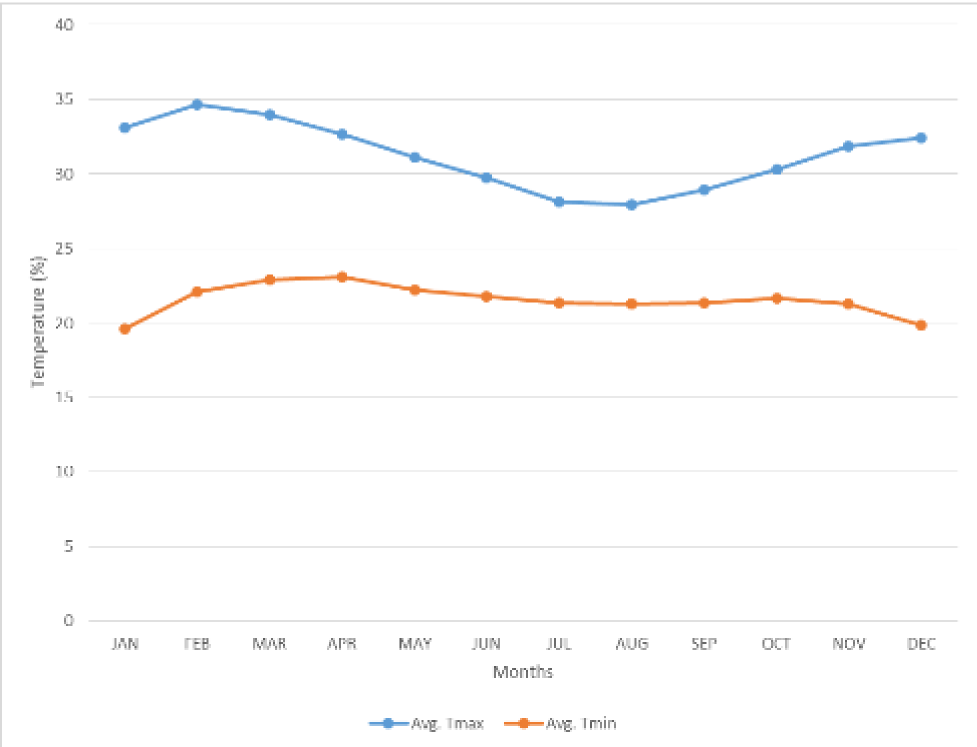


Figure 4.14: Maximum and Minimum temperature of Ondo State for the period of 1997-2019. Source: NIMET, Oshodi

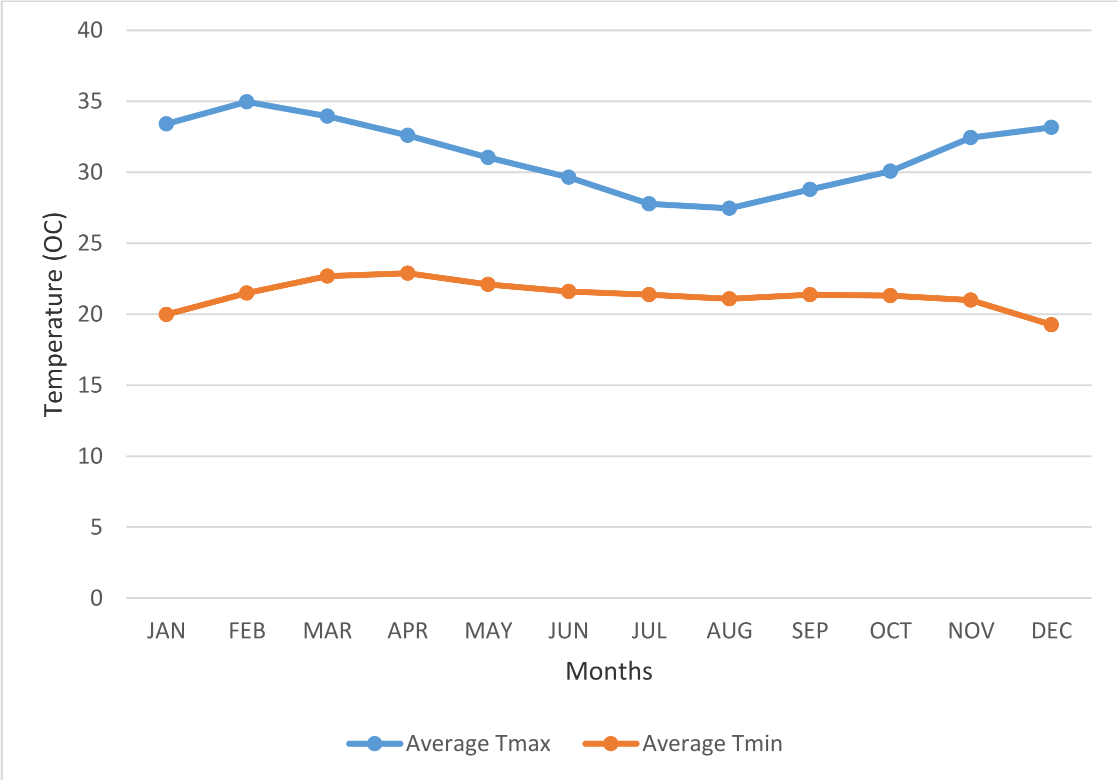


Figure 4.15: Maximum and Minimum temperature of Osun State for the period of 1997-2019. Source: NIMET, Oshodi

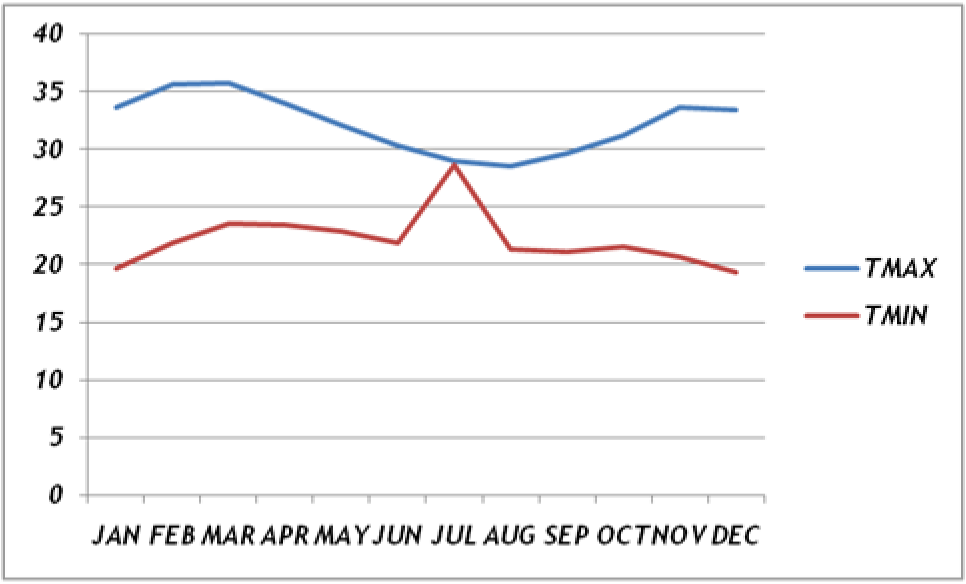


Figure 4.16: Maximum and Minimum temperature of Kwara State for the period of 1997-2019. Source: NIMET, Oshodi

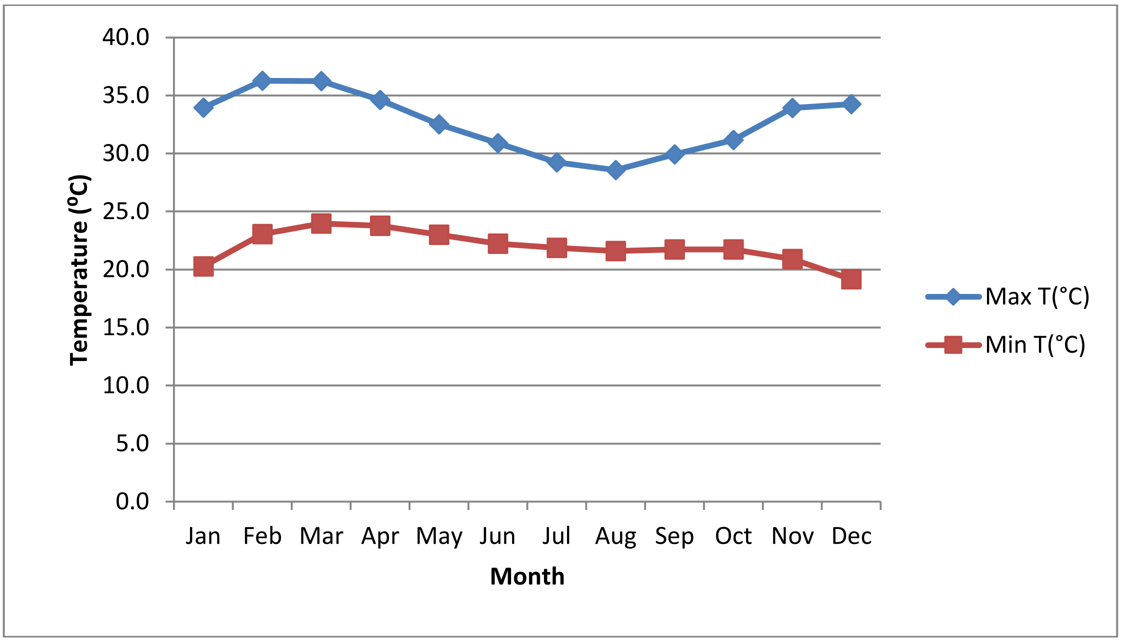


Figure 4.17: Maximum and Minimum temperature of Kogi State for the period of 1997-2019. Source: NIMET, Oshodi

Wind Speed and Direction

The annual mean wind speeds in the study areas ranged from about 2 to 9.5 m/s and the annual power density range between 3.40 and 520 kW/m^2 based on recent reported data. The trend shows that wind speeds are low in the south and gradually increases to relatively high speeds in the north. Generally, the wind in the study areas varies between the gentle breeze, moderate breeze and high breeze.

The proposed project would have no effect on the wind direction. However, wind could aid the distribution of pollutants in the areas. Table 4.2 to Table 4.6 below shows the wind speed and direction in the study States.

Table 4.6: Monthly Wind Data of Lagos State (1997-2019)

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1997	***Speed***	2.4	3.5	3.8	3.6	2.3	2.6	3.9	4	2.7	2.8	1.9	1.6
	Direction	S	S	S	S	S	S	S	SW	S	S	NW	NW
1998	***Speed***	2.2	3.4	4.6	4.2	2.5	3.1	4.2	4.2	3.7	3.4	2.7	3.5
	Direction	N	W	S	S	W	W	W	W	W	W	S	W
1999	***Speed***	4.6	3.6	4.5	4.3	4	3.9	4.7	5.4	3.5	3.9	2.6	3.5
	Direction	W	W	S	S	S	S	W	W	W	W	W	SW
2000	***Speed***	4.2	5.3	6.3	5.9	4.3	5.2	4.2	5.4	5.8	4	3.6	3.8
	Direction	W	S	S	S	S	S	W	W	SW	S	S	SW
2001	***Speed***	4.5	5.5	5.7	5.3	4.9	4.8	5.8	5.5	5.3	4.5	3.9	3.9
	Direction	W	S	S	W	S	W	S	SW	W	SW	S	SW
2002	***Speed***	4.5	5.3	5.4	5.1	4.7	4.6	5.1	5	5.2	4.1	3.7	3.8
	Direction	S	W	W	S	S	S	W	S	SW	S	SW	W
2003	***Speed***	4.4	4.7	5.1	4.8	4.5	4	6.2	5.1	3.9	3.1	3.1	3.1

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Direction	S	S	S	S	S	SW	SW	S	S	S	W	W
2004	***Speed***	4.3	4.9	5	5.2	4.2	3.9	5.1	5.9	5.1	3.8	3.9	3.7
	Direction	S	S	S	S	S	S	S	SW	S	S	NW	NW
2005	***Speed***	4.6	4.3	5.6	5.6	4.1	6.8	6.1	5.2	7.5	5.6	3.5	5.1
	Direction	N	W	S	S	W	W	W	W	W	W	S	W
2006	***Speed***	6.1	4.2	7.8	7.6	6.3	5.9	7.1	7.3	6.3	5.8	5.3	5.8
	Direction	W	W	S	S	S	S	W	W	W	W	W	SW
2007	***Speed***	6.1	7.1	8.7	7.6	6.4	6	7.7	8.7	7.4	5.7	5.8	5.9
	Direction	W	S	S	S	S	S	W	W	SW	S	S	SW
2008	***Speed***	6	8	8.6	7.6	6.5	6.9	8	9.7	2.5	5.9	5.1	5.5
	Direction	W	S	S	W	S	W	S	SW	W	SW	S	SW
2009	***Speed***	6.1	7.1	8.7	7.6	6.4	6	7.7	8.7	7.4	5.7	5.8	5.9
	Direction	N	W	S	S	W	W	W	W	W	W	S	W
2010	***Speed***	6	8	8.6	7.6	6.5	6.9	8	9.7	2.5	5.9	5.1	5.5
	Direction	N	W	S	W	S	S	SW	W	W	SW	S	SW
2011	***Speed***	5.9	8.2	8.5	8.6	7.1	6.5	8.4	10.3	8.2	5.4	5.5	5.1
	Direction	N	S	S	S	SW	SW	SW	SW	SW	S	S	W
2012	***Speed***	7.2	8.7	8.4	9	6.1	5.9	8.7	9.7	8	5.5	4.1	5
	Direction	N	S	S	SW	SW	S	W	W	W	W	W	SW
2013	***Speed***	4.4	8.7	9	9.8	6.8	7.7	9.8	10.5	7.6	5.7	5.9	5
	Direction	SW	SW	W	SW	SW	SW	W	W	SW	W	SW	SW
2014	***Speed***	5.6	6.9	9.3	8.1	6.4	5.9	5.1	6.7	4.8	4.2	3.9	3.8
	Direction	S	S	S	S	S	SW	SW	S	S	S	W	W
2015	***Speed***	5.8	8	8.8	9.1	7.4	5.3	6.5	8.2	6.1	5.1	5.7	5
	Direction	S	S	S	S	S	S	S	SW	S	S	NW	NW
2016	***Speed***	5.5	6.4	7.1	6.7	5.7	6.1	5.9	5.9	5.9	5.8	5.7	4.7
	Direction	N	W	S	S	W	W	W	W	W	W	S	W
2017	***Speed***	5.1	4.8	5.2	5.5	4	0.4	6.1	9.5	4.2	3.1	1.2	5.1
	Direction	SW	S	SW	S	S	S	W	W	SW	SW	SW	S
2018	***Speed***	3.5	3.5	3.1	3.5	2.3	3.4	3.2	2.9	2.7	2.9	2.4	2.9
	Direction	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
2019	***Speed***	2.3	2.6	2.6	2.5	2.3	2.2	3	3.2	2.4	2.2	2.6	3.2
	Direction	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W

Source: NIMET

Table 4.7: Monthly Wind Data of Ogun State (1997-2019)

YEAR	Speed Direction	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1997	Speed	2.5	4	3	3	2.4	2.4	2.4	2.7	2.6	2.3	2.2	2.4
	Direction	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1998	Speed	2.4	2.5	2.4	2.6	2.1	2.2	2.1	2.4	2.2	2.4	2	2.1
	Direction	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
1999	Speed	2.9	2.7	2.8	2.6	2.5	2.7	2.6	2.6	2.1	2.1	2	2
	Direction	SW	SW	SW	SW	SW	W	W	W	W	SW	SW	W
2000	Speed	2.3	2.4	2.4	2.4	2	2.1	2	2	1.6	1.5	1.2	1.2
	Direction	SW	SW	SW	S	SW	SW	W	W	W	SW	SW	SW
2001	Speed	2.1	2	2.3	2.1	1.8	1.9	1.6	2.8	2.3	1.9	1.9	2

YEAR	Speed Direction	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Direction	SW	SW	W	W	SW	W	W	SW	SW	SW	SW	SW
	Speed	2	2.6	2.4	3.3	2.9	1.9	2.3	2	2.7	3.1	2.1	2.5
2002	Direction	NW	W	SW	W	SW	SW	SW	W	W	SW	W	SW
	Speed	3	3.3	3.3	3.3	2.7	2.3	2.4	1.9	1.9	2.8	3	3.4
2003	Direction	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Speed	3.2	3.5	3.7	2.9	3.2	2.9	3.3	3.1	3.3	3.1	3	2.5
2004	Direction	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
	Speed	3.5	3.9	3.9	3.9	3.7	3.4	3.5	3.3	2.7	2.8	3.1	2.6
2005	Direction	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
	Speed	2.8	3.4	3.2	2.9	3	2.9	3	3.3	2.7	2.9	3.1	3.4
2006	Direction	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
	Speed	3.2	3.7	3.8	3.5	3.2	3.2	3	2.9	3	3.1	3.3	3.6
2007	Direction	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	SW
	Speed	3.6	4	4	3.6	3.2	2.9	3.3	3	3.3	2.9	3.2	3.7
2008	Direction	E	SW	SW	SW	SW	SW	SW	SW	SW	SW	W	E
	Speed	1.9	2.7	2.7	0	1.9	1.8	1.9	2	2.1	1.9	2	1.9
2009	Direction	S	SW	SW	SW	SW	S	SW	SW	SW	SW	SW	SW
	Speed	1.9	2.2	2.2	0	2.3	2.2	2.3	1.9	1.9	1.7	1.9	1.9
2010	Direction	S	N	SW	SW	S	SW	SW	SW	SW	SW	S	NE
	Speed	1.8	2.3	2.3	2.2	2.1	1.7	1.6	1.6	1.7	1.6	1.9	1.7
2011	Direction	SW	S	S	S	SW	S	SW	SW	SW	SW	SW	S
	Speed	2.2	2	2.7	2.3	2.3	1.9	2	1.7	2	2.1	2.1	1.8
2012	Direction	SW	SW	SW	SW	SW	SW	S	SW	SW	SW	SW	W
	Speed	1.7	2.4	2.2	2.2	2.2	2	1.8	1.9	1.9	2	2.2	2.1
2013	Direction	S	W	W	S	S	S	W	S	SW	S	SW	W
	Speed	2.4	2.6	2.4	2.4	2.7	2.3	2.1	2.1	2.2	2.1	2.2	2.3
2014	Direction	S	S	S	S	S	SW	SW	S	S	S	W	W
	Speed	2.3	0	0	2.5	2.2	2.3	2.2	2.3	2.3	2.4	2	2.2
2015	Direction	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
	Speed	3.5	3.5	3.1	3.5	2.3	3.4	3.2	2.9	2.7	2.9	2.9	2.9
2016	Direction	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
	Speed	2.3	2.6	2.6	2.5	2.3	2.2	2	2.2	2.4	2.2	2.4	2.2
2017	Direction	E	W	SW	SW	SW	SW	SW	SW	SW	W	W	W
2018	Speed	3.8	3.3	3.3	2.2	2.1	2.7	2.6	2.6	1.7	1.6	2.6	2.7
	Direction	SW	S	S	S	SW	S	SW	SW	SW	SW	SW	S
2019	Speed	3.2	3	2.7	2.3	2.3	2.9	3	2.7	2	2.1	2.4	2.8
	Direction	SW	SW	SW	SW	SW	SW	S	SW	SW	SW	SW	W

Source: NIMET, Oshodi

Table 4.8: Monthly Wind Data of Oyo State (1997-2019)

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	W.S.	6	7.1	8.5	8.3	7.4	6.4	5.3	3.8	3.4	4.2	3.1	3.3
1997	W.D.	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
	W.S.	2.9	3.9	5.2	6	4.8	5.1	5	4.2	4.5	4.3	4.2	4.5
1998	W.D.	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	W.S.	5.2	4.5	3.6	3.6	3.8	3.6	4.2	3.9	3.5	3.2	2.7	3.1
1999	W.D.	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
	W.S.	6.1	4.4	4.4	4.9	4.7	4.3	5.1	5.2	4.3	3.3	3.3	3
2000	W.D.	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	SW
	W.S.	3.6	2.7	4.1	3.3	3.9	3.8	4.7	3.9	3.5	2.8	2.9	3.2
2001	W.D.	E	SW	SW	SW	SW	SW	SW	SW	SW	SW	W	SW
	W.S.	3	3.8	4.1	3.7	3.5	3.9	4.7	3.4	4	3.4	2.7	3.5
2002	W.D.	S	SW	SW	SW	SW	S	SW	SW	SW	SW	SW	SW
	W.S.	3.2	4	3.8	4	4.1	4.1	4	4.1	3.5	2.7	2.2	2.3
2003	W.D.	S	N	SW	SW	S	SW	SW	SW	SW	SW	S	NE
2004	W.S.	3.3	2.6	2.7	3	2.1	2.6	3.7	4.4	2.8	1.9	2.4	2.6
	W.D.	SW	S	S	S	SW	S	SW	SW	SW	SW	SW	S
2005	W.S.	3.1	3.1	3.3	3	1.9	3.5	2.4	3	2.3	1.3	1.2	1.8
	W.D.	SW	SW	SW	SW	SW	W	W	W	W	SW	SW	W
2006	W.S.	2.8	3.4	3.3	4	3.4	3.5	4.2	4.2	4	4.5	3.8	3.6
	W.D.	SW	SW	SW	S	SW	SW	W	W	W	SW	SW	SW
2007	W.S.	3	4.4	3.9	3.5	3	3.3	3.9	4.3	3.6	4.2	2	2.5
	W.D.	SW	SW	W	W	SW	W	W	SW	SW	SW	SW	SW
2008	W.S.	3.6	2.8	3.9	3.7	3.4	4.4	4.7	5.3	4.2	3.5	3.2	3.2
	W.D.	NW	W	SW	W	SW	SW	SW	W	W	SW	W	SW
2009	W.S.	4.4	3.2	4.8	4.4	4.1	3.7	4.9	3.8	3.9	3.3	3.3	2.7
	W.D.	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	W.S.	4	3.9	5	5.1	4.1	4.7	4.9	4.2	5.1	3.4	2.8	3.9
2010	W.D.	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
	W.S.	3.6	4.5	4.7	4.6	3.7	3.8	4.8	3.9	5	3.3	2.8	3.4
2011	W.D.	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
	W.S.	3.8	4.3	4.8	4.3	3.7	3.9	4.4	5.1	4.5	3.7	3.5	3.3
2012	W.D.	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
2013	W.S.	4.1	4.1	4.4	4.5	3.9	3.6	4.8	4	4.1	3.8	3	3.6
	W.D.	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	SW
2014	W.S.	4.4	4.4	4.5	5.5	5	4.5	4.7	5.1	4.4	4.2	4.4	4.5
	W.D.	E	SW	SW	SW	SW	SW	SW	SW	SW	SW	W	W
2015	W.S.	4.5	4.8	5.3	4.8	4.8	4.1	4.6	5.2	4.2	3.6	3.3	4
	W.D.	S	SW	SW	SW	SW	S	SW	SW	SW	SW	SW	SW
2016	W.S.	3.8	4	3.5	3.5	3	3.3	3.9	8.6	6.2	3.5	3	1.9
	W.D.	S	N	SW	SW	S	SW	SW	SW	SW	SW	S	NE
2017	W.S.	3.2	3.5	3.4	3.7	3.4	4.4	4.7	2.3	3.8	0.3	2.1	1.9
	W.D.	SW	S	S	S	SW	S	SW	SW	SW	SW	SW	S
2018	W.S.	3.8	3.4	3.2	2.9	3	3.9	3	3.3	2.7	2.9	2.5	3.0
	W.D.	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
2019	W.S.	3.2	3.7	3.8	3.5	3.2	3.2	3	2.9	3	3.1	2.6	2.8
	W.D.	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	SW

Source: NIMET, Oshodi

Table 4.9: Monthly Wind Data of Ekiti State (1997-2019)

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	S	3.2	1.6	5.9	4.5	2.9	3.7	4	3.3	2.9	2.8	2.1	8.2
1997	D	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	S	2	2.9	3.2	3	2.8	2.9	3.3	1.1	2.5	2.2	2.1	3.6
1998	D	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
	S	2.5	3	3.3	3.4	2.8	2.6	3	4	4.3	3.6	2.7	2.9
1999	D	N	W	S	S	W	W	W	W	W	W	S	W
	S	2.9	3.9	4.1	3.7	3.2	2.8	3.9	4.2	3.9	3.4	4.2	4.2
2000	D	W	W	S	S	S	S	W	W	W	W	W	SW
	S	3.5	4.8	4.8	4	3.3	3.6	3.2	3.4	3.3	3.1	2.9	2.4
2001	D	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	S	2.8	2.8	4.1	3.5	3	3	2.9	2.8	3.3	3.4	3.3	3.5
2002	D	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
	S	3.5	6.8	4.2	3.9	3.3	3.4	3	4	4.3	3.6	2.7	2.9
2003	D	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
	S	3.2	1.6	5.9	4.5	2.9	3.7	3.9	4.2	3.9	3.4	4.2	4.2
2004	D	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
	S	2	2.9	3.2	3	2.8	2.9	3.2	3.4	3.3	3.1	2.9	2.4
2005	D	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	S	2.5	3	3.3	3.4	2.8	2.6	5.9	3.3	4.8	3.2	2.8	4.1
2006	D	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
	S	2.6	3.4	3.6	3.2	3	2.8	2.9	3.7	3.1	2.5	2.4	2.1
2007	D	N	W	S	S	W	W	W	W	W	W	S	W
	S	3.1	2.9	3.3	3.7	3.3	3	3.1	2.7	3.1	2.2	2.5	2.8
2008	D	W	W	S	S	S	S	W	W	W	W	W	SW
	S	2.4	3	3.5	3.4	2.8	3.2	3.1	3.3	3.2	2.8	2.5	2.7
2009	D	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	S	2.9	3.9	4.1	3.7	3.2	2.8	3.9	4.2	3.9	3.4	4.2	4.2
2010	D	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
	S	3.5	4.8	4.8	4	3.3	3.6	3.2	3.4	3.3	3.1	2.9	2.4
2011	D	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
	S	2.8	2.8	4.1	3.5	3	3	2.9	2.8	3.3	3.4	3.3	3.5
2012	D	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
	S	3.5	6.8	4.2	3.9	3.3	3.4	3	4	4.3	3.6	2.7	2.9
2013	D	N	W	S	S	W	W	W	W	W	W	S	W
	S	2.4	3	3.5	3.4	2.8	3.2	3.1	3.3	3.2	2.8	2.5	2.7
2014	D	W	W	S	S	S	S	W	W	W	W	W	SW
	S	3	3.4	3.1	3.1	2.8	3	3.3	3.3	3.2	2.8	2.2	2.7
2015	D	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	S	3.2	1.6	5.9	4.5	2.9	3.7	4	3.3	2.9	2.8	2.1	3.2
2016	D	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
	S	2	2.9	3.2	3	2.8	2.9	3.2	3.4	3.3	3.1	2.9	2.4
2017	D	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
	S	3.2	4	4	3.8	3.5	3.7	3.9	4	4	3.2	2.8	3.7
2018	D	NE	NE	SW	SW	W	SW	W	W	SW	SW	SW	E
	S	4.9	4.9	4.5	4.4	3.7	3	3.5	3.4	3.5	3.5	3.5	3.3
2019	D	W	W	SW	S	S	W	SW	W	W	W	W	NE

Source: NIMET; D=Direction; S= Speed

Table 4.10: Monthly Wind Data of Ondo State (1997-2019)

YEAR	Speed Direction	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1997	Speed	2.5	4	3	3	2.4	2.4	2.4	2.7	2.6	2.3	2.2	2.4
	Direction	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1998	Speed	2.4	2.5	2.4	2.6	2.1	2.2	2.1	2.4	2.2	2.4	2	2.1
	Direction	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
1999	Speed	2.9	2.7	2.8	2.6	2.5	2.7	2.6	2.6	2.1	2.1	2	2
	Direction	SW	SW	SW	SW	SW	W	W	W	W	SW	SW	W
2000	Speed	2.3	2.4	2.4	2.4	2	2.1	2	2	1.6	1.5	1.2	1.2
	Direction	SW	SW	SW	S	SW	SW	W	W	W	SW	SW	SW
2001	Speed	2.1	2	2.3	2.1	1.8	1.9	1.6	2.8	2.3	1.9	1.9	2
	Direction	SW	SW	W	W	SW	W	W	SW	SW	SW	SW	SW
2002	Speed	2	2.6	2.4	3.3	2.9	1.9	2.3	2	2.7	3.1	2.1	2.5
	Direction	NW	W	SW	W	SW	SW	SW	W	W	SW	W	SW
2003	Speed	3	3.3	3.3	3.3	2.7	2.3	2.4	1.9	1.9	2.8	3	3.4
	Direction	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
2004	Speed	3.2	3.5	3.7	2.9	3.2	2.9	3.3	3.1	3.3	3.1	3	2.5
	Direction	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
2005	Speed	3.5	3.9	3.9	3.9	3.7	3.4	3.5	3.3	2.7	2.8	3.1	2.6
	Direction	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
2006	Speed	2.8	3.4	3.2	2.9	3	2.9	3	3.3	2.7	2.9	3.1	3.4
	Direction	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
2007	Speed	3.2	3.7	3.8	3.5	3.2	3.2	3	2.9	3	3.1	3.3	3.6
	Direction	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	SW
2008	Speed	3.6	4	4	3.6	3.2	2.9	3.3	3	3.3	2.9	3.2	3.7
	Direction	E	SW	SW	SW	SW	SW	SW	SW	SW	SW	W	E
2009	Speed	1.9	2.7	2.7	0	1.9	1.8	1.9	2	2.1	1.9	2	1.9
	Direction	S	SW	SW	SW	SW	S	SW	SW	SW	SW	SW	SW
2010	Speed	1.9	2.2	2.2	0	2.3	2.2	2.3	1.9	1.9	1.7	1.9	1.9
	Direction	S	N	SW	SW	S	SW	SW	SW	SW	SW	S	NE
2011	Speed	1.8	2.3	2.3	2.2	2.1	1.7	1.6	1.6	1.7	1.6	1.9	1.7
	Direction	SW	S	S	S	SW	S	SW	SW	SW	SW	SW	S
2012	Speed	2.2	2	2.7	2.3	2.3	1.9	2	1.7	2	2.1	2.1	1.8
	Direction	SW	SW	SW	SW	SW	SW	S	SW	SW	SW	SW	W
2013	Speed	1.7	2.4	2.2	2.2	2.2	2	1.8	1.9	1.9	2	2.2	2.1
	Direction	S	W	W	S	S	S	W	S	SW	S	SW	W
2014	Speed	2.4	2.6	2.4	2.4	2.7	2.3	2.1	2.1	2.2	2.1	2.2	2.3
	Direction	S	S	S	S	S	SW	SW	S	S	S	W	W
2015	Speed	2.3	0	0	2.5	2.2	2.3	2.2	2.3	2.3	2.4	2	2.2
	Direction	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
2016	Speed	3.5	3.5	3.1	3.5	2.3	3.4	3.2	2.9	2.7	2.9	2.9	2.9
	Direction	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
2017	Speed	2.3	2.6	2.6	2.5	2.3	2.2	2	2.2	2.4	2.2	2.4	2.2
	Direction	E	W	SW	SW	SW	SW	SW	SW	SW	W	W	
2018	Speed	1.9	2.3	2.3	2.2	2.6	3.2	3.6	3.8	4.1	3.4	0.2	3.4
	Direction	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	SW
2019	Speed	3.2	2.7	3.8	3.1	2.7	2.7	2.9	3.0	0.0	3.4	2.8	3.4
	Direction	E	SW	SW	SW	SW	SW	SW	SW	SW	SW	W	W

Source: NIMET, Oshodi

Table 4.11: Monthly Wind Data of Osun State (1997-2019)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1997	3	3.5	4.5	4.6	3.2	3.4	4.2	3.5	3.2	2.9	2.2	2.5
	N	W	S	S	W	W	W	W	W	W	S	W
1998	3.4	3.4	3.7	4.8	3.8	3.3	4.5	4.8	3.4	2.6	2.3	2.4
	W	W	S	S	S	S	W	W	W	W	W	SW
1999	3.5	3.6	4.8	4.1	4	2.9	4.4	4.3	3.1	2.6	1.8	2.2
	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
2000	2.9	3.5	3.9	4.7	4	3	3.4	2.8	3	2.1	1.4	2
	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
2001	1.6	2.6	4.5	4.5	3.3	2.2	2.8	2.5	1.9	1.5	2.3	2.4
	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
2002	2.3	2.2	2.9	2.3	1.8	4.9	2.5	2.3	1.7	1.4	0.8	1.2
	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
2003	0.9	1.3	2.2	1.9	1.4	4.7	3.3	2.9	1.9	1.7	0.9	1.9
	N	W	S	S	W	W	W	W	W	W	S	W
2004	1.9	3.5	5.1	4.1	3.4	3.1	3	5.2	2.9	1.9	1.3	1.3
	W	W	S	S	S	S	W	W	W	W	W	SW
2005	2.7	2.4	5	4.1	4.7	4.3	4.3	3.9	2.8	1.6	1.8	1.9
	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
2006	4.4	5	5.6	5.2	4.2	4.1	4.2	4.6	3.4	2.4	2.9	2.6
	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
2007	0.5	1.6	2.6	1.8	2.8	2.8	2.7	2.3	1.3	1.6	1.7	1.8
	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
2008	1.9	3.5	3.1	3.4	2.6	3.2	4.5	4.1	3.4	2.8	1.6	1.8
	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
2009	1.9	3.2	3.1	2.9	3.3	2.8	2.6	2.8	1.8	2	0.7	1.3
	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	SW
2010	1.2	2.3	2.7	2.9	1.9	2	3.6	3.8	2.6	1.3	1	0.6
	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
2011	1.6	2.6	4.5	4.5	3.3	2.2	2.8	2.5	1.9	1.5	2.3	2.4
	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
2012	2.3	2.2	2.9	2.3	1.8	4.9	2.5	2.3	1.7	1.4	0.8	1.2
	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
2013	4.1	3.3	4.4	4.1	3.3	2.6	3.5	3.2	2.1	2.4	2.9	1.6
	NE	E	W	SW	SW	SW	SW	SW	SW	SW	W	W
2014	3.3	4.7	4.8	5.3	3.9	3.9	3.9	5.3	4.5	2.5	1.9	3.1
	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	SW
2015	2.5	3.1	4.3	4.2	3.5	3.1	4.5	4.1	3.2	2.8	2.3	2.5
	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
2016	2.9	4.1	4.8	5	4.3	3.8	4.6	4.4	3.7	2.9	2.5	2.3
	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
2017	3.3	3.2	3.2	3.3	3.3	2.5	2.9	2.6	2.8	2.8	2.9	3.2

	SW	SW	SW	SW	SW	W	W	W	W	SW	SW	W
2018	3.3	3.4	3.2	3.1	3.1	3.4	3.0	3.9	3.3	3.3	2.8	3.2
	SW	SW	SW	S	SW	SW	W	W	W	SW	SW	SW
2019	2.8	3.0	3.4	3.2	3.3	3.3	3.9	3.7	2.9	3.2	3.3	3.0
	SW	W	W	SW	W	W	W	SW	SW	SW	W	SW

Source: NIMET, Oshodi

Table 4.12: Monthly Wind Data of Kwara State (1997-2019)

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Speed	4.3	5.1	6.7	7.7	8.6	6.3	7	7.4	6.8	5.5	5.5	4.2
1997	**Direction**	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	S
	Speed	5	4.9	7.3	8.1	7.7	7.2	6.4	7.1	5.9	4.5	4.6	5.1
1998	**Direction**	SW	SW	SW	SW	SW	W	W	W	W	SW	SW	W
	Speed	4.2	5.5	5.8	7.7	7	6	6.5	7.2	4.8	5.2	4.8	5.1
1999	**Direction**	SW	SW	SW	S	SW	SW	W	W	W	SW	SW	W
	Speed	3.6	6.2	6.2	6.5	4.5	5.2	5.6	5.7	4.1	4.2	3	1.3
2000	**Direction**	SW	SW	SW	S	SW	SW	W	W	W	SW	SW	W
	Speed	3.8	3.3	6.2	6.2	5	6	6.1	6.5	2.9	3.6	2.7	2.3
201	**Direction**	SW	SW	W	W	SW	W	W	SW	SW	SW	SW	S
	Speed	3.2	4.4	6	6.8	6.1	4.8	4.9	5.5	3.3	3.8	3.5	2.7
2002	**Direction**	NW	W	SW	W	SW	SW	SW	W	W	SW	W	S
	Speed	2.3	2.5	5.7	5.1	4.4	5.5	5.7	6.4	4.5	3.1	2.7	3.5
2003	**Direction**	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	W
	Speed	2.4	2.9	6.5	5.9	4.6	4.9	6.7	6.6	5.5	4.5	3.9	3.4
2004	**Direction**	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	W
	Speed	3.8	4.8	5.4	6.5	6.2	6	6.8	7	5.6	4.8	5.1	3.5
2005	**Direction**	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
2006	**Speed**	4	6.2	6	5.7	4.4	4	4.1	3.8	4	3.3	3.2	3.7
	Direction	NW	NW	SW	SW	SW	SW	W	W	W	W	S	NW
2007	**Speed**	3.7	4.3	5.6	4.5	4.5	4	3.8	3.4	4	3.9	3.6	3.4
	Direction	NW	N	SW	SW	W	W	W	W	W	S	S	NW
2008	**Speed**	1.7	1.1	3.3	4.2	3.9	2.2	2.1	2.1	2	2	1.5	1.2
	Direction	SW	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
2009	**Speed**	1.6	1.9	2.6	5.3	2.8	1.9	2.2	2.3	1.8	1.7	1.5	1
	Direction	NW	NW	SW	SW	SW	SW	W	W	W	W	S	NW
2010	**Speed**	1.7	2.9	5	4.6	2.7	1.9	2.2	1.9	1.5	1.6	1.8	1.2
	Direction	NW	N	SW	SW	W	W	W	W	W	S	S	NW
2011	**Speed**	1.7	1.6	2.5	4.2	3.2	2.4	2	2	1.6	1.8	1.8	1.5
	Direction	S	S	S	S	S	S	S	S	W	W	S	S
2012	**Speed**	1.9	2.6	4.7	2.8	3.2	2.6	2.7	3.2	2.4	4.7	2.9	3.2
	Direction	W	W	SW	S	S	W	W	W	W	W	S	NW
2013	**Speed**	6.8	6.4	6.9	5.8	4.7	4.6	5.0	4.7	3.8	3.1	4.7	5.9
	Direction	W	W	S	S	S	S	W	W	W	W	W	SW
2014	**Speed**	6.0	7.5	7.5	5.6	5.9	5.2	4.2	4.6	3.7	2.7	4.1	4.8
	Direction	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
2015	**Speed**	6.6	5.5	5.5	6.3	5.5	5.2	4.8	4.2	3.8	2.3	5.5	6.2
	Direction	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW
2017	**Speed**	2.8	3.4	3.2	2.9	3.0	2.9	3.0	3.3	2.7	2.9	3.1	3.4
	Direction	W	W	SW	SW	SW	SW	SW	SW	SW	SW	W	S
2018	**Speed**	5.9	10.0	7.2	5.4	4.2	4.4	4.8	3.8	3.1	3.4	2.8	3.8
	Direction	W	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW

2019	**Speed**	6.8	7.4	7.2	4.4	5.1	4.4	4.1	4.0	3.2	2.8	4.4	5.6
	Direction	SW	S	SW	S	SW	SW	SW	SW	W	S	SW	SW

Source: NiMet

Table 4.13: Monthly Wind Data of Kogi State (1997-2019)

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1997	**Speed**	0.9	0.9	1.7	3.1	1.3	1.2	1.1	1	0.9	0.8	0.6	1.0
	Direction	NE	NE	NE	SE	SE	SE	SE	SE	SE	SE	SE	NE
1998	**Speed**	2.6	3.2	2.7	3.6	2.5	2.5	1.6	1	1.0	1.0	1.1	1.1
	Direction	NE	NE	NE	SE	SE	SE	S	S	S	S	NE	NE
1999	**Speed**	2.5	2.3	3	5.1	5.5	4.5	3.5	5.4	4.8	4.5	5.1	5.4
	Direction	E	E	NE	SW	SW	SW	SW	SW	SW	E	E	NE
2000	**Speed**	3.2	8.3	7.9	6.3	5.6	5.8	5.3	4.9	5.8	4.5	5.2	6.1
	Direction	E	E	E	NE	SW	SW	SW	W	W	SW	E	NE
2001	**Speed**	5.7	8	7.9	8.6	8.3	8	7.9	6.6	5.7	5.5	5.9	5.5
	Direction	E	NE	E	SW	SW	SW	SW	SW	SW	SW	E	E
2002	**Speed**	6.8	5.6	6.8	7	6.9	7.9	7.6	6.4	4.4	4.9	5.2	5.5
	Direction	E	E	NE	SW	SW	SW	SW	SW	SW	W	NE	NE
2003	**Speed**	3.8	5.4	6.3	5	6.4	7.3	7.2	6.1	5.1	4.7	5.5	5.6
	Direction	E	E	W	SW	SW	SW	W	W	SW	E	E	E
2004	**Speed**	2.9	2.8	1.5	4.7	2.6	2.1	2.0	2.9	1.6	1.2	1.1	2.2
	Direction	E	E	E	E	W	W	W	W	W	W	E	E
2005	**Speed**	4.2	4.8	3.5	3.5	3.4	4.4	3.3	4	4.2	3.8	2.6	3.2
	Direction	NE	SW	SW	SW	S	SW	W	SW	SW	SW	W	W
2006	**Speed**	4.2	4.5	4.6	5.1	4.5	4.4	4.2	4.3	4.1	3.3	2.7	3.3
	Direction	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	NE
2007	**Speed**	4.2	4.2	5.2	5.1	3.8	4.5	4.6	4.4	3.7	3.6	3	2.9
	Direction	SW	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	W
2008	**Speed**	3	3.9	4.6	4.4	3.7	3.6	3.8	3.2	3.7	3.1	3.2	3
	Direction	NE	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	E
2009	**Speed**	3.2	4	4	3.8	3.5	3.7	3.9	4	4	3.2	2.8	3.7
	Direction	NE	NE	SW	SW	W	SW	W	W	SW	SW	SW	E
2010	**Speed**	4.9	4.9	4.5	4.4	3.7	3	3.5	3.4	3.5	3.5	3.5	3.3
	Direction	W	W	SW	S	S	W	SW	W	W	W	W	NE
2011	**Speed**	5.2	4.4	5.3	4.9	4.4	4	3.7	3.5	3.3	3.4	3.4	3.1
	Direction	W	NE	W	SW	SW	S	SW	SW	SW	SW	SW	E
2012	**Speed**	2.5	2.3	3	5.1	5.5	4.5	3.5	5.4	4.8	4.5	5.1	5.4
	Direction	E	E	NE	SW	SW	SW	SW	SW	SW	E	E	NE
2013	**Speed**	3.2	8.3	7.9	6.3	5.6	5.8	5.3	4.9	5.8	4.5	5.2	6.1
	Direction	E	E	E	NE	SW	SW	SW	W	W	SW	E	NE
2014	**Speed**	5.7	8	7.9	8.6	8.3	8	7.9	6.6	5.7	5.5	5.9	5.5
	Direction	E	NE	E	SW	SW	SW	SW	SW	SW	SW	E	E
2015	**Speed**	6.8	5.6	6.8	7	6.9	7.9	7.6	6.4	4.4	4.9	5.2	5.5
	Direction	E	E	NE	SW	SW	SW	SW	SW	SW	W	NE	NE
2017	**Speed**	3.8	5.4	6.3	5	6.4	7.3	7.2	6.1	5.1	4.7	5.5	5.6
	Direction	E	E	W	SW	SW	SW	W	W	SW	E	E	E

2018	**Speed**	2.9	2.8	1.5	4.7	2.6	2.1	2.0	2.9	1.6	1.2	1.1	2.2
	Direction	E	E	E	E	W	W	W	W	W	W	E	E
2019	**Speed**	1.7	2.8	1.6	4.1	2.7	1.0	2.0	2.1	1.1	1.3	0.7	0.9
	Direction	E	E	E	W	W	W	W	W	W	E	E	E

Source: NiMet

Relative humidity

The regional Relative Humidity data of the study areas are presented in Figure 4.31 to Figure 4.45 and it shows the pattern of variation at various periods of the year. Relative humidity is highest at the peak of rainy season and lowest at peak of dry season. It could be as high as 80% between night and morning during wet season and as low as 18% at mid-day during dry season. Generally, the drier months between December and February have lower values.

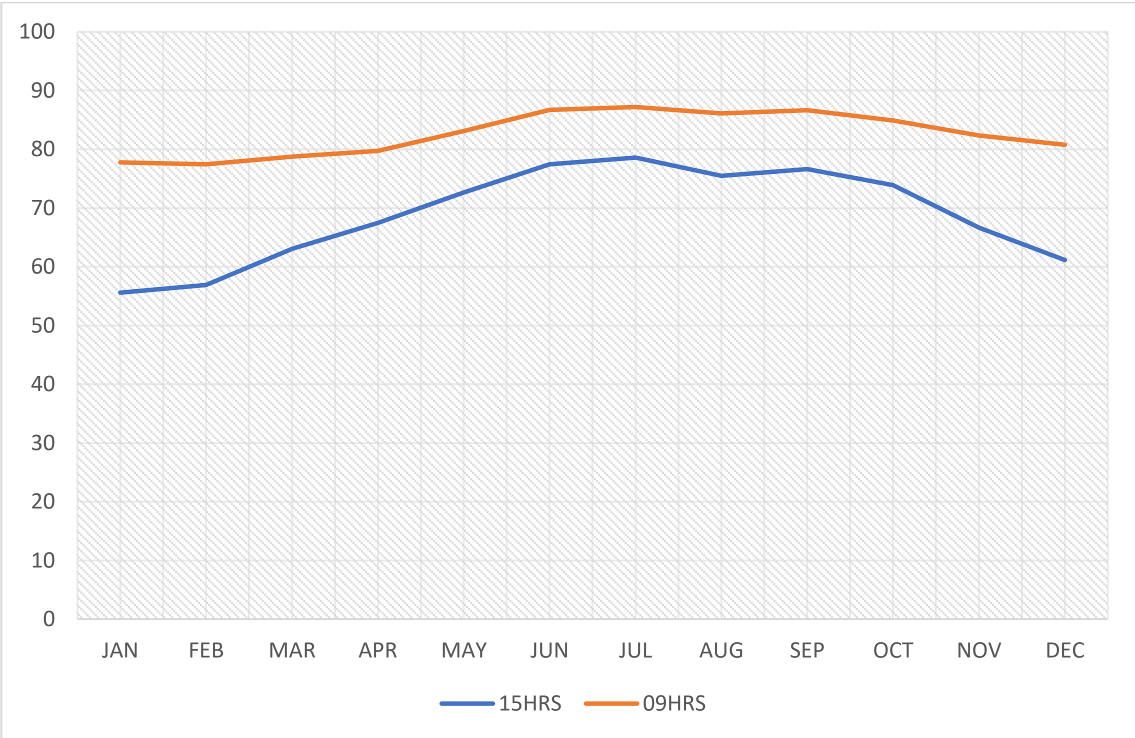


Figure 4.18: Average Monthly Relative Humidity of Lagos State (1997-2019) (Source: NIMET)

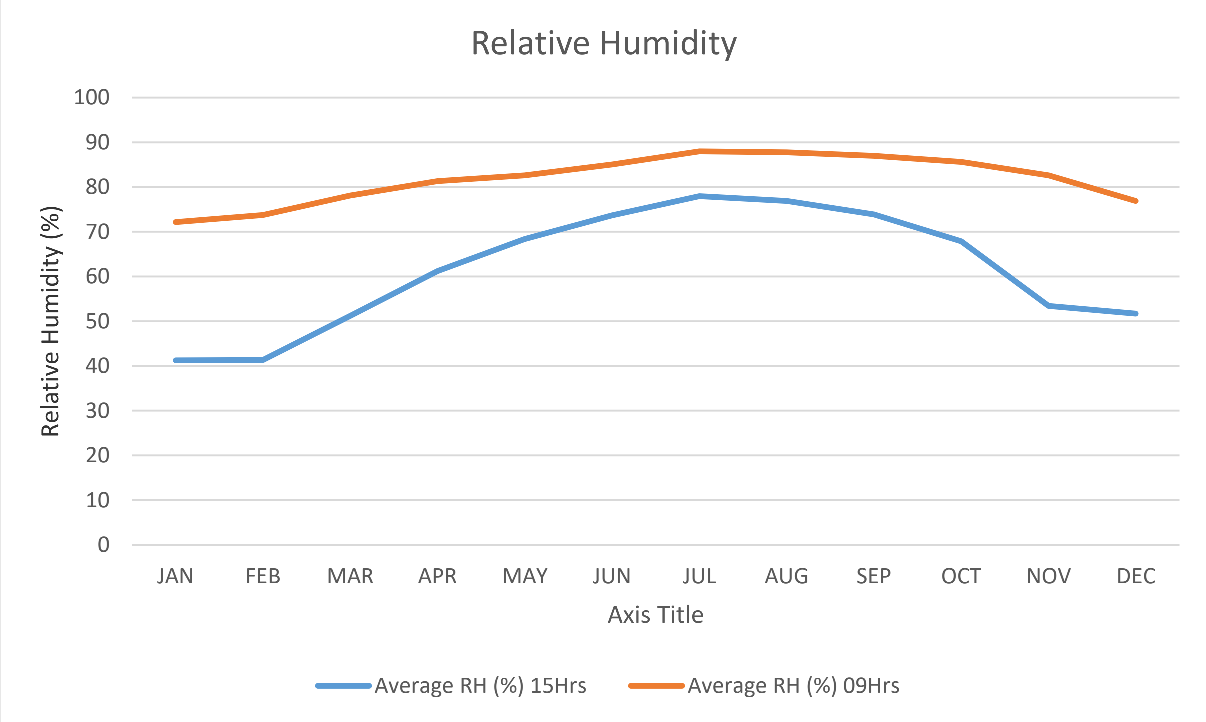


Figure 4.19: Average Monthly Relative Humidity of Ogun State (1997-2019) (Source: NIMET)

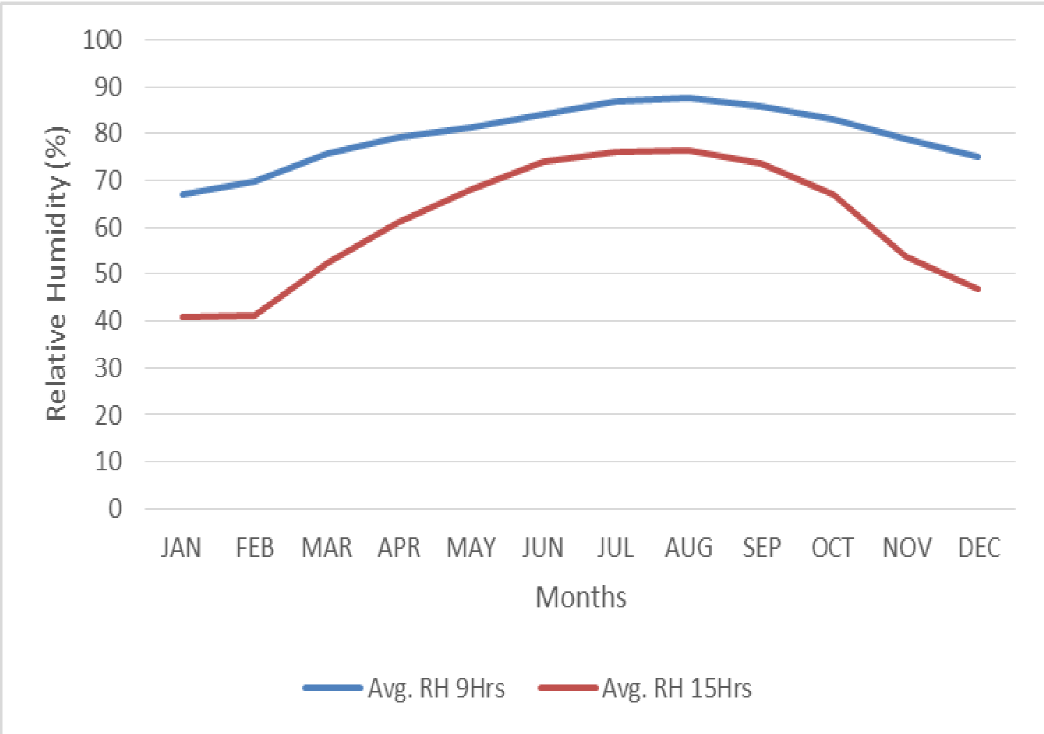


Figure 4.20: Average Monthly Relative Humidity of Oyo State (1997-2019) (Source: NIMET)

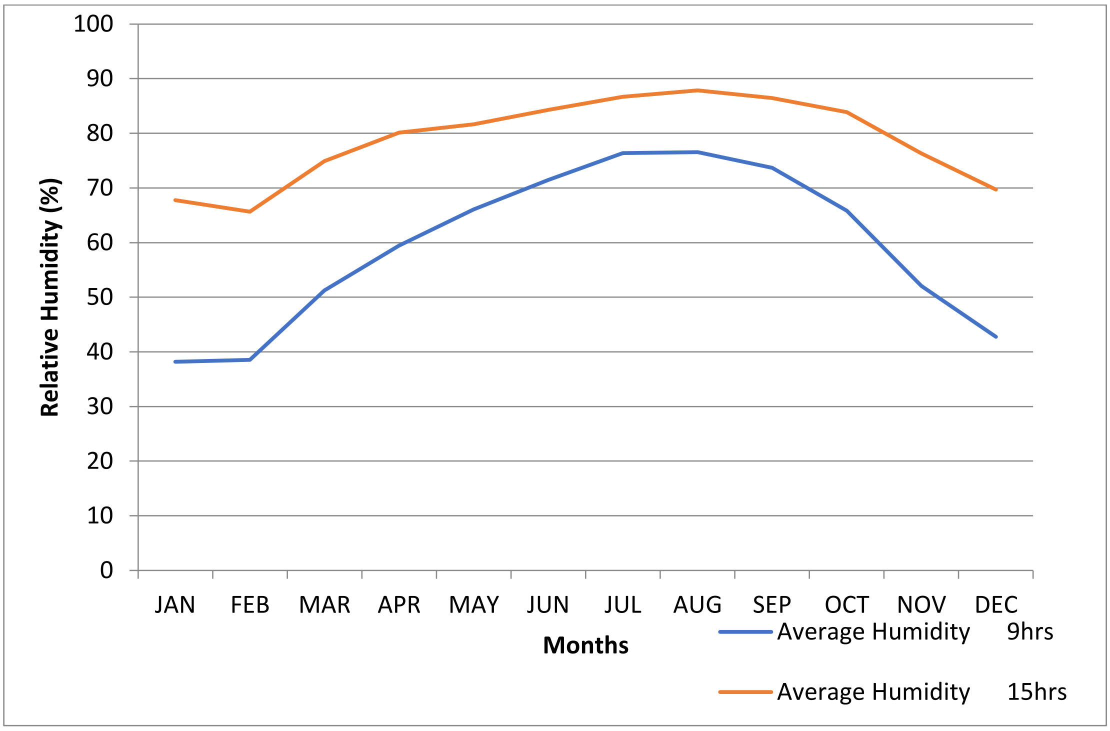


Figure 4.21: Average Monthly Relative Humidity of Ekiti State (1997-2019) (Source: NIMET)

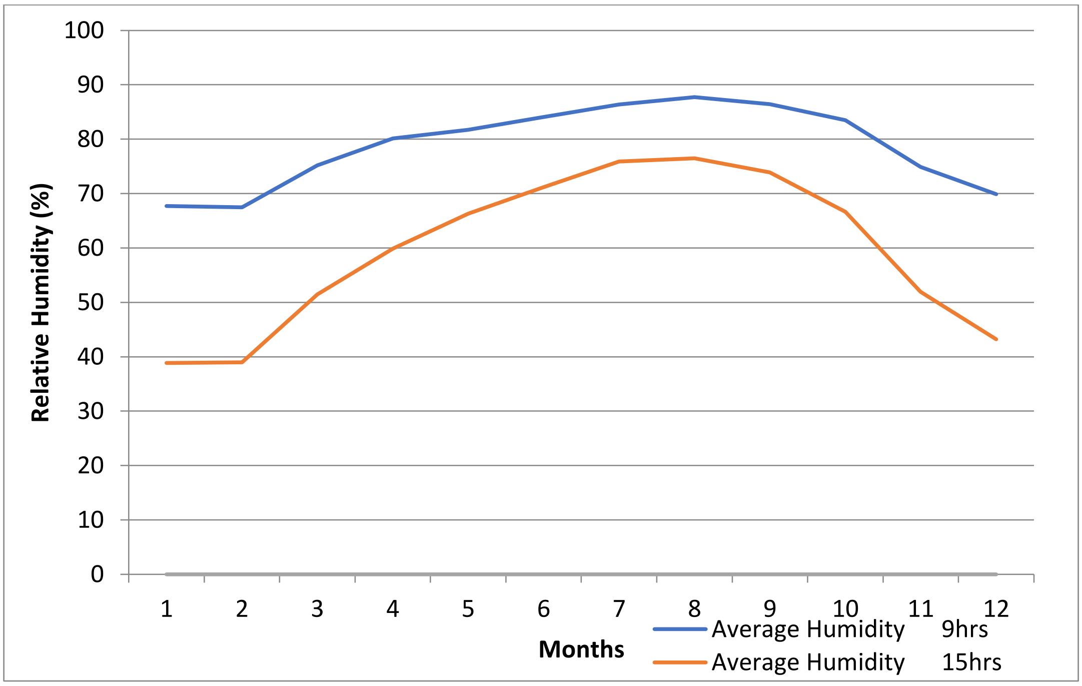


Figure 4.22: Average Monthly Relative Humidity of Ondo State (1997-2019) (Source: NIMET)

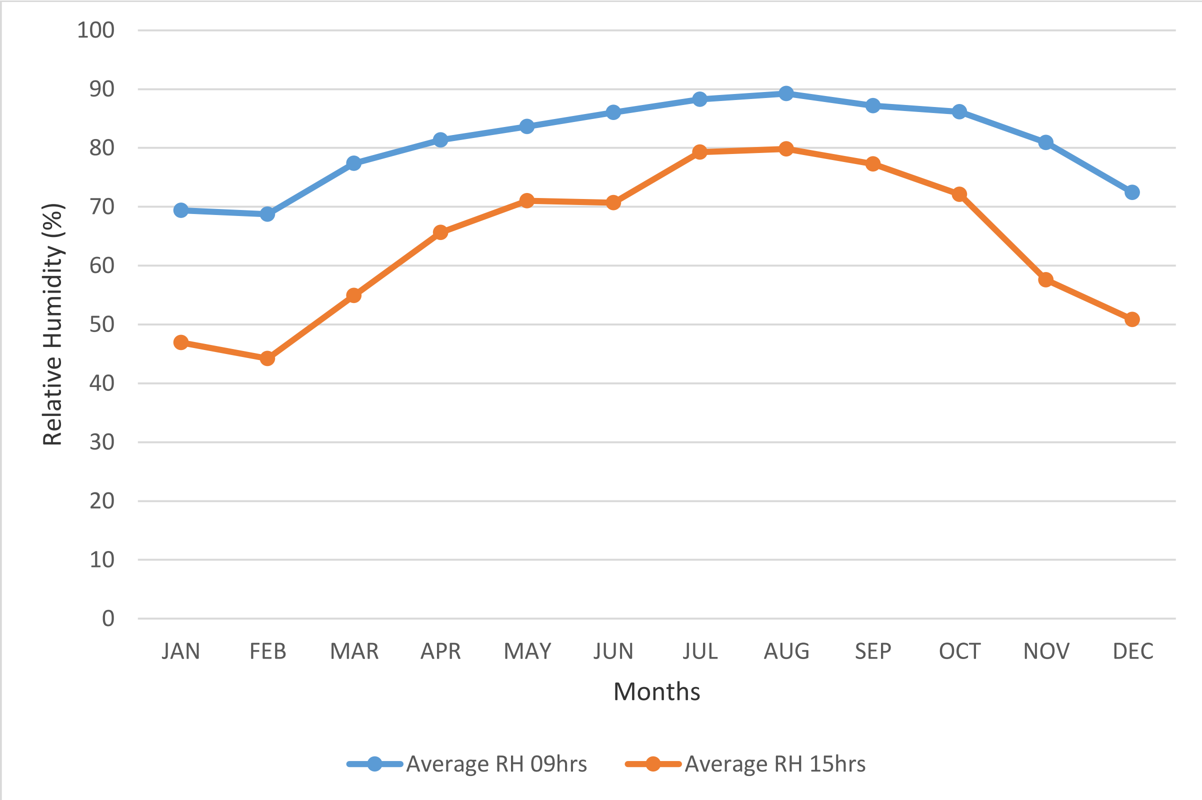


Figure 4.23: Average Monthly Relative Humidity of Osun State (1997-2019) (Source: NIMET)

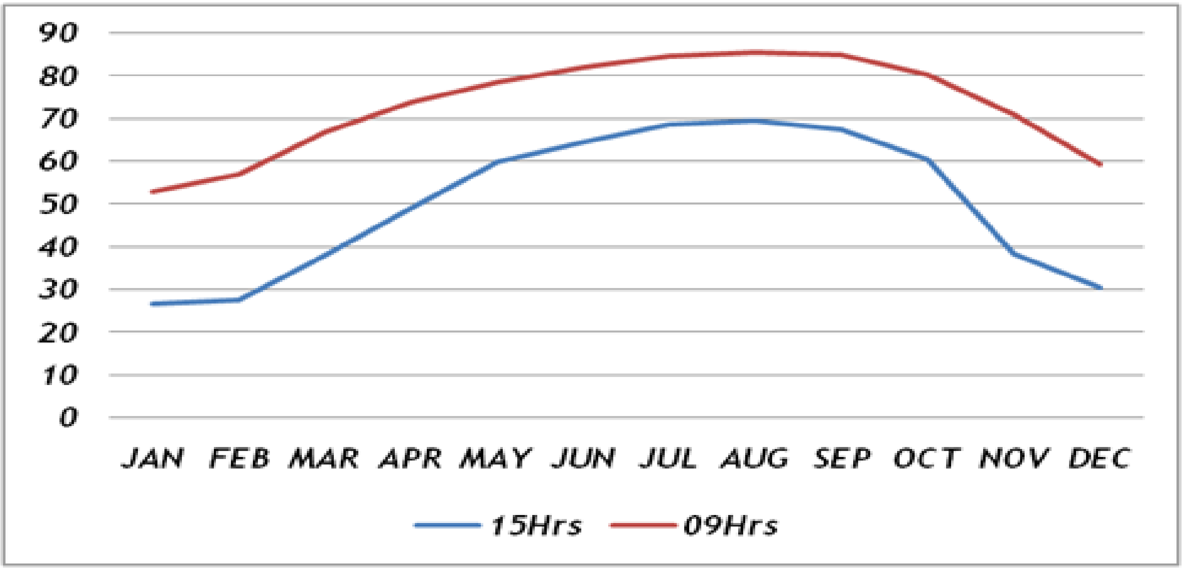


Figure 4.24: Average Monthly Relative Humidity of Kwara State (1997-2019) (Source: NIMET)

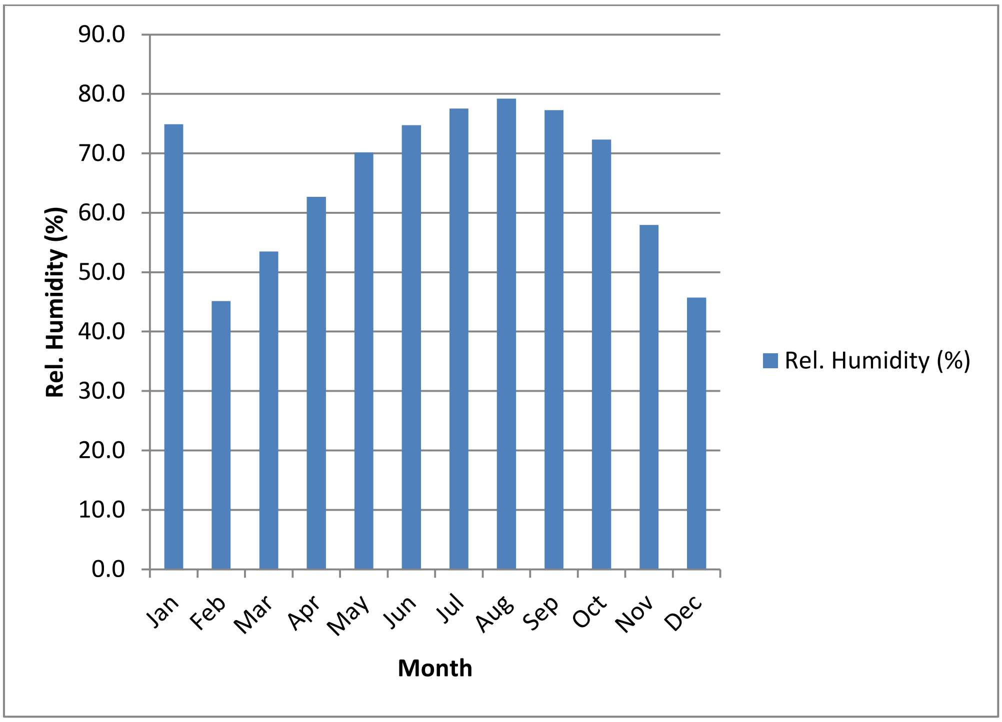


Figure 4.25: Average Monthly Relative Humidity of Kogi State (1997-2019) (Source: NIMET)

➢ ***Baseline microclimatic data of the study area***

Microclimatic data can be described as the weather data for a short period of time typically daily, unlike macroclimatic data which covers a longer period typically in years, as discussed above. The baseline microclimatic description of the study area was based on in situ data collection (fieldwork 2020) ***(Appendices 4.2a to 4.2b).*** The microclimatic condition of the area shows similar condition with the data derived from NiMet, between 1997 and 2019.

Ambient temperature is a weather variable that could be directly but temporarily affected by the proposed refinery project. Sources of heat causing ambient temperature rise include flaring, vapour emission and thermal emission from process equipment. Therefore, the ESIA established the ambient temperature for the project area. The study was carried out within the hours of 8:00 AM to 6:00 PM, to present a representative temperature value for day and night.

The study recorded 30.167°C as the mean temperature of the project area with the maximum being 33.3°C and the minimum 24.0°C for dry season 2020 and mean value of 30.95 °C ranging from 32.90 °C to 29.00 °C during wet season ***(Appendices 4.2a to 4.2b).*** The temperature variation was observed to be influenced by daily time variation. It was low in the morning and gradually increases towards afternoon. Maximum temperature was recorded just after noon.

Also, towards the evening, temperature also declines. Graphical Presentation of Relative Humidity is shown in **Figure 4.26**

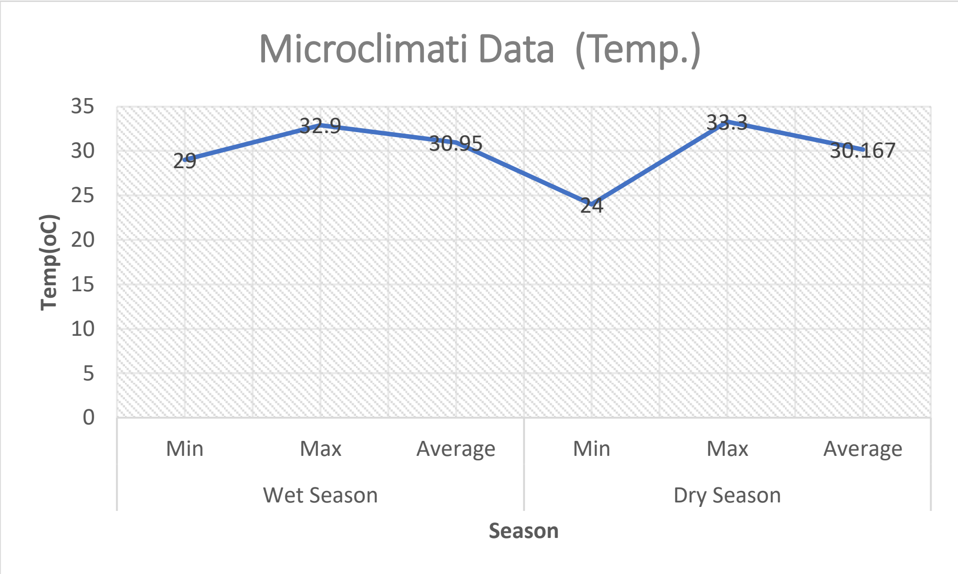
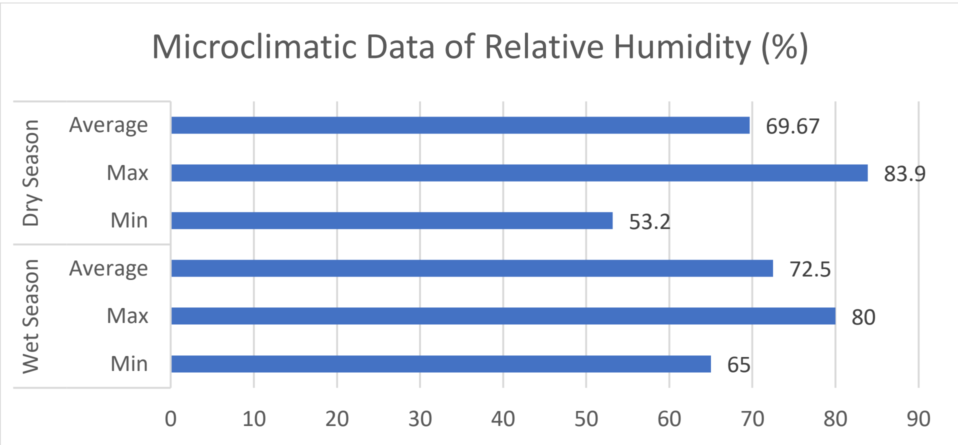


Figure 4.26: Temperature data of the study area

Relative Humidity

The Relative Humidity (RH) varied from 65% to 80% during wet season and varied from 53.2% to 83.9% during wet season. Graphical Presentation of Relative Humidity is shown in **Figure 4.27.**

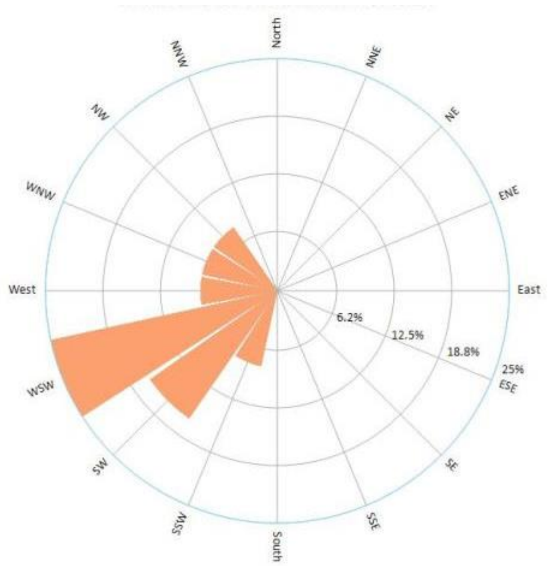


	Wet Season			Dry Season		
	Min	Max	Average	Min	Max	Average
Series1	65	80	72.5	53.2	83.9	69.67

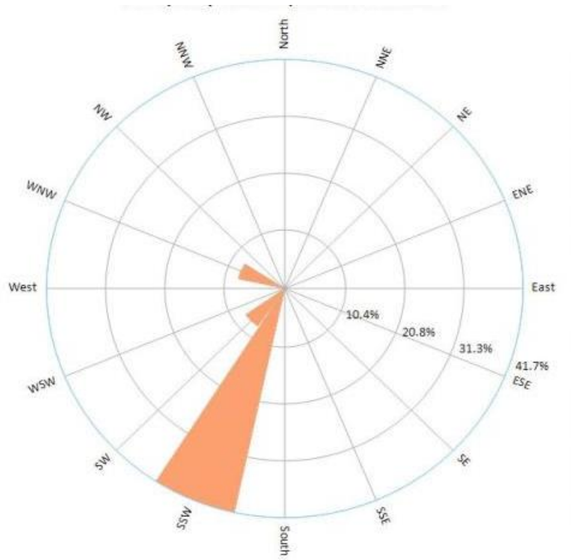
Figure 4.27: Relative Humidity data of the study area

Wind Speed and Direction

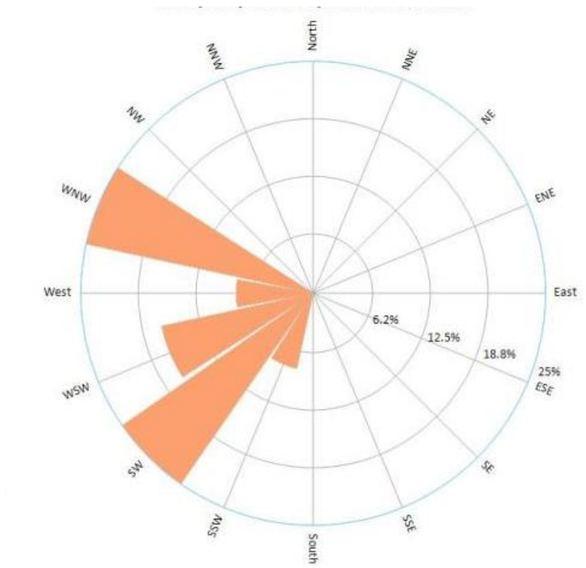
The Wind speed value ranged from 0.3ms^{-1} to 1.3ms^{-1} for dry season and 0.3 ms^{-1} to 1.8ms^{-1} during wet season. The dominant wind direction was observed to be South West directions. Graphical Presentation of Relative Humidity is shown in **Figure 4.8.**



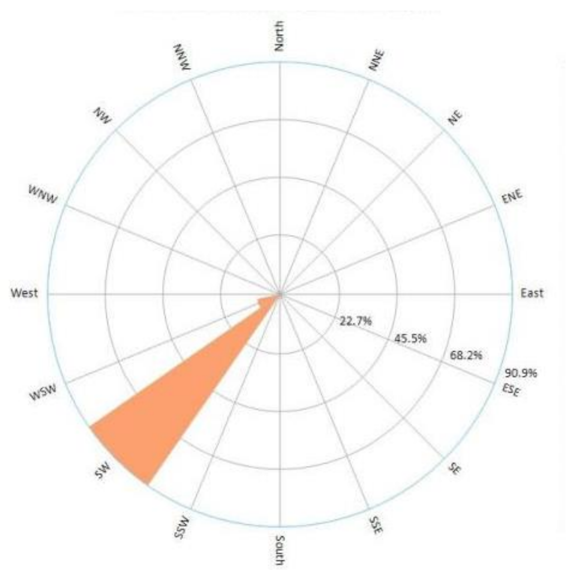
Ekiti State



Ondo State



Oyo State



Ogun State

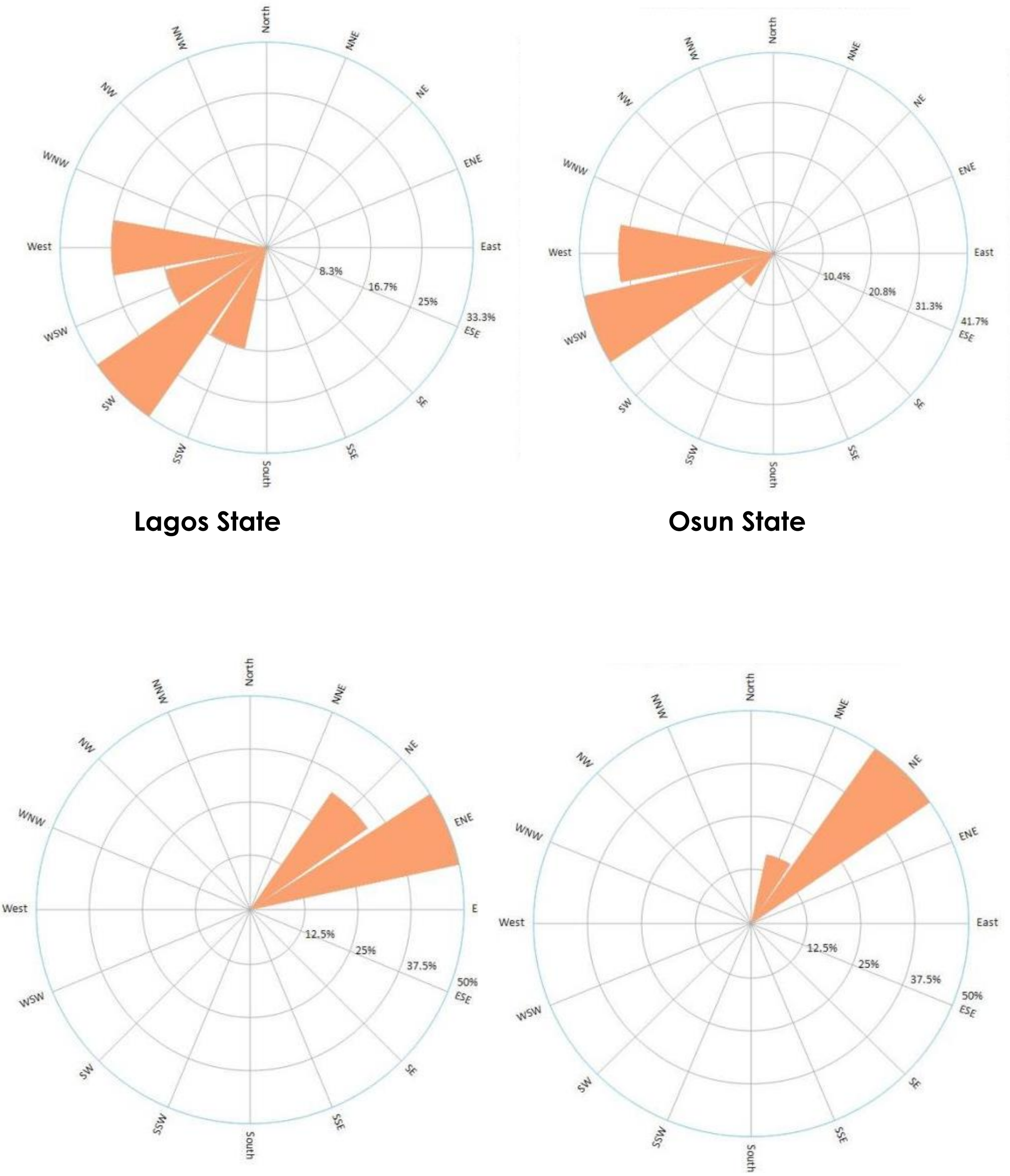


Figure 4.28: Windrose Diagrams for the study area

4.4.2 Air Quality Study

- ***Oxides of Nitrogen (NOx)***

NOx is the group formula for nitric oxide (NO) and nitrogen dioxide (NO_2). Nitrogen dioxide is a toxic component in the air; it could be released directly from combustion points or arises as the oxidation product of nitric oxide which is a less harmful species. NO_2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. The NO_X concentrations during the dry ranged from 0.00 to 0.024ppm and ranged from 0.001 to 0.002ppm during wet seasons. These values obtained were below the stipulated limit of 0.04 – 0.06ppm by FMEnv.

- ***Oxides of Sulphur (SO_X)***

SO_X is the group formula for SO_2, SO_3 and SO_4^{2-} which usually occur as both primary and secondary air pollutants. Power plants, industry, and the oceans emit these gases as primary pollutants. In addition, biological decay processes and some industrial sources emit H_2S which is oxidized to form the secondary pollutant, SO_2. The combustion of fossil fuels containing Sulphur yields SO_2 in direct proportion to the Sulphur content of the fuel.

The primary threat of SO_2 to urban atmosphere may arise not from SO_2 itself but from the changes it undergoes in the atmosphere such as the formation of sulphuric acid (H_2SO_4), a reaction which is catalysed by particulate matter; and the formation of sulphate aerosols. SO_2 can also be absorbed on small particles such as the salts of iron, manganese and vanadium present in the atmosphere and thus enter the alveoli of the lungs. The SO_X concentrations during the dry ranged from 0.00 to 0.003ppm and ranged from 0.01 to 0.06ppm during wet seasons. These values obtained were below the stipulated limit of the stipulated limit of 0.08ppm by FMEnv. ***(Appendices 4.2a to 4.2b).***

- ***Carbon monoxide (CO)***

CO is a colorless, odorless gas emitted from combustion processes. In urban areas, the majority of CO emissions to ambient air come from mobile sources. At extremely high levels, CO can cause death (Kao, 1994). In the study area, CO concentrations during dry sampling period ranged from 0.001 to 1.8ppm with a mean value of 0.980ppm while the values ranged from 0.01 to 3.00ppm with a mean value during wet season was 1.505ppm. ***(Appendices 4.2a to 4.2b).*** Thus, the values obtained were below the stipulated limit of 10ppm by the FMEnv.

- ***Hydrogen Sulphide (H_2S)***

Concentration of hydrogen Sulphide for dry season ranged from 0.00 to 0.004ppm while it ranged from 0.001 to 0.004ppm during wet season. The concentration during this season were found below the limit of FMEnv. of the project area.

- ***Volatile Organic Compounds (VOCs)***

VOC is an aggregate parameter defining volatile hydrocarbon compounds. These are airborne and are usually composed of low and intermediate molecular weight hydrocarbons. The concentrations of volatile organic compounds during dry season sampling period showed that the VOC concentration ranged from 0.0 to 0.005 μg/m^3 while it ranged from 0.01 to 0.06 μg/m^3 during wet season ***(Appendices 4.2a to 4.2b).*** However, all the values obtained during the season under consideration are lower than the stipulated limit of 0.160 μg/m^3 by FMEnv.

- ***Suspended Particulate Matters (SPM)***

The concentration of particulates in the ambient air during dry season ranged from 19.35 μg/m^3 to 127.18μg/m^3 (mean value of 68.631μg/m^3) for particle size of 10 micron. During wet season, SPM ranged from 31.4 μg/m^3 to 87.7μg/m^3 (mean value of 59.5μg/m^3). All the values recorded for particle size were below the FMEnv limit of 250μg/m^3.

- **Radio Frequency**

The results of Power Density intensities measured at the site were very low ranging from 0.001 to 0.016 μW/m^2 during wet season and from 0.020 to 0.380 μW/m^2. When compared with the ICNIRP limits, the values obtained from both dry and wet seasons were very low.

- **Noise Level**

The average noise levels recorded at the project areas during dry season was 44.87 dB and 51.00dB during wet season. A large proportion of background noise in the area is due to human activities around the project area. In spite of this, the mean values recorded were below the FMEnv limit of 90dB (A) for 8 hours exposure respectively.

Table 4.14: Summary of Air Quality, Noise, Rf And Microclimatic Data for Wet Season and Dry Season 2020

Parameters		SO_2 (ppm)	NO_2 (ppm)	NH_3 (ppm)	VOC (µg/m^3)	CO (ppm)	H_2S (ppm)	SPM (µg/m3)	Noise Level (dB)	Radiation (µW/m^2)	Temp (^{0}C)	Relative Humidity (%)	Wind Speed (m/s)	Wind Direction
Wet Season	**Min**	0.01	0.001	0.001	0.01	0.01	0.001	31.4	40.1	0.001	29	65	0.3	SW
	Max	0.06	0.002	0.179	0.06	3	0.004	87.7	61.9	0.016	32.9	80	1.8	SW
	Average	0.035	0.0015	0.09	0.035	1.505	0.0025	59.55	51	0.0085	30.95	72.5	1.05	
	Control (Mean)	0.015	0.001	0.011	0.020	0.588	0.001	50.295	50.764	0.006	30.672	72.785	0.950	SW
Dry Season	**Min**	0.000	0.000	0.001	0.000	0.001	0.000	19.350	35.800	0.020	24.000	53.200	0.300	SW
	Max	0.003	0.024	0.150	0.005	1.800	0.004	127.180	49.800	0.380	33.300	83.900	1.300	SW
	Average	0.001	0.002	0.013	0.003	0.980	0.001	68.631	44.867	0.181	30.167	69.670	0.926	SW
	Control (Mean)	0.001	0.002	0.014	0.003	1.016	0.002	70.456	45.202	0.187	30.395	70.280	0.949	SW
FMEnv Limits		**0.08**	**0.04-0.06**	**0.29**	**0.160**	**10.00**	**0.006**	**250**	**90.0**	**1.0**				

Source: Spatial Ecosystems Limited fieldwork and Woodsworth Environ Limited Fieldwork 2020

Detection limit for NO_2 = 0.001ppm; SO_2 = 0.001ppm; CO = 0.001ppm; SPM = 0.01µg/m^3; H_2S = 0.001ppm

4.4.3 Groundwater Baseline Description

The Physico-chemical analysis results of groundwater collected from existing borehole in the project area during wet and dry seasons are presented in Table 4.6 above and ***Appendices 4.3 – 4.4.*** The quality of the groundwater samples was compared with World Health Organisation (WHO) drinking water quality index, with most of the parameters recorded to be within WHO drinking water quality index, except for low pH value recorded at some stations. The water is generally clear and unobjectionable in terms of odour and other physical appearances.

- ***Physico-chemical Description of groundwater***

During the wet season the values of pH ranged from 5.7 which was slightly acidic to 7.4 which was slightly basic during dry season while it ranged from 6.82 which was slightly acidic to 8.1 which was slightly basic (***Appendices 4.3- 4.4***). These results show that most of the groundwater values around the project area were basic. The pH is a measure of the hydrogen ion concentration in water. The pH concentration in the groundwater could be attributed to a series of interactions involving organic acids, biological activities as well as physical processes. Most of these values were within FMEnv and WHO limit of 6.5 – 8.5 for drinkable water.

The water temperature for wet season ranged from 27.40 to 30.50 ^{O}C whit ranged from 25.20 to 32.4 ^{O}C during dry season. The water Turbidity ranged from 0.00 to 19 NTU during the wet season while it ranged from 0.00 to 1.0NTU during dry season. Total Suspended Solids ranged from 0.5 to 27.0mg/L during wet season while it ranged from 0.00 to 11.0mg/L during dry season. Electrical conductivity varied between 9.0 and 43.5µS/cm in wet season and 120.2 to 892µS/cm during dry season.

The groundwater Dissolved Oxygen (DO) recorded for wet season was between 3.21 and 4.75 mg/L while it was between 0.00 and 5.2mg/L during dry season. The groundwater Biological Oxygen Demand (BOD^5) as the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period had a mean value of 3.305 mg/L and 3.5mg/L for wet season and dry season respectively.

The groundwater cations were dominated by Sodium (Na), Calcium (Ca) and Potassium (K) as presented in Table 4.6**.** Sodium has values ranging from 1.6 to 77.23 mg/L and 0.29 to 21.1mg/L during wet and dry seasons respectively. Also, Potassium has values ranging from 0.03 to 9.74 mg/L during wet season and 0.00 to 2.45mg/L during dry season. Calcium ranged from 70.161 to 7.795mg/L during wet season while it had a mean value of 11.675mg/L during dry season. The heavy metal concentration values were low in all the sampling locations during the two seasons under consideration and do not pose any pollution threat related to hydrocarbon contamination.

Groundwater hydrocarbon concentration is a very important quality monitoring parameter for oil and gas activities, as it can be used to detect any oil related groundwater pollution. Hydrocarbon concentration of the groundwater was generally low (***Table 4.7***). Therefore, the ground water hydrocarbon concentration in all sampling locations were below detection limit. This is an indication of no oil pollution along the optic fibre routes.

Groundwater microbial analysis

From the Microbiology results recorded, THB count which varied from 0.96 x 10^3 cfu/ml to 1.98 x 10^3 cfu/ml for wet season and 1.0 x 10^3 cfu/ml to 3.1 x 10^3 cfu/ml for dry season. THF count ranged from 0.17 x 10^3 cfu/ml to 0.69 x 10^3 cfu/ml for wet season while it ranged from 1.0 x 10^3 cfu/ml to 2.5 x 10^3 cfu/ml for dry season. The hydrocarbon utilizing bacteria and fungi were low and not detected in some locations during the field sampling. This shows that the groundwater poses no danger to human health.

In conclusion, the decrease and increase of pH concentration in the groundwater could be attributed to a series of interactions involving organic acids, biological activities as well as physical processes. Also, heavy metal concentration values were low in all the sampling locations and do not pose any pollution threat related to hydrocarbon contamination. In addition, the ground water hydrocarbon concentration also recorded low concentration and were below detection limit. This is an indication of no oil pollution in the project area. The hydrocarbon utilizing bacteria and fungi were not detected during the field sampling. This shows that the groundwater poses no danger to human health.

Table 4.15: Summary of Physico-chemical, Heavy Metals and Microbial Result of Ground water in Wet and Dry seasons

PARAMETERS	WET SEASON					DRY SEASON						
Physico-chemical	**Min**	**Max**	**Mean**	**Stdev**	**Control**	**Min**	**Max**	**Mean**	**Stdev**	**Control**	**WHO Limits**	FMEnv Limits
Temperature (°C)	27.4	30.5	28.95	1.55	27.5	25.2	32.4	28.8	3.6	28.81	27-28	40
pH	5.7	7.4	6.55	0.85	7.105	6.82	8.1	7.46	0.64	5.68	6.0-9.0	6.5 – 8.5
Electrical Conductivity, µS/cm	9	435	222	213	167	120.2	892	506.1	385.9	159.50	1000	NS
Total Suspended Solids (TSS), mg/l	0.5	27	13.75	13.25	1.245	0	11	5.5	5.5	5.90	250	600
Colour (PCU)	0	87	43.5	43.5	0	0	24.5	12.25	12.25	24.25	NS	NS
Total Dissolved Solids (TDS), mg/l	5.76	278.4	142.08	136.32	88.5	60.1	446	253.05	192.95	82.80	1000	NS
Dissolved Oxygen (DO), mg/l	3.2	4.75	3.975	0.775	3	0	5.2	2.6	2.6	4.27	15	NS
Salinity as Chloride, mg/l	2.18	140.96	71.57	69.39	0	0	1.2	0.6	0.6	55.08	NS	NS
Biochemical Oxygen Demand (BOD), mg/l	3	3.61	3.305	0.305	2	0	7	3.5	3.5	2.53	NS	NS
Turbidity, NTU	0	19	9.5	9.5	0	0	1	0.5	0.5	23.88	25	NS
Redox Potential,	-45	132	43.5	88.5	0	0	0	0	0	52.86	NS	NS
Organics, (mg/l)												
Total Hydrocarbon Content (THC)	<0.01	0.32	0.32	0	0	0	0	0	0	0.30	0.1	NS
Anions (mg/l)												
Sulphate, (SO_4^{2-}) mg/l	0.276	18.125	9.2005	8.9245	1.5	0.02	18.9	9.46	9.44	6.58	400	NS
Phosphate, (PO_4^{3+}) mg/l	0.005	1.124	0.5645	0.5595	0.5	0	1.99	0.995	0.995	0.78	3.5	5
Nitrate, (NO_3^-) mg/l	0.009	0.598	0.3035	0.2945	0.435	0	4.41	2.205	2.205	0.11	10.0-50.0	NS
Cations (mg/l)												
Calcium, (Ca^{2+}) mg/l	0.161	7.795	3.978	3.817	11.75	0	23.35	11.675	11.675	2.86	200	NS
Ammonium, (NH_4^+) mg/l	<0.01	0.069	0.0345	0.024395	0	0	0	0	0	0.10	NS	NS
Magnesium,(Mg^{2+}) mg/l	0.164	4.518	2.341	2.177	4	0.16	62	31.08	30.92	2.43	1	20
Potassium, (K^+) mg/l	0.038	9.745	4.891	4.8535	0.43	0	2.45	1.225	1.225	0.54		

			5									
Sodium, (Na^{2+})	1.6	77.23	39.415	37.815	26.6	0.29	21.1	10.695	10.405	28.32	200	NS
Heavy Metals (mg/l)												
Iron, (Fe)	0.01	<0.006	0.01	0	0.045	0.001	0.122	0.0615	0.0605	0.24	1	2
Zinc, (Zn)	0.008	0.019	0.0135	0.0055	ND	0.002	0.07	0.036	0.034	<0.001	5	1
Chromium, (Cr)	<0.006	<0.006	<0.006	0	ND	ND	ND	ND	0	<0.006	0.05	NS
Lead, (Pb)	0.001	0.005	0.003	0.002	ND	0	0.01	0.005	0.005	0.03	5	<1.0
Copper, (Cu)	0.02	0.084	0.052	0.032	0.035	ND	ND	ND	0	0.03	1	NS
Cadmium, (Cd)	<0.002	<0.002	<0.002	0	ND	ND	ND	ND	0	<0.002	5	<1.0
Mercury, (Hg)	<0.001	<0.001	<0.001	0	ND	ND	ND	ND	0	<0.001	0.001	NS
Vanadium, (V)	<0.001	<0.001	<0.001	0	ND	0	0	0	0	0.02	NS	NS
Nickel, (Ni)	<0.001	0.076	0.038	0.02687	0.045	0	0.142	0.071	0.071	0.24	5	5
Microbiology												
Total Heterotrophic Bacteria (THB), Cfu/ml x 10^3	0.96	1.98	1.47	0.51	0	1	3.1	2.05	1.05	0.90	NS	NS
Total Heterotrophic Fungi (THF), Cfu/ml x 10^3	0.17	0.69	0.43	0.26	0	1	2.5	1.75	0.75	0.19	NS	NS
Hydrocarbon Utilizing Bacteria (HUB), Cfu/ml x 10^3	0	0	0	0	0	ND	ND	ND	0	0.00	NS	NS
Hydrocarbon Utilizing Fungi (HUF), Cfu/ml x 10^2	0	0.01	0.005	0.005	0	ND	ND	ND	0	0.27	NS	NS
Faecal Coliform, Cfu/ml x 10^2	0.2	`0.35	0.2	0	0	0	2	1	1	2.49	NS	NS
E.coli, MPN/100ml	5.4	11.8	8.6	3.2	0	0	0	0	0	0.90	NS	NS
Coliform Count (cfu/100mL)	0	0	0	0	0	0	2	1	1	1.00	NS	NS

Source: Spatial Ecosystems Limited Fieldwork, 2020

4.4 Surface Water Baseline Description

The main surface water body along the optic fibre routes are rivers where samples were collected. The physico-chemical properties of surface water are summarized in Tables 4.16 and discussed in subsequent subsections, while the detailed results of the physico-chemical analysis and microbiology of surface water are presented in Appendix 4.7.

Table 4.16: Summary of Physico-chemical Characteristics of Surface Water

	Min	Max	Mean	Stdev	Control
pH	6.05	6.97	6.51	0.46	4.65
Electrical Conductivity, µS/cm	20	70.6	45.3	25.3	47.07
Total Dissolved Solids (TDS), mg/L	12.8	36	24.4	11.6	24.00
Temperature (°C)	27.9	29.7	28.8	0.9	19.80
COD (mg/L)	15	54	34.5	19.5	22.6
TSS (mg/L)	0	16	8	8	1
Acidity (mg/L)	11	30	20.5	9.5	29.4
Total Hardness (mgCaCO3/L)	10	180	95	85	186.2
Sulphate (mg/L)	10	39	24.5	14.5	17.8
Nitrate (mg/L)	0.02	0.39	0.205	0.185	0.428
Phosphate (mg/L)	0.05	0.68	0.365	0.315	0.646
TOC (%)	0.022	0.054	0.038	0.016	0.0494
THC (mg/L)	0.0111	0.0982	0.05465	0.04355	0.036533
Available Phosphate (mg/L)	0.05	0.36	0.205	0.155	0.368
Total Nitrogen (mg/L)	0.2	0.65	0.425	0.225	0.246
Ammonium (mg/L)	0.11	0.49	0.3	0.19	0.084
Nitrite (mg/L)	0.006	0.031	0.0185	0.0125	0.03
METALS					
Sodium (mg/L)	1.13	50.73	25.93	24.8	48.942
Potassium (mg/L)	0.7	8.42	4.56	3.86	9.486

Iron (mg/L)	0.3	1.89	1.095	0.795	1.912
Chromium (mg/L)	<0.001	<0.001	<0.001	0	<0.001
Nickel (mg/L)	<0.001	<0.001	<0.001	0	<0.001
Calcium (mg/L)	5.01	68.14	36.575	31.565	38.178
Vanadium (mg/L)	<0.001	<0.001	<0.001	0	<0.001
Barium (mg/L)	<0.001	<0.001	<0.001	0	<0.001
MICROBIOLOGY					
THB (x 10^4 cfu/ml)	13.1	22.9	18	4.9	48.2
HUB (x 10^4 cfu/ml)	8	18	13	5	46
THF (x 10^4 cfu/ml)	10.1	20	15.05	4.95	16.27
HUF (x 10^4 cfu/ml)	5	11	8	3	22.67
Total Coliforms (x 10^4 cfu/ml)	21	58	39.5	18.5	50
HUB/THB Ratio	0.0464	0.1174	0.0819	0.0355	0.1
HUF/THF Ratio	0.0298	0.1127	0.07125	0.04145	0.16

Source: Spatial Ecosystems Limited Fieldwork, 2020

pH

The pH is a measure of the hydrogen ion concentration in water. The pH concentration in rivers can be attributed to a series of interactions involving organic acids, biological activities as well as physical processes. Surface water pH recorded ranged from 6.05 to 6.97 which is slightly acidic with a mean value of 6.51 during wet season

Temperature

Water temperature influences chemical reactions, water density, solubility of gases, and the buoyancy mechanism of plankton. The water temperature ranged from 27.9 to 29.7^{0}C with a mean of 28.8^{0}C during wet season.

Chemical Oxygen Demand

Chemical Oxygen Demand (COD) is used to measure the total quantity of oxygen-consuming substances in the complete chemical breakdown of organic substances in water. All aquatic plants and animals contribute to chemical oxygen demand through their metabolism and excretion of waste products. COD concentration ranged from 15 to 54mg/L with a mean of 34.5mg/L during wet season.

Electric Conductivity/Total Dissolve Solids

Electric conductivity refers to the total ionic composition of water. In many cases, the electrical conductivity can be correlated with the Total Dissolved Solids (TDS) levels. Conductivity ranged from 20 to 70.6us/cm with a mean of 45.3us/cm. TDS on the hand ranged from 12.8 to 36mg/L during wet season.

Exchangeable Cations

Calcium (Ca), Potassium (K) and Sodium (Na) are very abundant elements in the earth's crust/aquatic environment and are key elements required to ensure optimal primary and secondary productivity. The mean concentration of for the exchangeable cations for wet season respectively are: Calcium had 36.58mg/L; the average sodium concentration was 25.93mg/L; while potassium retuned average value of 4.56mg/L. Calcium was the most abundant cation during the fieldwork.

Nutrients

Nitrate levels in the surface water ranged from 0.02 - 0.39 mg/L with a mean of 0.205mg/L. On the hand, sulphate concentration ranged from 10 mg/L to 39 mg/L, with a mean of 24.5 mg/L. Phosphates enter water bodies from sewage or runoff from fertilized land/crops. Phosphate levels were generally low in the study, ranging from 0.05 to 0.68mg/L with a mean of 0.365mg/L.

Hydrocarbons/ Total Organic Content
Total Organic Carbon (TOC) ranged from 0.022 – 0.054 %, with a mean of 0.038%. Total Hydrocarbon Content (THC) ranged from 0.0111 to 0.0982mg/L

Heavy Metals in Surface Water
Heavy metal concentrations were generally low and within acceptable limits, with Iron ranging from 0.3mg/l to 1.89mg/L; barium having a constant value at all the locations with a concentration of <0.001mg/l. Also, chromium, nickel and vanadium were below equipment detection limits of 0.001mg/l.

Surface Water Microbiology
The density of the Total Heterotrophic Bacteria ranged from 13.1 x 10^4cfu/ml to 22.9 x 10^4cfu/ml. The population of the Hydrocarbon Utilizing Bacteria ranged from 8 x 10^4cfu/ml to 18 x 10^4cfu/ml. The population of THF ranged from 10.1 x 10^4cfu/ml to 20.0 x 10_4cfu/ml. HUF ranged from 5 x 10^4cfu/ml to 11 x 10^4cfu/ml.

4.5 Sediment Studies

4.5.1 Physico-chemical Properties of Sediment

The summary (in mean and range) of the physiochemical characteristics of the sediments in the study area is presented in table 4.9. The sediments are slightly acidic to almost neutral and the Total Hydrocarbon level of the sediments was low. The heavy metals have a relatively high and wide range of concentrations.

pH: The sediments in the entire area were mainly acidic with pH ranging from 6.0 to 6.9.

Total Organic Carbon (TOC %): The sediments exhibited wide variability in terms of total organic carbon content. TOC ranged from 1.79 to 5.3%, with a mean value of 3.55%. The production, accumulation and degradation of organic matter are greatly dependent on climate. Temperature, sediment moisture and topography are the major factors affecting the accumulation of organic matter in sediments.

Organic matter tends to accumulate under wet or cold conditions where decomposer activity is impeded by low temperature (Buol, 1990) or excess moisture which results in anaerobic conditions (Trofimov et al 2008). Conversely, excessive rain and high temperatures of tropical climates as in the present assessment enables rapid decomposition of organic matter and leaching of plant nutrients. Excessive slope may encourage the erosion of the top layer of sediment which holds most of the raw organic material that would otherwise eventually become humus.

Nitrate: The trend exhibited by the total organic carbon content was also manifested by the total organic matter content. Nitrate content varied between 0.32% to 1.13% with a mean value of 0.725%.

Anions: Sulphate and Phosphate: The mean levels of these anions were generally low as follows; Sulphate (114.5 mg/kg) and phosphate (7.9 mg/kg) respectively.

Electrical Conductivity (E.C): The E.C. of the sediments varied between 10 to 220 µS/cm with a mean value of 115µS/cm.

Total Hydrocarbon Content (THC): The THC of the sediments ranged from 0.01 to 0.13mg/kg in all the locations.

Heavy metals: The mean concentration of the heavy metals and related sediment micronutrient elements were as follows; Iron (390 mg/kg), Chromium (0.025mg/kg), Nickel (2.846 mg/kg), Barium (<0.001 mg/kg). These values are consistent with levels of these metals as found in non-contaminated or none anthropogenically impacted sediments.

Total Heterotrophic Bacteria (THB). The amount of the THB in the sediments ranged from 11.8 to 18.1x10^4cfu/g with a mean value of 14.95 x10^4cfu/g. Total Heterotrophic fungi, (THF) in the sediment ranged from 10.7 to 19.4 x10^4cfu/g with a mean value of 15.05 x10^4cfu/g.

Table 4.17: Summary of Physico-Chemical Properties of Sediment

Parameters	Min	Max	Mean	StDev	Control
pH	6	6.9	6.45	0.45	4.60
Electrical Conductivity, µS/cm	10	220	115	105	146.67
Total Nitrogen, mg/kg	31.23	41.52	36.375	5.145	27.68
Sulphate (mg/kg)	49.0	180.0	114.5	65.5	40.26
Nitrate (mg/kg)	1.32	9.24	5.28	3.96	2.704
Phosphate (mg/kg)	5.7	10.1	7.9	2.2	11.54
Total Nitrogen (%)	0.12	0.28	0.2	0.08	0.132
Ammonium (mg/kg)	1.5	17.5	9.5	8	1.858
Nitrite (mg/kg)	0.32	1.13	0.725	0.405	0.416
TOC (%)	1.79	5.3	3.545	1.755	4.59
THC (mg/kg)	0.01	0.13	0.07	0.06	0.022
Moisture Content (%, Oven- dry basis)	56	455	255.5	199.5	134.2
Heavy Metals					
Sodium (mg/kg)	4.88	12.15	8.515	3.635	12.74
Potassium (mg/kg)	3.29	7.03	5.16	1.87	8.114
Calcium (mg/kg)	31.57	60.32	45.945	14.375	36.942
Iron (mg/kg)	40	740	390	350	49.2
Vanadium (mg/kg)	<0.001	<0.001	<0.001	0	<0.001
Chromium (mg/kg)	0	0.05	0.025	0.025	0.028
Barium (mg/kg)	0	0	0	0	0.018
Nickel (mg/kg)	1.822	3.846	2.834	1.012	<0.001
Microbiology					
THB (x 10^4 cfu/g)	11.8	18.1	14.95	3.15	20.73
HUB (x 10^4 cfu/g)	5	24	14.5	9.50	34
THF (x 10^4 cfu/g)	10.7	19.4	15.05	4.35	10.47
HUF (x 10^4 cfu/g)	7	25	16	9.00	11.67
Total Coliforms (x 10^4 cfu/g)	28	49	38.5	10.50	31.67
HUB/THB Ratio	0.0237	0.1436	0.08365	0.06	0.18
HUF/THF Ratio	0.0416	0.1937	0.11765	0.08	0.11

Source: Spatial Ecosystems Limited Fieldwork, 2020

4.6 Plankton

Plankton refer to the free-floating organisms (animals, plants, archaea, or bacteria) that inhabit the pelagic zone of aquatic bodies. They are defined by their ecological niche rather than phylogenetic or taxonomic classification. Plankton play a key role in the sustenance of aquatic life as they are primarily responsible for the introduction of energy into the ecosystem, either directly by photosynthesis, or indirectly by feeding on the photosynthetic products of plants and plant materials in the water bodies (Nybakken, 1988).

They provide food for larger animals and indirectly for humans, who feed on fish that depend on plankton. Plankton can be subdivided into the phytoplankton and the zooplankton. The phytoplankton comprise of the free-floating plants of the aquatic environment that are capable of photosynthesis, while zooplankton are free-floating animals (Nyabakken, 1988).

4.6.1 Phytoplankton

A total number of 22 phytoplankton species belonging to two (2) major taxonomic groups were found in surface water along the optic fibre routes. The major groups recorded were Bacillariophyta and Cyanophyta. The group Bacillariophyta had the highest percentage of abundance (95.80%) and percentage number of species (90.91%), while Cyanophyta as a group recorded the lowest abundance (4.20%) and number of species (9.09%) as shown in **Figure 4.29**. In the previous study 29 species were recorded belonging to five divisions viz Bacillariophyta (12), Chlorophyta (10), Cyanophyta (4), Euglenophyta (2) and Dinophyta (1). As with the case with this study Bacillariophyta was also the most dominant.

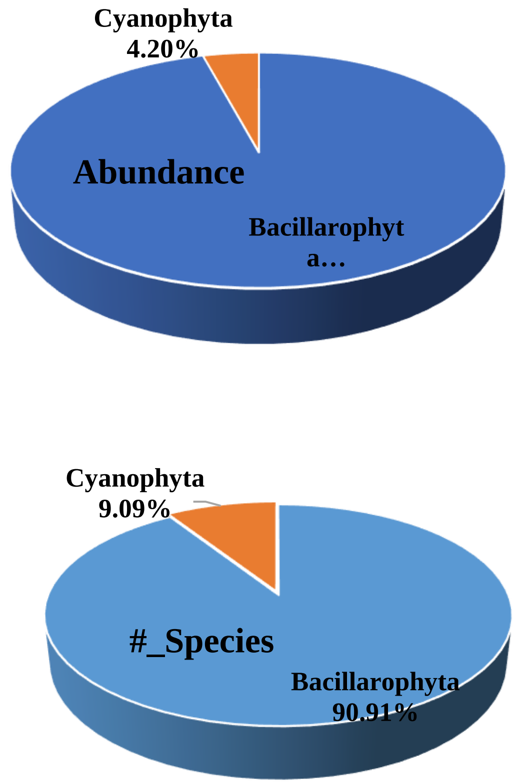


Figure 4.29: Percentage Abundance and Number of Phytoplankton by Major Group found in Surface Water around the Study Area.

The variation in numerical abundance of species within major taxa per station is as presented in **Figure 4.30**. The species belonging to Bacillariophyta were most abundant at station SW 2 and SW 3, while the least abundant were in station Control 1, SW 1 and SW 2 represented by the Cyanophyta group.

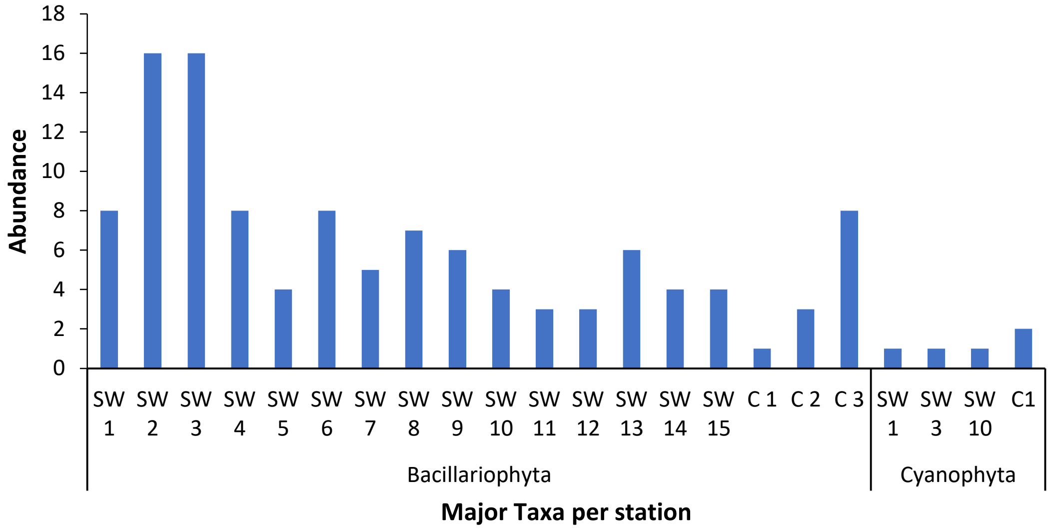


Figure 4.30: Variation in Abundance of Species and Number of Species Recorded per taxa per Station along the optic fibre routes
Source: Fieldwork 2020

Various species recorded with their abundance and occurrence at stations in the study area is presented in **Table 4.18**. *Thalassiothrixfrauenfeldii* had the highest abundance (count/ml) of all the species recorded and occurred in 7 out of the 17 stations sampled along the optic fibre routes While other species include *Skeletonemacostatum* recorded 14 in abundance and occurred in 6 of 17 stations and *Rhizosoleniasetigera* also recorded 11 in abundance and occurred in 5 of 17 stations distributed along the optic fibre routes

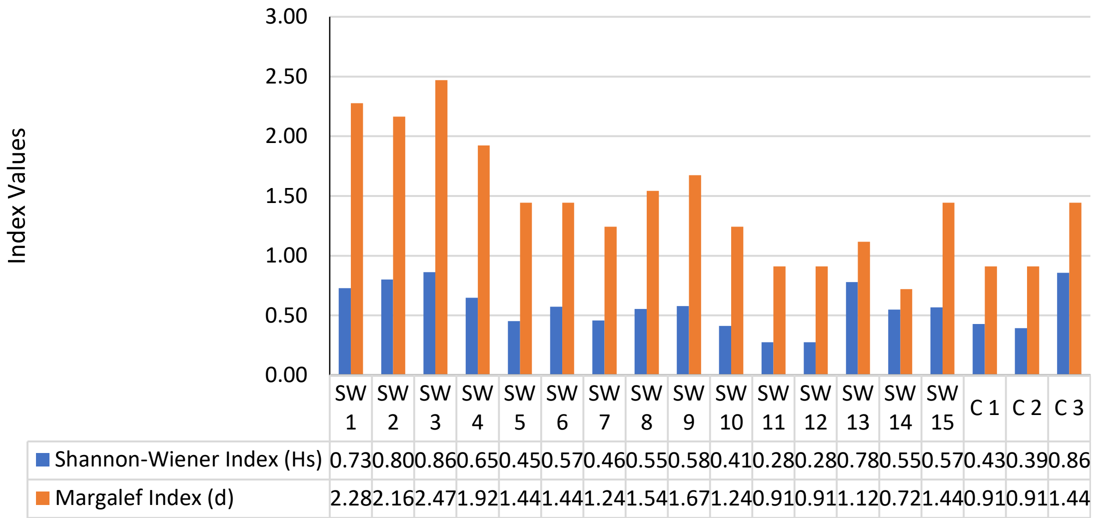
Table 4.18: Phytoplankton Species Recorded with Numerical Abundance (counts/ml) and Occurrence (number of stations recorded)

PHYLA	SPECIES	ABUNDANCE	OCCURRENCE
Bacillariophyta	*Thalassiothrixfrauenfeldii*	16	7
	Thalassiothrixlongissima	5	3
	Biddulphia favus	4	3
	Biddulphia rhombus	4	2
	Biddulphiaaurita	2	2

	Skeletonemacostatum	14	6
	Bacteriosira fragilis	3	3
	Melosirasp	2	1
	Tabellariafenestrata	8	5
	Nitzschiaseriata	8	4
	Nitzschiadelicatissima	2	1
	Nitzschiaclosterium	8	4
	Certaulinabergonii	2	1
	Navicularhyncocephala	4	2
	Naviculasp	7	6
	Fragilaria sp	2	1
	Rhizosoleniahebetata	8	4
	Rhizosoleniasetigera	11	5
	Rhizosoleniadelicatula	3	2
	Detonulacystifera	1	1
Cyanophyta	*Merismopedia glauca*	2	2
	Oscilatoriaformosa	3	2

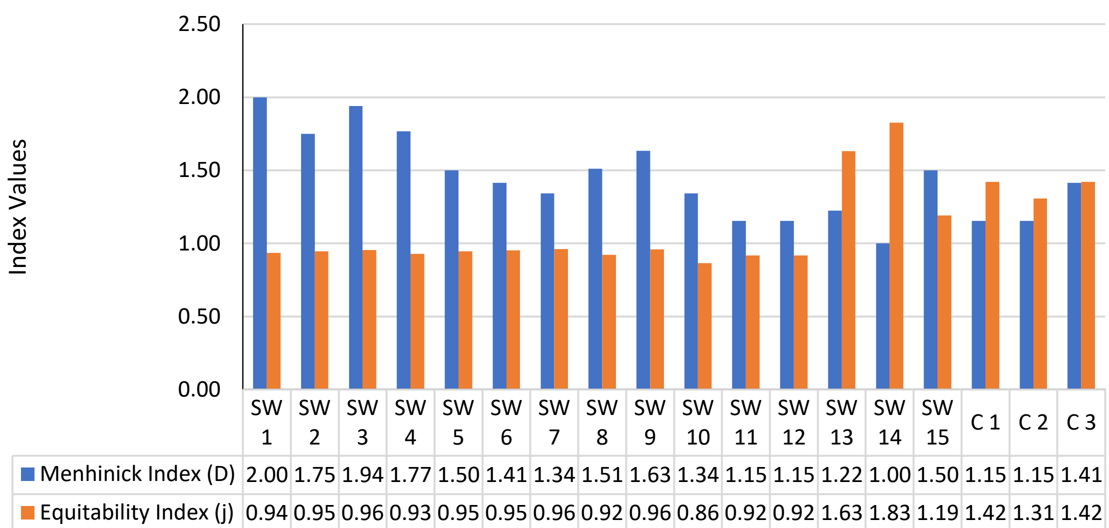
Source: Fieldwork 2020

The species diversity and richness indices estimated per station and for the whole study area is as shown in **Figures 4.23** and 4**.24**. Overall average species diversity, richness, Menhinick and equitability for the entire study area were 0.57, 1.44, 1.43 and 1.11 respectively. The highest species diversity was recorded at station 3 and control station 3 and the highest richness value at station 1, 2 and 3 (**Table 4.18**). Lowest indices values were at stations 11 and 12 respectively for diversity and richness.



	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SW 11	SW 12	SW 13	SW 14	SW 15	C 1	C 2	C 3
Shannon-Wiener Index (Hs)	0.73	0.80	0.86	0.65	0.45	0.57	0.46	0.55	0.58	0.41	0.28	0.28	0.78	0.55	0.57	0.43	0.39	0.86
Margalef Index (d)	2.28	2.16	2.47	1.92	1.44	1.44	1.24	1.54	1.67	1.24	0.91	0.91	1.12	0.72	1.44	0.91	0.91	1.44

Figure 4.31: Shannon-Wiener and Margalef of Phytoplankton Recorded per Station along the optic fibre routes Source: Fieldwork 2020



	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SW 11	SW 12	SW 13	SW 14	SW 15	C 1	C 2	C 3
Menhinick Index (D)	2.00	1.75	1.94	1.77	1.50	1.41	1.34	1.51	1.63	1.34	1.15	1.15	1.22	1.00	1.50	1.15	1.15	1.41
Equitability Index (j)	0.94	0.95	0.96	0.93	0.95	0.95	0.96	0.92	0.96	0.86	0.92	0.92	1.63	1.83	1.19	1.42	1.31	1.42

Figure 4.32: Menhinick and Equitability of Phytoplankton Recorded per Station along the optic fibre routes Source: Fieldwork 2020

Table 4.19: Diversity indices Recorded in Descending order per Station in the Study Area

Indices	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9
Total species diversity (S)	6	7	8	5	3	4	3	4	4
Total abundance (N)	9	16	17	8	4	8	5	7	6
Log of Species diversity (Log S)	0.78	0.85	0.90	0.70	0.48	0.60	0.48	0.60	0.60
Log of abundance (Log N)	0.95	1.20	1.23	0.90	0.60	0.90	0.70	0.85	0.78
Shannon-Wiener Index (Hs)	0.73	0.80	0.86	0.65	0.45	0.57	0.46	0.55	0.58
Menhinick Index (D)	2.00	1.75	1.94	1.77	1.50	1.41	1.34	1.51	1.63
Margalef Index (d)	2.28	2.16	2.47	1.92	1.44	1.44	1.24	1.54	1.67
Equitability Index (j)	0.94	0.95	0.96	0.93	0.95	0.95	0.96	0.92	0.96
Simpson's Dominance Index (C)	0.21	0.14	0.15	0.25	0.38	0.28	0.36	0.31	0.28

Indices	SW 10	SW 11	SW 12	SW 13	SW 14	SW 15	C 1	C 2	C 3
Total species diversity (S)	3	2	2	3	2	3	2	2	4
Total abundance (N)	5	3	3	6	4	4	3	3	8
Log of Species diversity (Log S)	0.48	0.30	0.30	0.48	0.30	0.48	0.30	0.30	0.60
Log of abundance (Log N)	0.70	0.48	0.48	0.78	0.60	0.60	0.48	0.48	0.90
Shannon-Wiener Index (Hs)	0.41	0.28	0.28	0.78	0.55	0.57	0.43	0.39	0.86
Menhinick Index (D)	1.34	1.15	1.15	1.22	1.00	1.50	1.15	1.15	1.41
Margalef Index (d)	1.24	0.91	0.91	1.12	0.72	1.44	0.91	0.91	1.44
Equitability Index (j)	0.86	0.92	0.92	1.63	1.83	1.19	1.42	1.31	1.42
Simpson's Dominance Index (C)	0.44	0.56	0.56	0.00	0.00	0.00	0.00	0.00	0.00

Source: Fieldwork 2020

4.6.2 Zooplankton studies

A total of eight taxa belonging to one major zooplankton group (Arhropoda – Copepoda and three orders – Calanoida, Cyclopoida and Decapoda) were recorded along the optic fibre routes (**Table 4.20**). Calanoida dominated the zooplankton community accounting for over 67.06% of the total zooplankton individuals (57 individuals/ m^3) recorded, Cyclopoida with 21.18% and Decapoda with 11.76% as presented in **Figure 4.33**. Widely distributed species were *Cyclopina longicornis, Acartia clausii* and *Pseudocalanus elongates*.

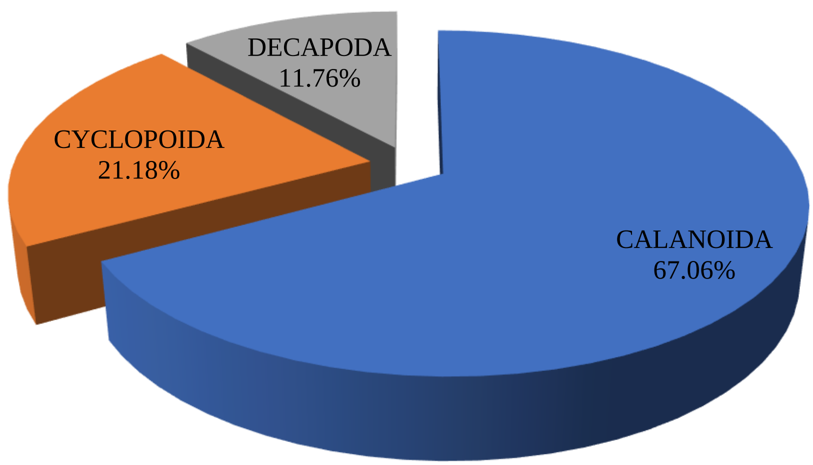


Figure 4.33: Percentage Abundance and Number of Zooplankton by Major Group along the optic fibre routes

Copepods are considered as important food item for various kinds of fish, play a key role in the energy transformation at different trophic levels. Copepod prefer eutrophicated environment with high abundance of phytoplankton diversity to grow in high numbers. However, the insignificant abundance of phytoplankton across the study area amounted to a sparse abundance of copepod which dominated the zooplankton community.

Diversity indices of the zooplankton community with Shannon-wiener range between 0 – 0.74; Simpson dominance with 0 – 1.00; Evenness with 0.91 – 1.00;

Margalef with 0 – 2.28; while Menhinick's recorded 0.71 – 2.00. The structure and composition trends of zooplankton in the study area may be related to both less abundance of phytoplankton. The diversity indices are presented in **Table 4.20** and **Figures 4.37** to 4**.46**.

Table 4.20:Checklist of Zooplankton Species along the optic fibre routes

CRUSTACEA	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SW 11	SW 12	SW 13	SW 14	SW 15	C 1	C 2	C 3
COPEPODA																		
CALANOIDA																		
Acartia clausii Geisbrecht		3			2			2	1	3			2					3
Calanus finmarchicus (Gunn.)	2		2	1		1		2		1		1	1		1		1	2
Centropage typicus Dana	2							1		1								
Paracalanus parvus (Claus)	1	2	2	1											2			
Pseudocalanus elongates Boeck		2	4			2		1		1		1		1				
Temora stylifera Dana			2															
CYCLOPOIDA																		
Cyclopina longicornis (Claus)	4		3	1	2		1		1	2	2			1		1		
DECAPODA																		
Lucifer foxonii Borrad	2		1		1		2			1			2					1

Source: Fieldwork 2020

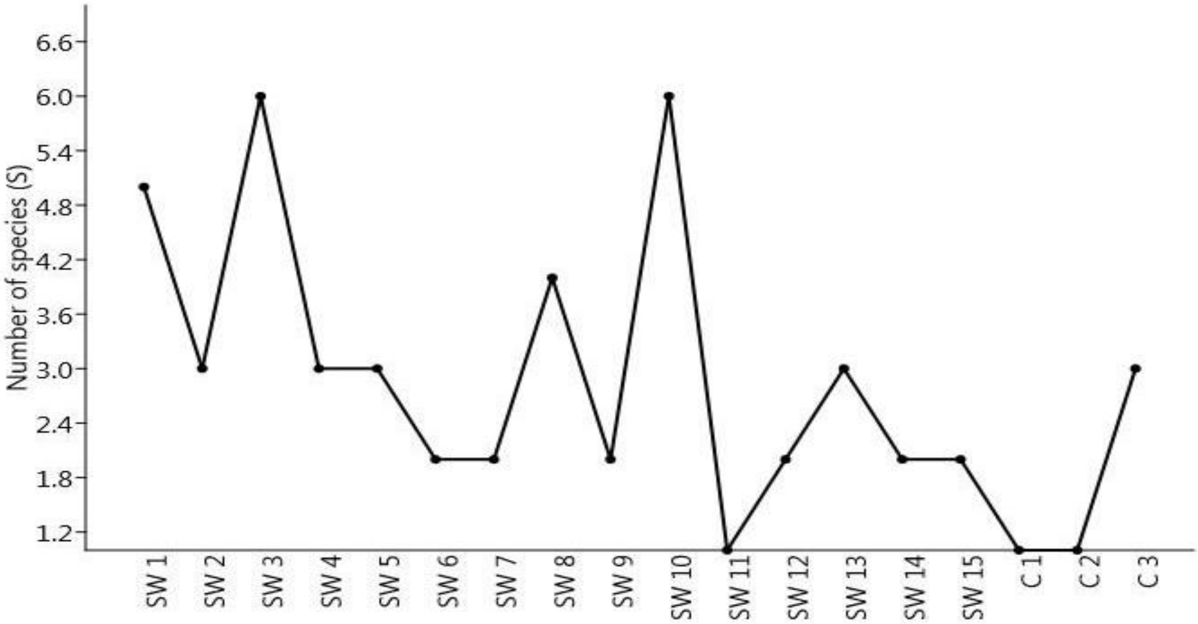


Figure 4.34: The Numerical Species (S) of Zooplankton across Stations along the optic fibre routes. Source: Fieldwork 2020

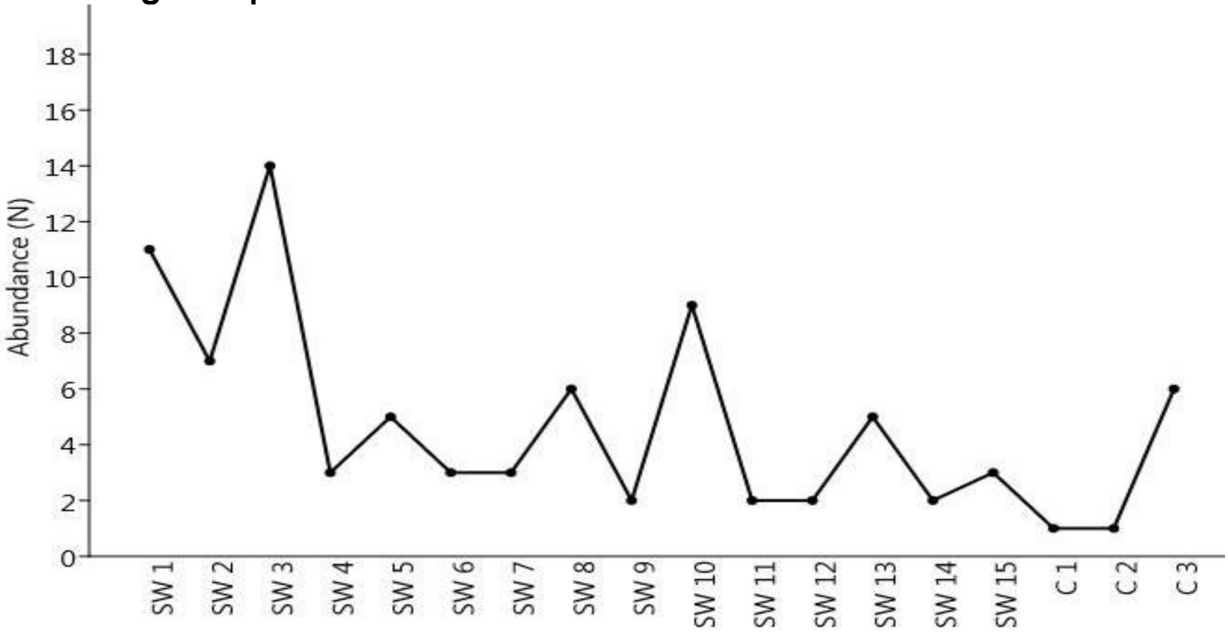


Figure 4.35: The Numerical Abundance (N) of Zooplankton across Stations along the optic fibre routes. Source: Fieldwork 2020

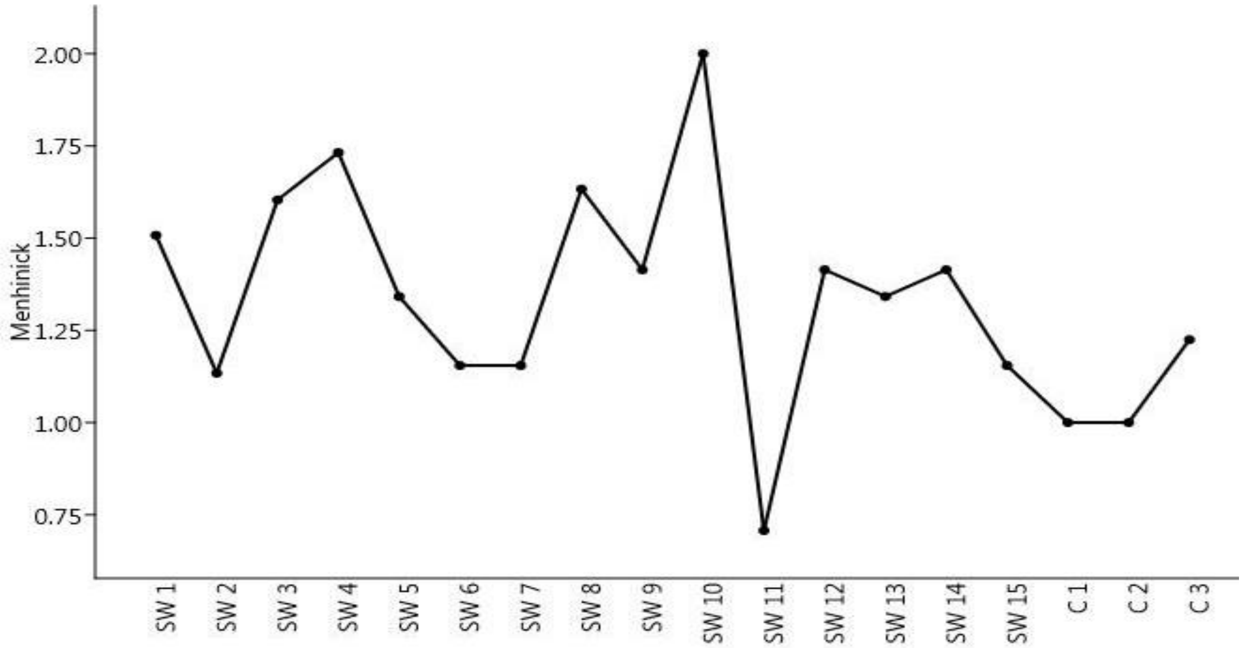


Figure 4.36: Menhinick's Index of Zooplankton across Stations along the optic fibre routes. Source: Fieldwork 2020

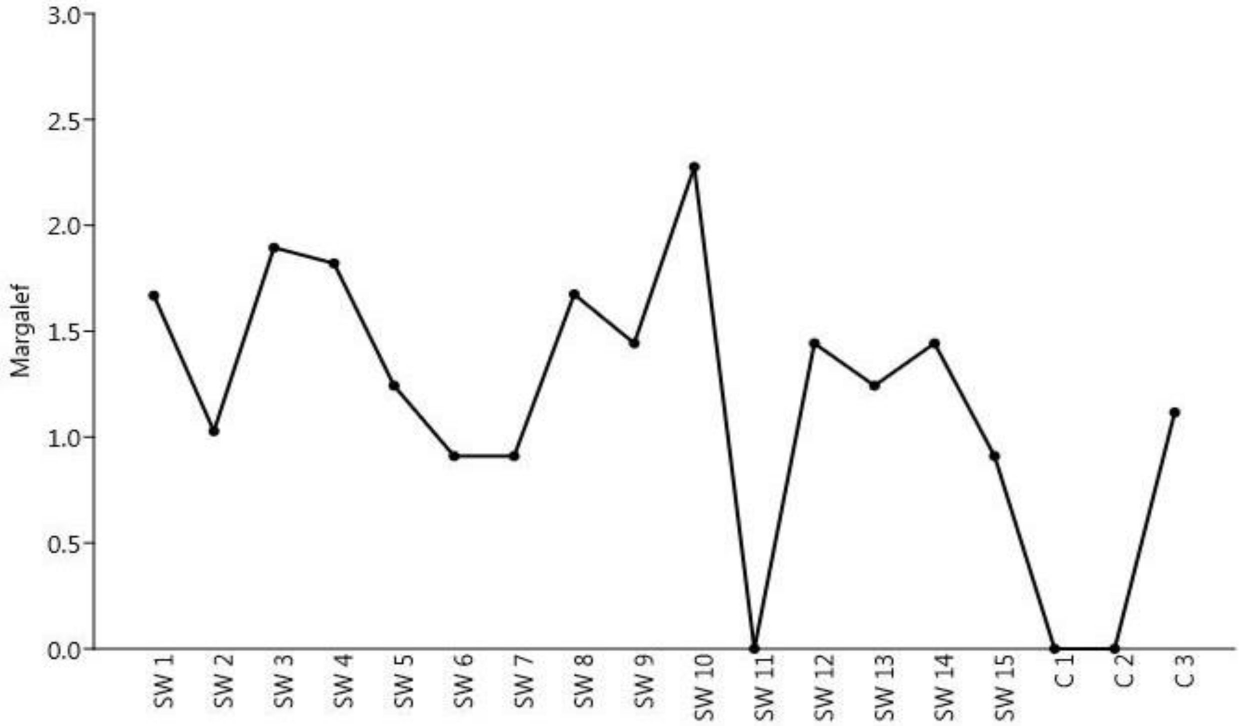


Figure 4.37: Margalef Index of Zooplankton across Stations along the optic fibre routes. Source: Fieldwork 2020

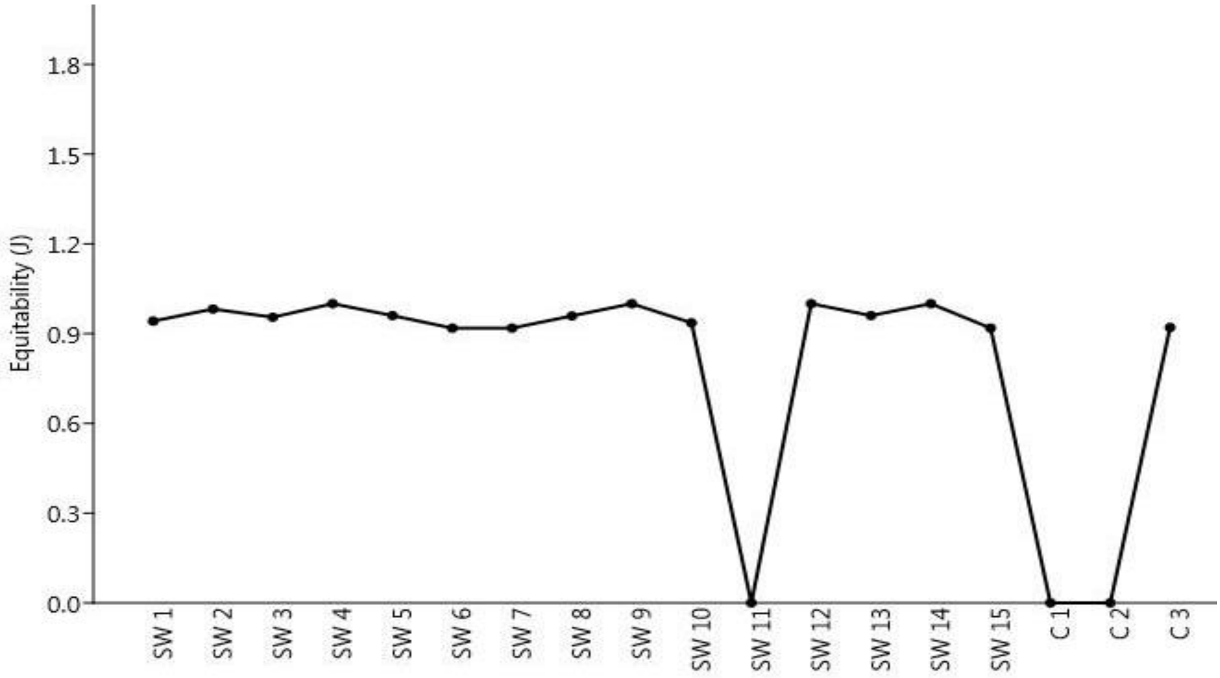


Figure 4.38: Equitability Index of Zooplankton across Stations along the optic fibre routes. Source: Fieldwork 2020

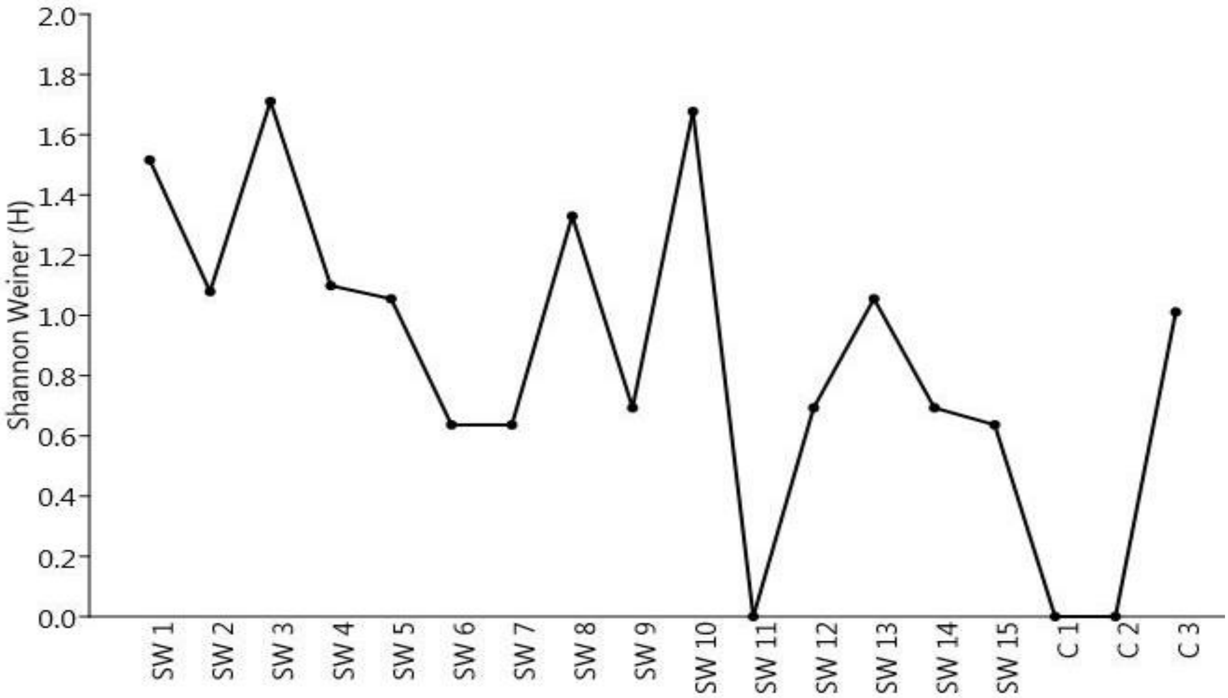


Figure 4.39: Shannon-Wiener's Index of Zooplankton across Stations along the optic fibre routes.

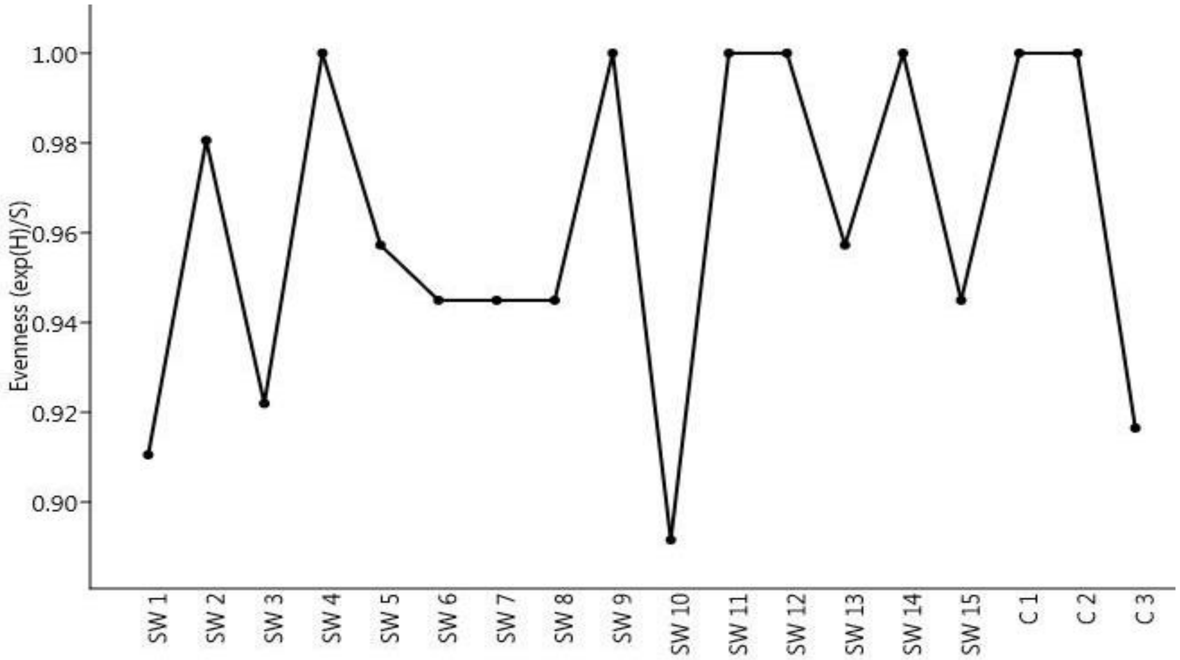


Figure 4.40: Evenness Index of Zooplankton across Stations along the optic fibre routes. Source: Fieldwork 2020

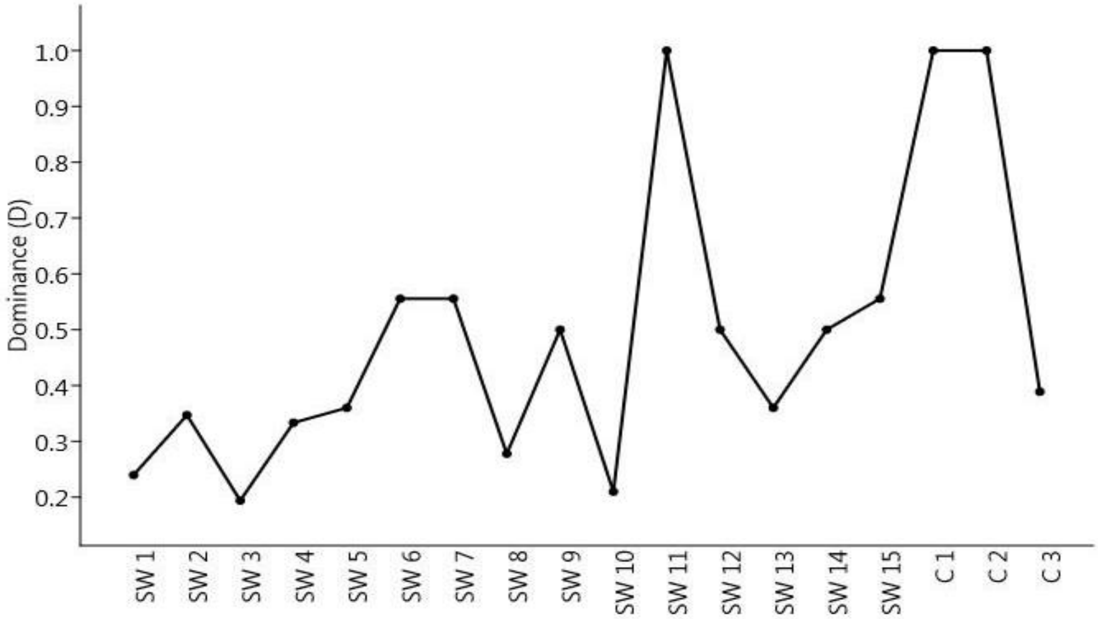


Figure 4.41: Dominance Index of Zooplankton across Stations along the optic fibre routes. Source: Fieldwork 2020

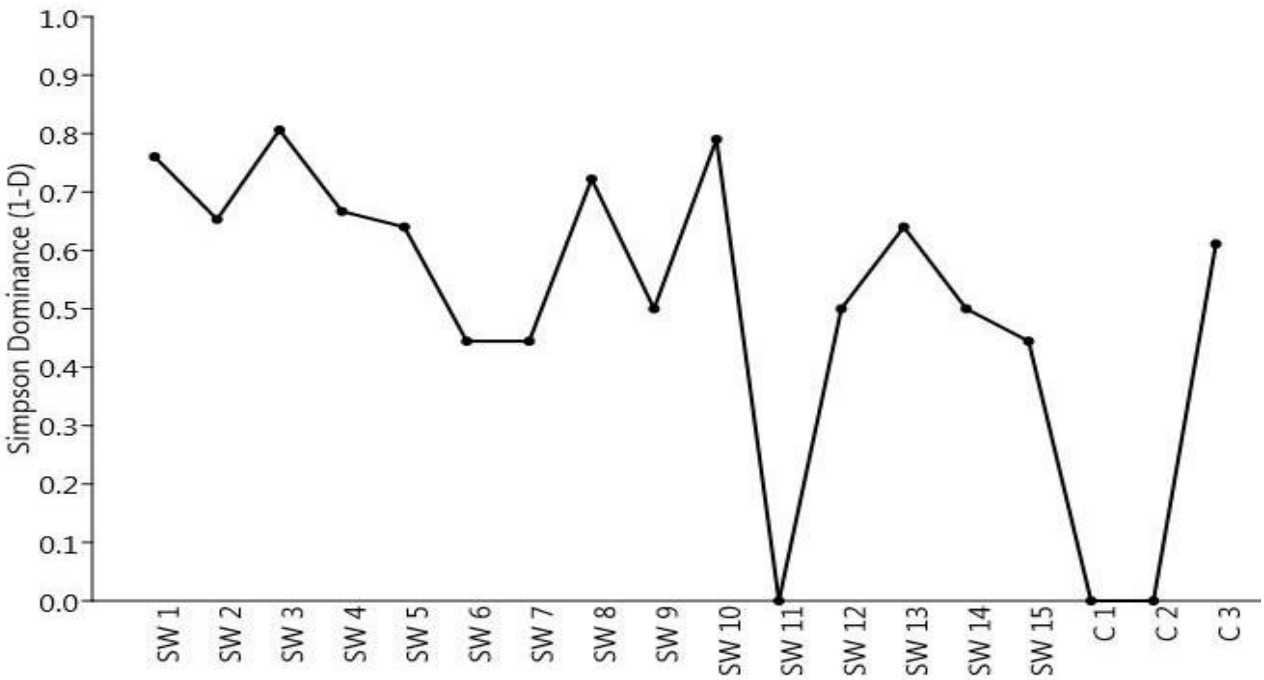


Figure 4.42: Simpson Dominance Index of Zooplankton across Stations along the optic fibre routes. Source: Fieldwork 2020

Table 4.21: Diversity indices of Zooplankton community along the optic fibre routes

	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SW 11	SW 12	SW 13	SW 14	SW 15	C 1	C 2	C 3
Taxa_S	5	3	6	3	3	2	2	4	2	6	1	2	3	2	2	1	1	3
Individuals	11	7	14	3	5	3	3	6	2	9	2	2	5	2	3	1	1	6
Dominance_D	0.24	0.35	0.19	0.33	0.36	0.56	0.56	0.28	0.50	0.21	1.00	0.50	0.36	0.50	0.56	1.00	1.00	0.39
Simpson_1-D	0.76	0.65	0.81	0.67	0.64	0.44	0.44	0.72	0.50	0.79	0.00	0.50	0.64	0.50	0.44	0.00	0.00	0.61
Shannon_H	1.52	1.08	1.71	1.10	1.06	0.64	0.64	1.33	0.69	1.68	0.00	0.69	1.06	0.69	0.64	0.00	0.00	1.01
Evenness_e^H/S	0.91	0.98	0.92	1.00	0.96	0.94	0.94	0.94	1.00	0.89	1.00	1.00	0.96	1.00	0.94	1.00	1.00	0.92
Brillouin	1.11	0.76	1.30	0.60	0.68	0.37	0.37	0.87	0.35	1.15	0.00	0.35	0.68	0.35	0.37	0.00	0.00	0.68
Menhinick	1.51	1.13	1.60	1.73	1.34	1.16	1.16	1.63	1.41	2.00	0.71	1.41	1.34	1.41	1.16	1.00	1.00	1.23
Margalef	1.67	1.03	1.90	1.82	1.24	0.91	0.91	1.67	1.44	2.28	0.00	1.44	1.24	1.44	0.91	0.00	0.00	1.12
Equitability_J	0.94	0.98	0.95	1.00	0.96	0.92	0.92	0.96	1.00	0.94	0.00	1.00	0.96	1.00	0.92	0.00	0.00	0.92

Source: Fieldwork 2020

4.7 Fisheries Study

The data on the fisheries from the project area obtain from directly from the fishermen catch and interactions with people living along the river bank communities. Most of the fish species were identified at the landing sites using standard guides but the ones that could not be identified immediately were had samples taken for further identification. Secondary information was also obtained from existing literatures.

Fishing activities are pronounced within project area. Fishing is done on a full-time basis by small scale and migrant fishermen especially along the optic fibre routes. Fishing gears employed by the fisher folks include gillnet different types of traps, hook and lines, long lines, lift net, and cast nets. All the crafts were wooden dugout canoes that are operated by one or two individuals.

A total of 27 species of fish belonging to 16 families were encountered from the project area (Table 4.12). Most of the fishermen operate between 4 to 6 hours per day, either at a stretch or in two phases of early mornings and evenings. All the 27 species encountered are considered to be of commercial importance. A total of 602 species were encountered during the studies and their percentage Composition and abundance of each family and species. These are given in tables 4.22 and 4.23

Though the project area is relatively rich in fish both in biomass and abundance of fish resources, there were however signs of overfishing as most of the fish caught by the fishermen in were mostly under aged Juveniles with only few that have attained maturity. The reason was visibly seen as the small mesh sizes of about 1.25cm to 3cm that are mostly used by the fisher folks. Other implicated causes are high fishing pressure and obnoxious fishing methods.

The fishes observed are highly mobile riverine fishes that move long distances up and down the river respond to seasonal floods by making lateral movements out over the flooded plain and into the pools, running to the main river channels as the flood subsides. The sudden increase in nutrients as a result of both organic and inorganic fertilizers being washed down by rain into ponds, rivers and storage reservoirs generates excessive growth of phytoplancton on which fishes feed. Fishes move up river, disperse on flood plains reproduce rapidly. The offspring feed and grow very fast and tend to move back to the river during the peak of the dry season which results to intensive fishing by fishermen. Large number of fish as also trapped in marshes as the water recedes. These give the bountiful harvests experienced during the onset of dry season.

Table 4.22 Fishes found along the Route of the project

Family	Species	Common Name
Mormyridae	*Marcusenius abadii*	Elephant Fish
	Mormyrus haselquisti	Elephant Snout
	Mormyrus rume	Bottle Nose
	Hyperopisus bebe	Ngai
Cichlidae	*Tilapia zilli*	Red Belly Tilapia
	Oreochromis niloticus	Nle Tilapia
	Oreohromis aureus	Blue Tilapia
	Sarotherodon galilaeus	Mango Tilapia
Claroteidae	*Clarotes laticeps*	Wide Head Fish
	Auchenoglanis occidentalis	Bubu
Alestidae	*Brycinus nurse*	Nurse Tetra
	Hydrocynus brevis	Tiger Fish
	Hydrocynus forskhalii	Elongated Tiger Fish
Mochokidae	*Synodontis Nigrita*	Squeaker
	Synodontis schall	Wahrindi
Bagridae	*Bagrus bayad*	Bayad
	Bagrus docmak	Semuntundu
Latidae	*Lates niloticus*	Nile Perch
Arapaimide	*Heterotis niloticus*	African Bony Tongue
Citharinidae	*Citharinus citharius*	Moon Fish
Cyprinidae	*Labeo coubie*	African Carp
Scilbeidae	*Schilbe myustis*	African Butter Fish

Channidae	*Parachana obscura*	Snake Head Fish
Clariidae	*Clarias anguillaris*	Mudfish
Gymnarchidae	*Gymnarchus niloticus*	Aba
Hepsetidae	*Hepsetus odoe*	Kafue Pike
Distichontidae	*Ichthyoborus besse*	Grass Eater

Table 4.23 Percentage Composition by Families of Fish

Family	Percentage(%)
Mormyridae	14.8
Cichlidae	14.8
Claroteidae	7.41
Alestidae	11.11
Mochokidse	7.41
Bagridae	7.41
Latidae	3.7
Arapaimide	3.7
Citharinidae	3.7
Cyprinidae	3.7
Schilbeidae	3.7
Channidae	3.7
Clarrdae	3.7
Gymnarchidae	3.7
Hepsetidae	3.7
Distichontidae	3.7

Abundance and Biomass Data For Fish Species Sampled

Familyand Species	Abundance	%	Biomass (G)	%	Length Range(cm)
MORMYRIDAE					
Marcusenius abadii	22	18.2	7000	11.9	15 – 28
M. haselquisti	15	9.9	8000	13.6	18 – 30
Mormyrus rume	32	26.4	3500	59.3	30 – 51

Hyperopisus bebe	22	18.2	1100	18.7 15 – 30
CICHLIDAE				
Tilapia zilli	77	41.8	2310	31.3 7 – 13
O. niloticus	52	28.3	1970	26.7 9 – 15
S. galilaeus	35	19	2100	28.4 9 – 16
Oreochromis aureus	20	10.8	1000	13.6 6 – 12
CLAROTEIDAE				
Clarotes laticeps	40	55.6	35000	59.3 30 – 50
A. occidentalis	32	44.4	24000	40.7 15 – 22
ALESTIDAE				
Brycinus nurse	33	50.0	9000	20 12 – 18
Hydrocynus brevis	14	21.2	19000	42.2 32 – 50
H. forskhalii	19	28.8	17000	37.8 30 – 50
MOCHOKIDAE				
Synodontis nigrita	19	52.8	6000	52.2 8 – 14
S. schall	17	47.2	55000	47.8 9 – 12
BAGRIDAE				
Bagrus bayad	15	41.7	1000	31.2 17 – 30
B. docmak	21	58.3	2200	68.8 22 – 52
LATIDAE				
Latis niloticus	2	100	50000	100 55 and 70
ARAPAIMIDAE				
Heterotis niloticus	1	100	7000	100 42
CITHARINIDAE				
Citharinus citharius	20	100	22500	100 20 – 35
CYPRINIDAE				
Labeo coubie	15	100	14600	100 15 – 33
SCHILBEIDAE				
Schilbe mystus	22	100	3000	100 4 – 8
CHANNIDAE				
Parachanna obscura	15	100	10000	100 25 – 35
CLARIIDAE				
Clarias anguillaris	13	100	10000	100 20 – 52
GYMNARCHIDAE				
G. niloticus	7	100	35000	100 45 – 71
HEPSETIDAE				
Hepsetus Odoe	17	100	9000	100 18 – 32
DISTICHONTIDAE				
Icthyoborus besse	5	100	1000	100 8 - 14

Table 4.24 Ecological indices

Species	No of Individuals
Marcusenius abadii	22
Mormyrus haselquisti	15
Mormyrus rume	32
Hyperopisus bebe	22
Tilapia zilli	77
Oreochromis niloticus	52
Oreohromis aureus	35
Sarotherodon galilaeus	20
Clarotes laticep	40
Auchenoglanis occidentalis	32
Brycinus nurse	33
Hydrocynus brevis	14
Hydrocynus forskhalii	19
Synodontis nigrita	19
Synodontis schall	17
Bagrus bayad	15
Bagrus docmak	21
Lates niloticus	**2**
Heterotis niloticus	1
Citharinus	
Citharius	20
Labeo coubie	15
schilbe myustis	22
Parachana obscura	15
Clarias anguillaris	13
Gymnarchus niloticus	7
Hepsetus odoe	17
Ichthyoborus besse	5
Number of species	27
Number of individuals	602
Margalef species richness	4.06
Shannon-Wiener Div. index	9.32
Evenness	2.83

Plate 4.5: Fishing net (small mesh size)

Plate 4.6: Fingerling of *Ethmalosa fimbriata* (bonga fish) caught in the net

4.8 Soil Physicochemical Properties

pH: The pH of the top soil in the wet season ranged from 6.0 to 6.9which is slightly acidic while the subsoil also ranged from 6.0 to 6.9 which is slightly acidic. However, during dry season, pH ranged from 4.9 which was acidic to 8.22 which was basic for top soil while the subsoil ranged from 4 to 9.87 which was basic.

Exchangeable Cations

Exchangeable cations are either adsorbed onto clay particles or Soil Organic Matter. The soils in the study area are rich in exchangeable cations with calcium being the most abundant; with the order of abundance being Ca >

Na > K. High Calcium soils have more oxygen, drain more freely and support aerobic breakdown of organic matter.

The exchangeable cations (K+, Na+ and Ca2+) varied across the sampling locations and with depth in both seasons. In the topsoil samples collected in the wet season, sodium ranged from 10.3 to 206.16mg/kg, with a mean value of 108.25mg/kg; potassium ranged from 6.27mg/kg to 86.15mg/kg, with a mean value of 46.21mg/kg; while calcium ranged from 10.86mg/kg to 167.43mg/kg, with a mean of 89.15mg/kg.

In the bottom soil samples collected in the wet season, sodium ranged from 7.11mg/kg to 142.63mg/kg, with a mean value of 74.87mg/kg; potassium ranged from 7.07mg/kg to 76.14mg/kg, with a mean of 41.61mg/kg; while calcium ranged from 9.87mg/kg to 157.43mg/kg, with a mean of 83.65 mg/kg.

In the topsoil samples collected in the dry season, sodium ranged from 0.513 to 69.32mg/kg with a mean value of 34.91mg/kg; potassium ranged from 0.34mg/kg to 24.09mg/kg, with a mean value of 12.21mg/kg; while calcium ranged from 2.16mg/kg to 75mg/kg, with a mean of 38.58mg/kg.

In the bottom soil samples collected in the dry season, sodium ranged from 0.548mg/kg to 75.67mg/kg, with a mean value of 38.11mg/kg; potassium ranged from 0.15mg/kg to 18.5mg/kg, with a mean of 9.33mg/kg; while calcium ranged from 3.01mg/kg to 100mg/kg, with a mean of 51.51mg/kg.

The results for the physico-chemical analysis of soil, showed seasonal variations in the exchangeable cations concentrations in the study area. These exchangeable cations are essential plant macro nutrients present in the soil and are vital for plant growth and survival.

Anions: NO_3-, SO_4^{2-}. The mean concentrations in the top soil for the wet season were as follows; NO_3-(0.086mg/kg), SO_4^{2-}. (53.85 mg/kg). Similarly, in the sub soil, mean concentration were NO_3-(0.077mg/kg), SO_4^{2-}. (50.10 mg/kg).

For dry season, the mean concentrations in the top soil were as follows; NO_3-(11.75mg/kg), SO_4^{2-}. (27mg/kg). Similarly, in the sub soil, mean concentration were NO_3-(11.05mg/kg), SO_4^{2-}. (28 mg/kg).

Total Hydrocarbon Content (THC): The concentration of the THC for top and sub soils during dry and wet seasons were very low.

Heavy Metals: The mean concentration of heavy metals in top soils as obtained in the wet season were: Fe(584.15mg/kg) Cu(0.66mg/kg), Zn(61.5mg/kg), Cd(<0.002 mg/kg), Cr(0.124mg/kg), Pb(3.53mg/kg), Ni(0.745 mg/kg), V(<0.002 mg/kg).

Also the mean concentration of heavy metals in sub soils as obtained in the wet season were: Fe(495.12mg/kg) Cu(0.934mg/kg), Zn(0.425mg/kg), Cd(<0.00 mg/kg), Cr(0.282mg/kg), Pb(3.517mg/kg), Ni(0.92mg/kg), V(<0.002 mg/kg).

On the other hand, the mean concentration of heavy metals in top soils as obtained in the dry season were: Fe(306.6mg/kg) Cu(15.97mg/kg), Zn(11.66mg/kg), Cd(<0.605mg/kg), Cr(24.57mg/kg), Pb(0.98mg/kg), Ni(0.48mg/kg), V(0.11 mg/kg).

Also, the mean concentration of heavy metals in sub soils as obtained in the dry season were: Fe(343.7mg/kg) Cu(17.71mg/kg), Zn(14.22mg/kg), Cd(0.95 mg/kg), Cr(29.44mg/kg), Pb(1.43mg/kg), Ni(0.75mg/kg), V(0.125 mg/kg).

Microbiology

Wet Season: For top soils, Total heterotrophic bacteria (THB) ranged between 0.12 x10^3cfu/100g and 2.76 x10^3cfu/100g while Total Heterotrophic Fungi ranged from 0.03 to 1.28 x10^3cfu/100g.

For sub soils Total heterotrophic bacteria (THB) ranged between 0.34 and 3.44 x10^3cfu/100g while Total Heterotrophic Fungi ranged from 0.06 to 1.36 x10^3cfu/100g.

Dry Season: For top soils, Total heterotrophic bacteria (THB) had a mean value of 14 x10^3cfu/100g while Total Heterotrophic Fungi had a mean value of 1.1 x10^3cfu/100g

For sub soils Total heterotrophic bacteria (THB) had a mean value of 13.5 x10^3cfu/100g while Total Heterotrophic Fungi had a mean value of 1.1 x10^3cfu/100g

Furthermore, the hydrocarbon utilizing bacteria and Hydrocarbon utilizing fungi were low during wet season and could not be found during dry season in the soil. (see appendices 4.5 – 4.6)

Table 4.25a: Summary of Physico-Chemical and Microbial Properties of the Soils Sampled at the Project Area (Wet Season)

	Top Soil (0-15 cm)					Sub Soil (15- 30 cm)				
Physico-chemical	**MIN**	**MAX**	**AVG**	**StDev**	**Control**	**MIN**	**MAX**	**AVG**	**StDev**	**Control**
pH	6.00	6.90	6.45	0.45	6.45	6.00	6.90	6.45	0.45	6.45
Electrical Conductivity, µS/cm	40.00	310.00	175.00	135.00	68.00	20.00	280.00	150.00	130.00	80.00
Total Nitrogen, mg/kg	0.00	0.33	0.16	0.16	0.15	0.00	0.59	0.30	0.30	0.18
Total Hydrocarbon Content (THC)	0.00	0.12	0.06	0.06	0.03	0.00	0.00	0.00	0.00	0.03
Bulk Density, g/cm^3	0.24	1.10	0.67	0.43	0.65	0.27	1.30	0.79	0.52	0.74
Sand%	66.20	96.01	81.11	14.91	82.10	68.50	96.85	82.68	14.18	79.17
Clay%	1.08	20.57	10.83	9.75	6.48	1.00	23.20	12.10	11.10	11.43
Silt%	0.66	21.78	11.22	10.56	12.10	1.20	19.97	10.59	9.39	13.84
Sulphate, (SO42-) mg/kg	6.26	101.43	53.85	47.59	55.66	7.34	92.87	50.11	42.77	63.33
Nitrate, (NO_3^-) mg/kg	0.00	0.17	0.09	0.08	0.04	0.00	0.15	0.08	0.08	0.05
Calcium, (Ca^{2+}) mg/kg	10.86	167.43	89.15	78.29	59.50	9.87	157.43	83.65	73.78	92.44
Magnesium,($Mg2^+$) mg/kg	1.63	42.36	22.00	20.37	26.76	1.82	39.25	20.54	18.72	24.31
Potassium, (K^+) mg/kg	6.27	86.15	46.21	39.94	27.13	7.07	76.14	41.61	34.54	27.11
Sodium, (Na^{2+}) mg/kg	10.33	206.16	108.25	97.92	86.35	7.11	142.63	74.87	67.76	111.52
Iron, (Fe) mg/kg	27.03	1141.26	584.15	557.12	491.31	116.53	873.71	495.12	378.59	599.43
Zinc, (Zn) mg/kg	0.00	123.00	61.50	61.50	0.17	0.00	0.85	0.43	0.43	0.17
Chromium, (Cr) mg/kg	0.00	0.25	0.12	0.12	0.18	0.00	0.56	0.28	0.28	0.24
Lead, (Pb) mg/kg	0.10	6.96	3.53	3.43	3.60	0.12	6.91	3.52	3.40	3.14
Copper, (Cu) mg/kg	0.11	1.21	0.66	0.55	0.74	0.14	1.73	0.93	0.79	0.67
Cobalt mg/kg	0.00	0.00	0.00	0.00	0.00	<0.002	<0.002	<0.002	0.00	0.00
Manganese mg/kg	0.00	0.00	0.00	0.00	0.00	<0.005	<0.005	<0.005	0.00	0.00
Cadmium, (Cd) mg/kg	<0.002	<0.002	<0.002	0.00	<0.002	0.00	0.00	0.00	0.00	<0.002
Mercury, (Hg) mg/kg	<0.005	<0.005	<0.005	0.00	<0.005	0.00	0.00	0.00	0.00	<0.005

Vanadium, (V) mg/kg	<0.002	<0.002	<0.002	0.00	<0.002	<0.002	<0.002	<0.002	0.00	<0.002
Nickel, (Ni) mg/kg	0.05	1.44	0.75	0.70	0.79	0.09	1.75	0.92	0.83	0.87
Barium, (Ba) mg/kg	<0.005	<0.005	<0.005	0.00	<0.005	<0.005	<0.005	<0.005	0.00	<0.005
Argon, (Ar) mg/kg	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	<0.001	<0.001	0.00	<0.001
Arsenic, (As) mg/kg	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	<0.001	<0.001	0.00	<0.001
Total Heterotrophic Bacteria (THB), Cfu/mg x 10^3	0.12	2.76	1.44	1.32	1.65	0.34	3.44	1.89	1.55	1.63
Total Heterotrophic Fungi (THF), Cfu/mg x 10^3	0.03	1.28	0.66	0.63	0.39	0.06	1.36	0.71	0.65	0.50
Hydrocarbon Utilizing Bacteria (HUB), Cfu/mg x 10^3	0.00	0.13	0.07	0.07	0.07	0.00	0.10	0.05	0.05	0.05
Hydrocarbon Utilizing Fungi (HUF), Cfu/mg x 10^2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Faecal Coliform count(Cfu/ml)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Spatial Ecosystems Limited Fieldwork, 2020
THB: Total Heterotrophic Bacteria,
THF: Total Heterotrophic Fungi, HUB: Hydrocarbon Utilizing Bacteria,
HUF: Hydrocarbon Utilizing Fungi, SRB: Sulphur Reducing Bacteria

Table 4.25b: Summary of Physico-Chemical and Microbial Properties of the Soils Sampled at the Project Area (Dry Season)

	Top Soil (0-15 cm)					Sub Soil (15- 30 cm)				
	Min	Max	Mean	StDev	Control	Min	Max	Mean	StDev	Control
pH	4.90	8.22	6.56	1.66	6.30	4.00	9.87	6.94	2.94	6.49
Electrical Conductivity, µS/cm	0.00	391.50	195.75	195.75	162.20	0.00	442.50	221.25	221.25	151.24
Total Nitrogen, mg/kg	0.00	15.36	7.68	7.68	3.49	0.00	17.23	8.62	8.62	3.17
Total Hydrocarbon Content (THC)	0.00	14.88	7.44	7.44	0.86	0.00	4.30	2.15	2.15	2.98
Bulk Density, g/cm^3	0.00	1.01	0.51	0.51	0.34	0.00	1.29	0.65	0.65	0.16
Sand%	0.00	72.40	36.20	36.20	28.70	0.00	76.54	38.27	38.27	21.63
Clay%	0.00	14.25	7.13	7.13	5.66	0.00	24.00	12.00	12.00	6.71
Silt%	0.00	20.00	10.00	10.00	6.24	0.00	36.00	18.00	18.00	6.26
Sulphate, (SO42-) mg/kg	0.00	54.00	27.00	27.00	26.21	0.00	56.00	28.00	28.00	16.85
Nitrate, (NO_3^-) mg/kg	0.00	23.50	11.75	11.75	12.53	0.00	22.10	11.05	11.05	18.05
Calcium, (Ca^{2+}) mg/kg	2.16	75.00	38.58	36.42	31.74	3.01	100.00	51.51	48.50	27.31
Magnesium,($Mg2^+$) mg/kg	0.23	79.00	39.61	39.39	12.28	0.09	98.00	49.05	48.96	14.88
Potassium, (K^+) mg/kg	0.34	24.09	12.22	11.88	4.39	0.15	18.50	9.33	9.18	5.29
Sodium, (Na^{2+}) mg/kg	0.51	69.32	34.92	34.40	20.90	0.55	75.67	38.11	37.56	29.33
Iron, (Fe) mg/kg	75.00	538.20	306.60	231.60	298.91	69.00	618.40	343.70	274.70	260.44
Zinc, (Zn) mg/kg	0.00	23.32	11.66	11.66	6.67	0.00	28.43	14.22	14.22	8.88
Chromium, (Cr) mg/kg	0.00	49.14	24.57	24.57	11.78	0.00	58.87	29.44	29.44	9.85
Lead, (Pb) mg/kg	0.00	1.96	0.98	0.98	0.91	0.00	2.86	1.43	1.43	0.39
Copper, (Cu) mg/kg	0.41	31.53	15.97	15.56	4.53	0.21	35.21	17.71	17.50	4.53
Cobalt mg/kg	0.00	1.21	0.61	0.61	0.38	0.00	1.90	0.95	0.95	0.22
Manganese mg/kg	0.00	1.20	0.60	0.60	12.82	0.00	32.54	16.27	16.27	16.17
Cadmium, (Cd) mg/kg	0.00	2.33	1.17	1.17	0.46	0.00	2.36	1.18	1.18	0.24

Mercury, (Hg) mg/kg	0.00	21.58	10.79	10.79	ND	0.00	1.00	0.50	0.50	0.19
Vanadium, (V) mg/kg	0.00	0.22	0.11	0.11	0.05	0.00	0.25	0.13	0.13	0.04
Nickel, (Ni) mg/kg	0.00	0.96	0.48	0.48	0.42	0.00	1.50	0.75	0.75	0.52
Barium, (Ba) mg/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Argon, (Ar) mg/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arsenic, (As) mg/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Heterotrophic Bacteria (THB), Cfu/mg x 10^3	0.00	28.00	14.00	14.00	3.80	0.00	27.00	13.50	13.50	4.00
Total Heterotrophic Fungi (THF), Cfu/mg x 10^3	0.00	2.20	1.10	1.10	1.00	0.00	2.20	1.10	1.10	0.20
Hydrocarbon Utilizing Bacteria (HUB), Cfu/mg x 10^3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrocarbon Utilizing Fungi (HUF), Cfu/mg x 10^2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Faecal Coliform count(Cfu/ml)	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.40

THB: Total Heterotrophic Bacteria,
THF: Total Heterotrophic Fungi, HUB: Hydrocarbon Utilizing Bacteria,
HUF: Hydrocarbon Utilizing Fungi, SRB: Sulphur Reducing Bacteria

4.9 Land use Pattern along Fibre optic Route

The following descriptions apply to land uses indicated on the route map of the proposed Fibre optic cable installation. Land use classifications are organized into the following categories: Residential, Mixed use, Commercial, Institutional, Recreational, Agricultural, Forestry, industrial and Public/Open Space.

4.9.1 Land-Use Approach & Method

Land use was examined from both a historical and regional perspective. Site specific analysis of the proposed landing site and for areas within 20-30 metres on both sides of the road within the right of way was seen as an appropriate extent for the area of interest. Relevant land uses immediately adjacent to the outer limits of the selected buffer was also taken into account. The following were also useful in the investigation:

- Aerial Photographs,
- Satellite Imagery of the area dating 2020 (Google Earth), and
- The use of field surveys to incorporate regional observations and documentation of existing land use, while providing verification of land use patterns depicted on the maps.

An accurate and thorough account of past and current land uses in the study area demanded a multi-faceted approach for collating land use information for the area.

4.9.2 Land Use Description along the Cable Route.

The predominant types of land use common along the route are Agricultural, Commercial, Institutional, Residential and Mixed use. The fibre optic cable route within the major cities, towns and villages cut across commercial land use and institutional land use except for rural areas and villages where mixed use of commercial land use and residential land use are noticed. It is a common phenomenon to see commercial land use springing up along major road networks or route.

Outside the settlement areas along the cable route is a long stretch of Vegetation and Agricultural land uses noticeable on both sides of the road. Within the North Central Zone from Ilorin to Lokoja, agricultural crops like maize, millet, beans and yam are the major agricultural crop along the route. While the south west zone presents a secondary forest re-growth, with sparse population of various food crops. Major changes, which had occurred during the wet season sampling included denser thicket and taller canopy stature of the predominant vegetation types, greener coloration of the leaves for both planted crops and wild plants and the submergence of some low growing grasses in the lowland areas along the proposed fibre cable route.

The various agricultural land use practice encountered in the study area include, Crop farming to produce cowpea, groundnuts, maize, sorghum, benni seed and leafy vegetables. Shifting cultivation or land rotation practices are however, generally fairly rudimentary, based almost entirely on traditional slash and burn techniques being enhanced by the annual bush fires. This takes place on the up slopes and middle slopes. Under suitable conditions, flood plains are used for intensive cultivation of rice in the wet season, and in the dry season irrigated leafy vegetables are cultivated.

4.10 Flora and Fauna Studies

4.10.1 Flora

Composition of floral species along the optic fibres routes:
Vegetation sampling was conducted using systematic sampling procedure. The vegetation of the proposed site was assessed using a 1 m square meter quadrat to estimate herbaceous flora of the plot. The vegetation of the site was randomly assessed for floristic identification using a 1m square meter quadrat because it was mainly composed of herbaceous plants. All species were identified to species level following Akobundu and Agyakwa (1987), and Hutchinson and Dalziel, (1968). Families and common names of plant species were provided also. At each sampling point, the floral diversity and population density of key economic species composition were obtained. Rare, exotic, invasive and endangered species were listed.

Samples of plants that could not be identified in the field were collected, pressed and carried to the herbarium for further identification. The health status of the vegetation was visually determined. Where a disease symptom was noticed, samples of the plant organ(s) were taken to the laboratory for identification of causative organism(s).

Data Analyses

Shannon-Weiner indices, Margalef index (as a measure of species richness), Dominance and Evenness indices using the PAST software (Harmer, 2001) were calculated.

Result

The project site is characterized with the mixture of eastern prototypes comprising of semi-savannah grassland with forests and swamps. The inhabitants of the project area are predominantly farmers and this has shown in the current deforestation and degradation that is prominent within the project area. This has resulted into existing vegetation in the project area being largely secondary in nature and typifies a derived savannah with abundance of grasses and herbs and few clumped or scattered trees, especially in the swampy forest region.

The predominant vegetation visible along these zones is the grasslands, with scattered forests and woodland areas, as well as tropical rainforest which comprise tall trees with thick undergrowth and less branches. The rainforest of southeastern Nigeria is among the richest anywhere in Africa, with very high species diversity in many taxonomic groups and numerous endemic species and subspecies, the region is widely recognized as a biodiversity ‘hotspot’ of global significance.

The vegetations along the optic fibre routes are rich in species diversity and the floristic composition is characterized by the following: *Raphia hookerii, Uapaca hendolotic, Elaeis guineensis, Pterocarpus santalinoides, Cleiostopholis patens, Anthocteista vogelii, Symphonia globulifera Mitragyna ciliata, Dalbergia ecastaphythm, Alchornea cordifolia, Ficus spp., Treculia africana. Rauwolfia macrophylla, Funtumia africana, Alstonia cinerria, Musanga necropolises, Albania spp., Klainedoxa gabonensis, and Irvingia gabonensis Necropolises, Albania spp., Klainedoxa gabonensis, and Irvingia gabonensis* occur in this ecotype mostly.

The species according to Raunkaerian classification showed that most of the plant species belong to the Phanerophytes. The helophytes and epiphytes were the least. This shows the woody nature of the forest. There is a serious and indiscriminate exploitation of the fresh forest water species. Restriction and strict laws on felling and logging is necessary in such areas.

The physiognomy of the vegetation of the project site is classified into three distinct layers, namely the upper, middle and the lower layers. The upper layer include species of Alstonia booneii, Piptaderiastrum africanum, Klainedoxa gabonensis etc. The second canopy layer is completely closed with marked canopy contact. Species in this layer are between 11 – 18 m tall and include

Cleiostopholis patens, Raphia spp., Anthocleista vogelii, Uapaca hendelotii, Musanga cecropoides. The lowest strata is poor in species composition and occupied by herbs, ferns, grasses, sedges and some lianas. These include Maranthocloa congensis, Cyrtosperma senegalensis, Afromomum spp., Costus afer and Diplazium sammantic. In the gaps, dense tangles of shrubs and lianas practically form impenetrable vegetation closely held together. These completely cover and overhang the entire forest.

In general, the project site is dominated with mosaic of lowland moist forest, derived savanna and farmland/plantation. The Red List Category and Criteria of IUCN provided assessment for all the plant species encountered within the proposed site of the project. Majority of the plant species are rated least concerned (LC) and some not evaluated (NE) while their uses ranged from medicinal purposes, ornamental and source of food. Species like Chromolaena odorata, Sida corymbosa, Sida acuta, Commelina diffussa, Elusine indica, and Panicum maximum were quite abundant.

Lowland Rainforest (Mixed tropical Rainforest)
The lowland rainforest formation is the most dominant forest type of the study area. Quite unfortunate that this forest is very discontinuous and in most areas are seen remnants of its own self. The stages of re-growth and maturity of this forest differ at different places along both sides of the proposed project area. In fact, human activities such as bush clearing, fuel wood gathering, road construction among others have greatly transformed the structure and probably species richness of this vegetation type.

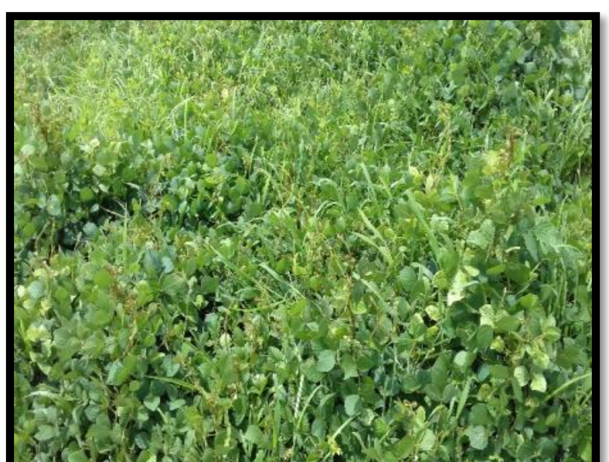


Plate 4.7: Vegetation of the Area: *Vernonia sp* and *Vigna gracilis*


Plate 4.8: Vegetation of the Area: *Panicum maximum*

Derived Savanna

The grassland areas are considered to be derived savannah, as a result of the destruction of forest for agricultural purposes and subsequent bush burning. This area is characterized with major grassland coverage with small areas of shrub species and smaller trees but dominated by *Elaeis guineensis* (Plate 4.9). Several tracks and roads have created through the grassland areas by pedestrian and vehicular access related to the gathering of wood for fuel as well as lumbering activities. This has provided increased better access for further exploitation of the trees in the area. The burning of the vegetation in the areas for cultivation further reduces the number of trees and shrubs and (if not used for cultivation) further contributes to the expansion of the grassland area.

Plate 4.9: *Elaeis guineensis* standing vegetation

Farmland / Plantations

The types of farms and plantations in the project area in include, Cocoyam farms, yam farms, Cassava farms, Gmelina plantations Oil palm plantations, Banana, Plantain plantations, rice farms and pineapple plantations.

Plate 4.10: Mosaic of *Xanthosomas esculentum* and *Manihot esculentum*

Though most of these farms are smallholdings and may mainly serve for subsistence, some cassava farms and Palm plantations along the optic fibre routes. Most of these existing plantations cover hundreds of hectares of farmland thus indicating their commercial status. Other crop plants identified in some of these farms are *Chrysophyllum albidium, Artocarpus communis, Dacroides edulis, psidium guajava* and *Cola acuminate*.

Crops predominantly cultivated are Cassava *(manihot esculenta*), Potatoes (*Ipomea batatas*), Cocoyam (*Colocosia esculenta*), Fluted pumpkin (*Telferia occidentalis*), Eggplant *(Abelmuschus esculenta*), Yam (*Discorea cayensis*), Mango (*magnifera indica*), Coconut (*Cocus nucifera*), Pepper (*Piper nigrum*) and Oil palm (*Elaeis guineensis*).

Table 4.26: Flora List within project site

S/No	Species	Common Name	Family	Growth Form	Conservation Status	Uses	Part Used
1	*Boerhavia diffusa L.*		*Nyctaginaceae*	Herb	LC	Used as Pain relief, anti-cancer anti-inflammatory, and for the treatment of jaundice, diabetes and protect eye sight.	Root & leaves
2	*Axonopus compressus*	Carpet Grass	*Poaceae*	Grass	LC	used as a permanent pasture, groundcover, and turf	Leaves
3	*Tridax procumbens*	Coat Button	*Asteraceae*	herb	NE	Used for wound healing and as an anticoagulant, antifungal, and insect repellent	Whole plant, leaf
4	*Rhoeo discolor*	Purple flower	*Commelinaceae*	Herb	NE	Ornamental	
5	*Desmodium triflorum*		*Fabaceae*	herb	NE	Medicinal	Root, Leaves
6	*Musa sp*	Banana	*Musaceae*	Herb	NE	Food, Medicine	Leaves, Fruit
7	*Azadirachta indica*	Neem	*Meliaceae*	Tree	LC	Medicine	Leaves, Bark
8	*Canna indica*	Arrow shot	*cannaceae*	herb	NE	Medicine, Ornamentals	
9	*Mangifera indica*	Mango	*Anarcadiaceae*	Tree	DD	Food. Medicine	Leaves, Fruit, Bark
10	*Talinum triangulare*	Water Leaf	*Portulacaceae*	Herb	LC	Food Medicine	Leaves
11	*Elaeis guineensis*	Oil Palm	*Arecaceae*	Tree	LC	Food, Medicine	Leaves, Fruits
12	*Sida acuta*	Stubborn Weed	*Malvaceae*	Herb	LC	Medicine	Leaves
13	*Phyllatus n iruri*	Stone breaker	*Euphorbiaceae*	Herb	LC	Medicine	Whole Plant
14	*Ficus benjamina*	Weeping Fig	*Moraceae*	Tree	NE	Ornamental	Whole Plant
15	*Cocos nucifera*	Coconut	*Arecaceae*	Tree	NT	Food, Medicine	Fruit,

							Whole Plant
16	*Platycerium sp*	Staghorn Ferns	*Polypodiaceae*	Herb	NE	Medicine	Leaves
17	*Celosia argentea*	silver cock's comb	*Amarantaceae*	Herb	NE	Food	Leaves
18	*Eleusine indica*	Goose grass	*Poaceae*	Grass	LC	Medicine	Whole Plant
19	*Ficus exasperata*	Sand paper tree	*Moraceae*	Tree	LC	Medicine	Leaves, Bark
20	*Aspilla africana (Pers,) Adams.*	Marigold	*Asteraceae*	Herb	LC	Heals wound and sores, stops bleeding, treats fever, skin diseases such as athlete's foot, night sweats, tuberculosis, gonorrhoea, cough and stomach trouble. As enema to pregnant women to quicken and ease delivery.	Leaves Whole plant
21	*Cassia occidentalis Linn syn. Senna occidentalis (L) Link*	Senna	*Caesalpiniaceae*	Tree	LC	Treats liver problems, asthma, bronchitis; menstrual problems, tuberculosis, anaemia, gonorrhoea, urinary tract disorders, constipation in babies, wounds, expels worms, reduces fever and inflammation and as analgesic	Leaves, flowers, roots and seeds
22	*Delonix regia*	Flamboyant	*Fabaceae*	Tree	LC	Ornamental, Medicine	Leaves, Bark
23	*Polylathia longifolia*	Masquerade Tree	*Annonaceae*	Tree	LC	Ornamental	Leaves
24	*Euphorbia milli*	Crown of Thorns	*Euphorbiaceae*	Shrub	LC	Ornamental	Whole Plant
25	*Plumeria rubra*	Frangipani	*Apocynaceae*	Tree	NE	Ornamental, Medicine	Leaves, Bark

26	*Acalypha wilkesiana*	Copperleaf	*Euphorbiaceae*	Herb	NE	Ornamental, Medicine	Leaves
27	*Syagrus romanzoffiana*	Cocos palm	*Arecaceae*	Tree	NE	Ornamental	Whole Plant

4.10.2 Fauna

The fauna species along the optic fibre routes are enumerated based on the presence of the species and observation of their faeces and reports from residents and hunters using questionnaire. The wildlife status of the project location is a reflection of the vegetation/habitat type of the area. The proximity of the proposed site to a busy road with noise affected the sighting and detection of wildlife in the plot.

The well branched trees are habitats to avifauna species, crawling reptiles, arboreal primates, arthropods, molluscs and small mammals. The ecological homogeneity provided by the large Palm tree populations implies that a uniform range of species are observable of large areas.

Nevertheless, four animal species were mentioned as forbidden, either for reasons of culture, taboo, religion personal dislike or on health grounds. These include; Tortoise, Monkey, Gorilla and Python.

Table 4.27: Forbidden animals in the study area

Common Names	Scientific Name	Conservation status
Tortoise	Geochelore eleganus	Least concern
Monkey	Cercopithecus mona	Endangered
Gorilla	Gorilla gorilla	Critically endangered
Python	Python sabae	Least concerned

The wildlife species of the study area have been well documented (Ita 1984; Happold, 1987; Anadu and Green 1990; Powell 1993, 1995, 1997; Akani et al. 1999, 2004, 2008).

The data shows that a total of 81 vertebrate wildlife species are presently resident in the area and its environs. This comprises:
30 mammalian species;
30 avian species;
21 reptilian species.

Animals that are labelled "rare", "threatened" or "endangered" are protected by law. Most nations have promulgated laws that protect conservation -reliant species which for example, forbids hunting, restricts land development or creating perseveres. Some animal species are protected from hunting, poaching and trading because their numbers are small and the produce no surplus harvest. For example, the Gorilla (Gorilla gorilla), has a gestation period of nine months and nurses its young ones for over six years. A loss of a mother or a baby therefore is critical to the already depleted population of these species.

Nigeria is a signatory to international laws and a member of bodies such as CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) which discourages illegal trans -border trades on endangered animal and plant products such as Ivory of Elephants, hides of yellow Antelopes etc.

Amphibia

Several breeding grounds for amphibians were spotted and their croaking sound and calls were rampant. The bulk of the amphibians recorded were from the streams and wet grasses in the area. The commonest of the amphibian fauna was the African toad; Bufo regularis AM/88 followed by the true frog, Rana temporaris (AM/89). Other amphibians of note, but which were not ubiquitous, were the Ptychadena sp., Dicroglosus occipitalis, and the Goliath frog (Gigantorina goliath).

Aves

The study area has a large and diverse population of avian species especially around Farmlands and bush fallows/secondary forest regrowth. High vocalisations were heard during the sampling survey in all the vegetation types of the study area. Dominant avian species identified in the study area include: Night jar (Caprimulgus vociferous), Pied Hornbill (Tockus fasciatus), Little Green bulbul (Andropadus virens), Red eyed dove (Streptopelia semitorguata), lesser striped swallow (Hirundo abyssinica), African cuckoo Hawk (Aviceda cuculoides), Black-shouldered kite (Elanus caeruleus). Plate below shows representative birds of the project area.

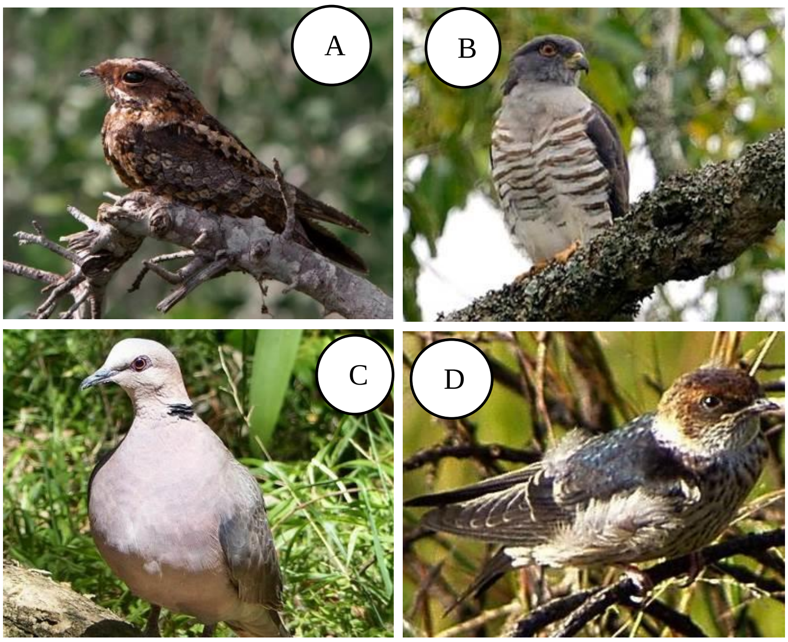


Plate 4.11: Representative birds of the project site: A: *Caprimulgus vociferous,* B: *Tockus fasciatus*, C: *Streptopelia semitorguata*, D: *Hirundo abyssinica*

Table below shows checklist of avian species found and reported along the optic fibre routes.

Table 4.28: A Checklist of Avian Species in the Study Area

BIRDS	STATUS IN STUDY AREA	LOCAL NAMES	IUCN	WCMC	ACT 11 of 1985	NUMBER SEEN	MODE OF DETECTION
Caprimulgidae				++			
Night jar – *Caprimulgus vociferus*	C			++	-	1	Direct sighting
Cuculidae							
Centropus grilli	C			+	-		Direct sighting
Bucerotidae							
Pied Hornbill - *Tockus fasciatus*	C			+	-	3	Direct sighting
White Crested Hornbill - *Tropicranus albocristatus*	C			+	-	5	Direct sighting
Apodidae							
Apus barbatus	C			+	-	1	Direct sighting
Pycnonotidae							
Little Green bulbul - *Andropadus virens*	C			++	2	1	Direct sighting
Red-Tailed Greenbul - *Criniger Calurus*	C			+	-	-	Questionnaire
Fringillidae							
Yellow-fronted canary-*Serinus mozambiscus*	C			+++	-	1	Direct sighting
Columbidae							
Green Fruit - Pigeon - *Treron a calva*	C			+	-	-	Questionnaire
Red eyed dove - *Streptopelia semitorguata*	C			++	-	-	Questionnaire

Tambourine Dove - *Turtur tympanistria*	C			+	-	1	Direct sighting
Laughing Dove - *Prinia subflava*	C			+++	-	1	Direct sighting
Ploceidae							
Black - headed weaver - *Ploceus melanocephalus*	C			+	-	-	Questionnaire
Grey - headed sparrow - *Passer griseus*	C			+++	-	1	Direct sighting
Pin-tailed whydah - *Vidau macroura*	C			+	-	1	Direct sighting
Blue Plantain-eater- *Corythaeola cristata*	C			+	-	-	Questionnaire
Estrildidae							
Orange - cheeked waxbill - *Estrilda melpoda*	C			+	-	-	Questionnaire
Numididae							
Helmeted Guineafowl - *Numida meleagris*	C			++	-	-	Questionnaire
Crested Guineafowl - *Guttera pucherani*	C			+	-	-	Questionnaire
Ardeidae							
Little Egret - *Egrelta garzetta*	C	Lekeleke		+++	-	2	Direct sighting
Great White Egret - *Egretta alba*	NU	Lekeleke		+	-	1	Direct sighting
Nectarinidae							

Yellow Bellied sunbird - *Nectarinia venusta*	C			+++	-	2	Direct sighting
Olive-bellied sunbird - *Cinnyris chloropygius*	C			+	-	-	Questionnaire
Olive sunbird - *Cinnyris olivacea*	C			+	-	-	Questionnaire
Carmelite sunbird - *Chalcomitra fuliginosa*	C			+	-	-	Questionnaire
Turdidae							
Turdidae pelios	C			+	-	1	Direct sighting
Pycnonotidae							
Pycnonotus barbatus	C			+	-	1	Direct sighting
Hirundinidae							
Lesser striped swallow - *Hirundo abyssinica*	C			+	-	-	Questionnaire
Common house martin - *Delichon urbica*	C		EN	-	-	-	Questionnaire
Motacillidae							
Yellow Wagtail - *Matacilla flava*	C			+	-	1	Direct sighting
Plain-backed Pipit - *Anthus leucophrys*	C			+	-	-	Questionnaire
Estrildidae							
Bronze manikin - *Lonchura cuculiata*	C			++	-	1	Direct sighting
Accipitridae							
Lizard Buzzard - *Kaupifalco monogrammicus*	C			-	1	-	Questionnaire
African cuckoo Hawk – *Aviceda cuculoides*	C			+++	-	2	Direct sighting

Black-shouldered kite – *Elanus caeruleus*	C			+++	-	1	Direct sighting
Lappet-faced vulture – *Torgos tracheliotus*	C			+	-	-	Questionnaire

KEY: C=Common, EX=Extinct, R: Rare, EN: Endangered, NU= Not uncommon (Animals or birds that will be seen by anybody who makes effort to search for it in the area), A=Abundant, IUCN= International Union for the conservation of nature, WCMC= National Ranking in WCMC's 1988 Nigeria Biodiversity Report: + = Few; ++ = Common; +++ = Abundant, Decree/Act 11 = Ranking in Federal Endangered Species Act 11 of 1985 (Schedules 1 – 2)

Reptilia and Arachnidas

The dominant reptilian species ranged from the poisonous (R/73 – R/78) types i.e. Boidae (pythons), Elapidae (Cobra), to the household lizards. Evidence of hissing sounds and habitats of snakes were observed around the secondary forest regrowth's. Plate below shows a Scorpion (Tityus serrulatus) found in the study area. Table below shows checklist of reptiles in the study area.

Plate 4.12: Scorpion (*Tityus serrulatus*)

Table 4.29: A checklist of reptiles in the study area

REPTILES	STATUS IN STUDY AREA	IUCN	WCMC	ACT 11 of 1985	MODE OF DETECTION
Testudinidae					
Serrale hinge-back tortoise - *Kinixys erosa*	C		+	-	Questionnaire
Boidae					
Royal Python - *Python regius*	EX		+	-	Questionnaire
Python sebae (African Rock Python)					
Calabaria reinhardtii (Calabar Python)					
Python sebae (African Rock Python)					
Elapidae					
Green Mamba - *Dendroaspis viridis*	C		+++	1	Questionnaire
Spitting Cobra - *Naja nigricollis*	NU		+	-	Questionnaire
Black Cobra - *Naja melanoleuca*	NU		+	-	Questionnaire
Colubridae					
Red-lined snake - *Bothrophthalmus lineatus*	NU		+	-	Questionnaire
Emerald snake - *Gastropyxis smaragdina*	C		+	-	Questionnaire
W. African house snake - *Boaedon virgatum.*	C		+	1	Questionnaire
Viperidae					
Burrowing Viper -	NU		+	-	Questionnaire

Atractaspis spp					
Carpet Viper - *Echis carinatus*	NU	EN	+	-	Questionnaire
Gaboon Viper - *Bitis gabonica*	NU		+	-	Questionnaire
Agamidae					
Agama Lizard - *Agama agama*	C		+++	-	Direct sighting
Scincidae					
GREY Skin - *Mabuya blandingi*	C		+	-	Questionnaire
Mabuya affinis (Blanding's snake)					
Lygosoma fernandi (Red/Fire Skink)					
Chamaeleontidae					
Chameleon - *Chamaeleo gracilis*	C		+	-	Questionnaire
Pelomedusidae					
West African Black forest turtle - *Pelusios niger*	C		+	-	Questionnaire

Mammalia

The study area has a rich mammalian fauna dominated by the *homonidae* (primates), *Sciuridae* (squirrels), *Viverridae* (Civets and mangoose) and *Bovidae* (busgbuck, sitatunga etc.). The conservation status of the aforementioned mammalian fauna was indeed satisfactory.

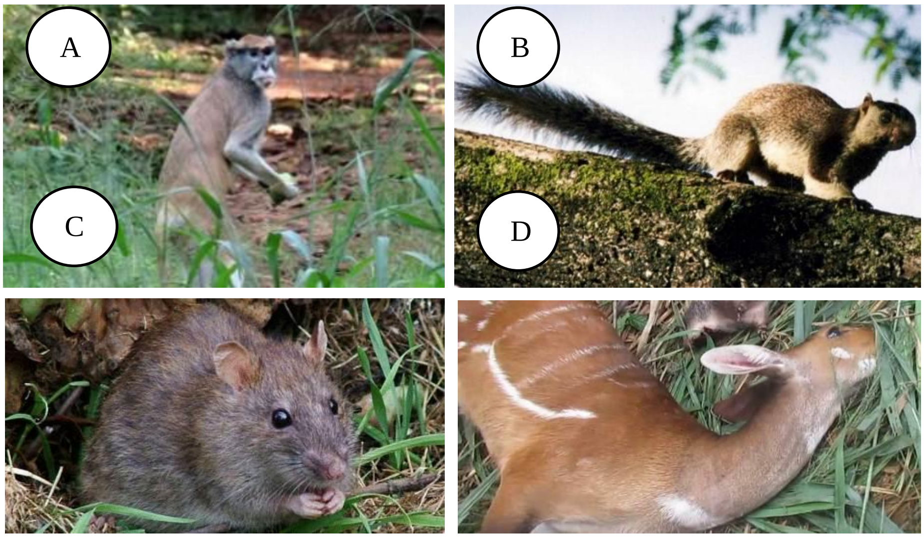


Plate 4.13: Common mammals in the study area- A: Mona monkey, B: Sciuridae, C: Gambian giant-rat

Table 4.30: Checklist of Mammalian Fauna in the Study Area

ANIMALS	STATUS IN STUDY AREA	IUCN	WCMC	ACT 11 of 1985	MODE OF DETECTION
HOMINIDAE					
Mona monkey - *Cercopithecus mona*	C		+	-	Questionnaire
Pata monkey - *Erythrocebus patas*	C	EX	+	1	Questionnaire
White-nose monkey- *Cercopithecus nicititans*	C				Questionnaire
Dwarf Galago - *Galagoides demidovii*	C				Questionnaire
Sciuridae					
Giant forest-Squirrel - *Protexerus stangeri*	C		+	-	Questionnaire
Gambian Giant-rat - *Cricetomys gambianus*	C	EN	-	1	Direct sighting
Cane rat - *Thryonomys swinderianus*	C		++	-	Direct sighting
Black rat - *Rattus rattus*	C				Direct sighting
Shaggy rat - *Dasymys incomtus*	C				Direct sighting
Striped mouse - *Hybomys vittatus*	C				
Cricetidae					
Palm Squirrel - *Epixerus ebii*					Direct sighting
Red-legged Sun Squirrel - *Helioscuirus rufobrachium*	C			1	Direct sighting
Hystricidae	C			-	
Brush - tailed porcupine - *Atherurus africanus*	C		+	-	Questionnaire
Muridae					
Giant rat -	C		+++	-	Direct sighting

Cricetomys gambianus					
Thryonomidae					
Thryonomys swinderianus - *Cane rat or Grass cutter*	C		+	-	Direct sighting
Atherurus africanus - *Brush tailed Porcupine*	C		-	2	Questionnaire
Mustelidae					
Forest Gene - *Genetta poensis*	C		+	-	Questionnaire
Leopard – *Panthera pardus*	EX				Questionnaire
Fox - *Aonyx capensis*	EX				
Carnidae					
Palm civet Serval - *Nandinia biotata*					
Bovidae					
Bush - buck - *Tragelaphus scriptus*	C		+	-	Questionnaire
Sitatunga - *Tragelaphus spekei*	C		++	-	Questionnaire
Blue duker Kob - Kobus kob					Questionnaire
Warthog - *Potamocherus porcus*	EX				Questionnaire
Bate's Pygmy Antelope - *Neotragus batesi*	C				Questionnaire
Herpestidae					
Marsh mongoose - *Atilax paludinosus*	EX		-	1	Questionnaire
Leporidae					
Bush rabbit – *Lepus capensis*	C		+++	-	Questionnaire
Manidae					
Long-tailed pangolin - *Uromanis tetradactyle*	C		+	-	Questionnaire

Tree pangolin - *Phataginus tricuspis*	C		+	-	Questionnaire
CHIROPTERA (Bats)					
Free - tailed Bat - *Tadarida pumila*	NU		+	-	Questionnaire
Viverridae					
Viverra civetta (African Civet Cat)	C				Questionnaire
Genetta poensis (Forest Genet)	C				Questionnaire
Nandinia binotata (Two-spotted Palm Civet)	C				Questionnaire
Herpestes ichneumon (Egyptian mongoose)	C				Questionnaire

KEY: C=Common, EX=Extinct, R: Rare, EN: Endangered, NU= Not uncommon (Animals or birds that will be seen by anybody who makes effort to search for it in the area), A=Abundant, IUCN= Internatioal Union for the conservation of nature, WCMC= National Ranking in WCMC's 1988 Nigeria Biodiversity Report: + = Few; ++ = Common; +++ = Abundant, Decree/Act 11 = Ranking in Federal Endangered Species Act 11 of 1985 (Schedules 1 – 2)

Soil fauna

The contributions of the soil microfauna (protozoa and nematodes) to the rhizosphere ecological functions cannot be underplayed. The microfauna in the rhizosphere play an important role in the release of nutrients available to plants, accumulation and stabilization of soil organic carbon, hormonal effects on roots and microbial diversity and functional stability, multi trophic interactions above the ground and bioremediation of contaminated soils.

Other predominant soil microfauna includes; spiders, soldier ants, earthworms, beetles and beetle larva. Most of these microfauna feed on decaying plant material and debris although centipedes, soldier ants and larger species of spiders feed on other soil microfauna. However, the larger members of this fauna group such as the ground squirrel and wild rabbit help to produce good soil structure through their burrowing and casting.

Macro fauna

The abundance of termites and ants are clearly visible by the numbers of termites and ant hills. Some of the termites' hills are over a meter tall. Crickets' mounds appear occasionally where soil texture is very soft. These mounds could be mistaken as nearly cultivated agricultural sites. The crickets' mounds occur at average of a mound per quadrat. Other macro faunal organisms present are; spiders, slugs, soldier ants' beetles and caterpillars. These animals burrow into the soil thereby aiding soil aeration and drainage. In addition, some organic materials pass through these burrows. Most macro fauna consume decaying plants materials and organic debris but centipedes, soldier ants and spiders mainly feed on micro faunal organisms.

Macro fauna biodiversity

Seven species of termites where found in the grasslands. Their total abundance was 210m2 while biomass was at 0.6gm-2. The dominant trophic group was the soil feeders, mastotermes, (320m2 and 0.4 gm-2) although the wood feeders, nasutitermes, (11m2 and 0.1gm-2) were not properly estimated due to their arboreal nature of nesting. Only three of the seven species of the soil feeders constructed epigeal nests (mounds).

The abundance of Tse Tse fly (Glossina morsitans) in the study area explains the reason for the neglect of the derived (Hursey and Slingenbergh (1991) savannah area in livestock rearing and development. These biting flies are the vectors of the disease Trypanosomiasis which is fatal to man and grazing herds. The Tse Tse fly lives in the trees and shrub covers.

4.11 Socio-economics

4.11.1 Objectives of the study

The primary objective of this study was to survey the baseline social and economic features of Oyo, Ondo, Osun, Ekiti, Ogun, Kwara, Kogi and Lagos States' communities where the proposed project is located. The aim of the study was to ascertain the potential effects of the proposed project on the social and economic lives of the people of the community including potentially positive effects. Specifically, this study was undertaken to achieve the following objectives:

- Establish baseline Socio-economic and Health Status of the host community.
- Identification or definition of ameliorative/mitigation/enhancement measures such as to protect and promote socio-economic and public safety.
- Advise on management or implementation plan so as to control levels of impacts.
- Define a monitoring mechanism that would ensure performance.
- Incorporate Socio-economic and Health factors in decision making.

4.11.2 Methodology of the Study

These were a modification of focus Group Discussion (FGDs) aimed at involving the local people as part of consultation and community engagement. The groups were made up of village head, clerics, representatives of the youth, and some selected elders of the communities. The objective of the group discussions was to identify community's perception of the proposed project, the problems associated with it, and how such problems may be mitigated. Information from such discussions was used to confirm and cross check the veracity of some of the answers provided in the questionnaires. A well-structured questionnaire was designed, field tested for cultural acceptability, amended and adopted. Interviewers were trained to administer the questionnaire on community members. All comments and contributions from the respondents were noted.

Table 4.31: Administration of Questionnaires

S/no	Community	Questionnaire administered	Questionnaire retrieved
1	Oyo	150	100
2	Osun	150	115
3	Ekiti	150	145
4	Ondo	150	100

5	Lagos	150	80
6	Ogun	150	150
7	Kwara	150	70
8	Kogi	150	95
5	Total	1,200 (100%)	855(71.25%)

A total of One Thousand, Two Hundred (1,200) questionnaires based on 50 questionnaires per a senatorial district were administered as shown in Table 4.200 above and Eight Hundred and Fifty-five (855) were retrieved. The questionnaires were administered based on age, gender, occupation income, access to infrastructure in the project locations. The questionnaires were designed to provide the age, occupation, educational level, waste and sewage disposal method, common ailment of the residents in the past six months. Also, to know the perception of the residents along the optic fibre routes about the proposed project.

4.11.3 Overview of Oyo States

Oyo State Demographics

The indigenes mainly comprise the Oyos, the Oke-Oguns, the Ibadans and the Ibarapas, all 3 belonging to the Yoruba family and indigenous city in Africa, south of the Sahara. Ibadan had been the center of administration of the old Western Region, Nigeria since the days of the British colonial rule. Other notable cities and towns in Ọyọ State include Ọyọ, Ogbomọsọ, Isẹyin, kishi, Okeho, Saki, Eruwa, Lanlate, Sepeteri, Ilora, Awe, Ilero, Igbeti, Igboho and Igbo-Ora.

There are significant groups of city-dwelling Hausa, Fulani, Igbo, as well as smaller communities of several other cultural/ethnic groups living in the state. Although Oyo State is densely populated and agriculturally oriented especially in the Oke-Ogun area of the state, nevertheless, livestock production is given a lower priority. Yet, Ibadan, the state capital, is a major livestock trading centre for the southwestern part of Nigeria. Generally, Yoruba do not rear cattle, although they may maintain a few for specific cultural or religious practices.

Oyo State Snapshot

- Total land area: 26,500 Km^2
- Capital: Ibadan
- Local Government Areas: 33 LGAs: Akinyele, Afijio, Egbeda, Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-West, Ibadan South-East, Ibarapa Central, Ibarapa East, Ido, Irepo, Iseyin,

Kajola, Lagelu, Ogbomosho North, Ogbomosho South, Oyo West, Atiba, Atigbo, Saki West, Saki East, Itesiwaju, Iwajowa, Ibarapa North, Olorunsogo, Oluyole, Ogo Oluwa, Surulere, Orelope, Ori Ire, Oyo East, Ona Ara.

- Population: 8,392,588 (Male- 4,280,220 and Female- 4,112,368)
- Vegetation: Tropical Savannah
- Major crops: Maize, Yam, Cassava, Millet, Rice, Plantain, Cocoa, Oil Palm and Cashew
- Solid minerals: Clay, Kaolin and Aquamarine

Main Investment Opportunities

Opportunities for investment exist in:

- Agribusiness
- Light Manufacturing
- Healthcare
- Tourism
- Energy
- Mining

Festivals in Oyo State

Sango Festival is an annual festival held among the Yoruba people in honour of Sango, a thunder and fire deity who was a warrior and the third king of the Oyo Empire after succeeding Ajaka his elder brother. Renamed in 2013 to World Sango Festival by the government of Oyo State, the festival is usually held in August at the palace of the Alaafin of Oyo and also observed in over forty countries around the world. Other notable festivals in Oyo State includes: Obatala Festival, Bere Festival, New Yam Festival, Egungun Festival, Ijala Festival and many more.

No shrine or deity was encountered in the course of the ESIA baseline study. Similarly, there were no sacred forests and sites of archaeological interest.

Table 4.32: Population distribution of Oyo State

LGA	POPULATION
Afijio	132,184
Akinyele	211,811
Atiba	168,246
Atisbo	109,965
Egbeda	283,643

Ibadan North	308,119
Ibadan North East	331,444
Ibadan North West	154,029
Ibadan South East	266,457
Ibadan South West	283,098
Ibarapa Central	103,243
Ibarapa East	117,182
Ibarapa North	100,293
Ido	104,087
Irepo	121,240
Iseyin	255,619
Itesiwaju	127,391
Iwajowa	102,847
Kajola	200,528
Lagelu	148,133
Ogbomosho North	198,859
Ogbomosho South	100,379
Ogo Oluwa	65,198
Olorunsogo	81,339
Oluyole	203,461
Ona-Ara	265,571
Orelope	104,004
Ori Ire	149,408
Oyo East	124,095
Oyo West	136,457
Saki East	108,957
Saki West	273,268
Surulere	140,339

Source: National Population Census, 2006

Settlements Along Route

Ibadan South West, Ibadan South East, Ibadan North West, Ibadan North, Ibadan North East, Ona Ara, Egbeda, Lagelu, Oluyole, Ogbomosho North, Ogbomosho South, Surulere, Kajola, Atiba, Oyo East , Oyo West, Afijio Akinyele, Irepo, Atisbo, Shaki West, Shaki East, Orelope, Kajola, Olorunshogo, Ori Ire. Iseyin, Itesiwaju, Iwajowa, Ibarapa North, Ibarapa Central, Ibarapa East and Ido

4.11.3.1 Socioeconomic Profiles of Oyo State

This section of the report is a summary of the main findings of socio-economic variables which are peculiar to the study area (Oyo State). Data analysed were obtained from questionnaires administered and retrieved from 100 household population spread across the various communities in the study area.

Table 4.33 shows the percent distribution of the household populations sampled. The study population profile comprised of 32% in the age category of 15-29yrs; 29% in the age category of 30-44yrs; 21% in the age category of 45-59; and 8% in the age category of 60yrs and above. The distribution of the household population by gender is depicted in Table 4.34. From 100-household populations considered, the female has 36.85% while the male has 63.15% representation.

Table 4.33: Age Distribution by Sex of Oyo State Household Population (along the optic fibre routes)

Age Range	Male (Frequency)	Percentage	Female (Frequency)	Percentage	Total (Frequency)	Percentage
15-29	22	22.00	10	10.00	32	32.00
30-44	26	26.00	13	13.00	29	29.00
45-59	11	11.00	10	10.00	21	21.00
60+	5	5.00	3	3.00	8	8.00
Total	**64**	**64.00**	**36**	**36.00**	**100**	**100.00**

Source: Wordsworth Environ Field survey (2020)

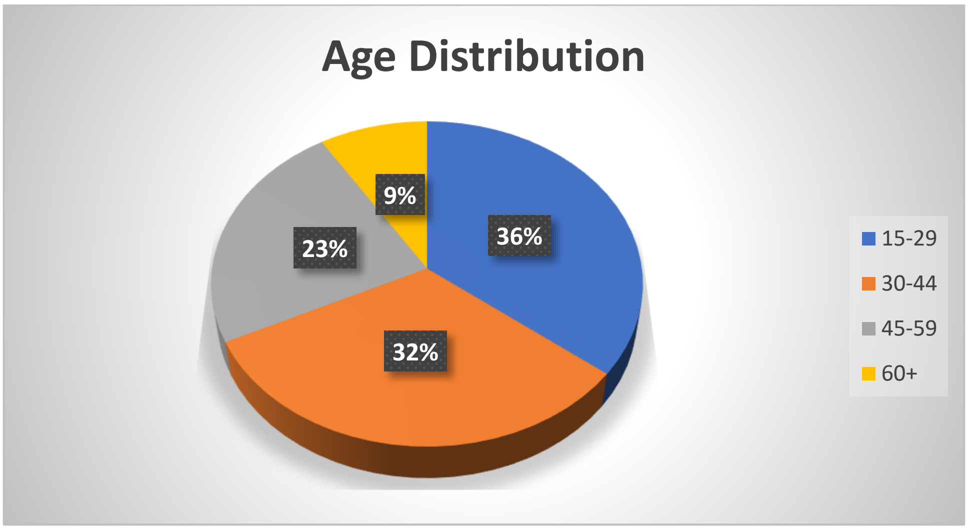


Figure 4.43: Percentage Distribution of Age Range of Oyo State Household Population

Marital Status of Household Population

The marital status of household population from 15 years old and above indicates that out of the 100-household population that constitute this age category, sixty-three (63) of them (63%) are married or living together in the family while 32 of the household population representing 32% are never married (Figure 4.44). 5 (5%) of the household population are widowed. The marital status distribution by age and sex of household population is shown in Table 4.34 below.

Table 4.34: Marital Status by Age Group and Sex of Oyo State Household Population (along the optic fibre routes)

Age Group	Married		Single		Divorced		Widow(er)		Total	
	F	M	F	M	F	M	F	M	F	M
15 – 29	5	14	4	5	0	0	0	0	9	19
30 – 44	8	16	6	9	0	0	0	0	14	25
45-59	4	13	3	5	0	0	0	0	7	18
60+	0	3	0	0	0	0	0	5	0	8
Sub total	17	46	13	19	0	0	0	5	30	70
Total	**63**		**32**		**0**		**5**		**100**	

Source: Wordsworth Environ Field survey (2020)

F= Female; M= Male

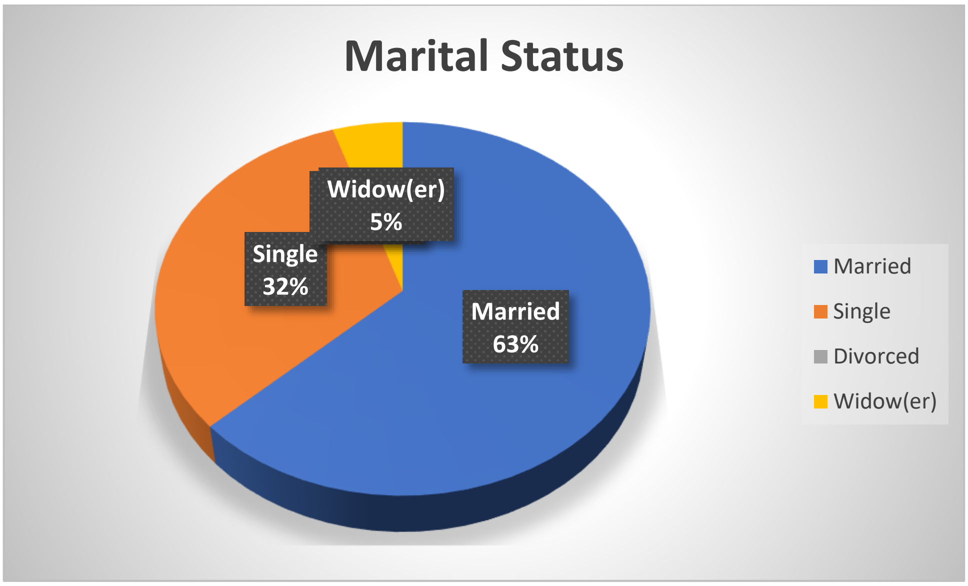


Figure 4.44: Percentage Distribution of Marital Status of Oyo State Household Population

Educational Institutions

Presently the State has 2,004 public schools, 971 private nursery/primary schools, 969 public secondary schools including 7 schools of Science and 57 private secondary schools. Also in the State, there are five government technical colleges at Oyo, Ogbomoso, Ibadan, Shaki-Okeogun and Igbo-Ora. There are also the Federal College of Animal Health and Production Technology, Ibadan; Federal College of Education (Special), Oyo, the Federal School of Surveying, Oyo; Cocoa Research Institute of Nigeria (CRIN), Institute of Agricultural Research and Training (IAR&T), the Nigerian Institute of Science Laboratory Technology (NISLT), the Federal College of Forestry, Ibadan (FEDCOFOR) a subsidiary of Forestry Research Institute of Nigeria (FRIN) and the Nigerian Institute Of Social And Economic Research (NISER), all in Ibadan.

Similarly, there are 15 Nomadic schools in the State. They are Gaa Jooro and Gaa Baale, both in Kisi (Irepo Local Government); Baochilu Government; Arin-Oye, Abiogun, Okaka and Baba-Ode (Itesiwaju Local Government); Iganna (Iwajowa Local Government); Igangan and Ayete (Ibarapa North Local Government); Gaa Kondo and Igbo-Ora, (Ibarapa Central Local Government) and Sepeteri (Saki East Local Government). There are 213 continuing education centres spread all over the State.

15 special primary schools and 8 special units in secondary schools cater for handicapped children. There are 11,732 teaching staff in the state public secondary schools and 2,789 non-teaching staff. The Agency for Adult and Non-formal Education (AANFE) caters for illiterate adults who had no opportunity of formal education. The agency has 455 classes in existence in the 33 Local Government areas of the State, while 200,000 illiterate adults and over 80,000 post-illiterate adults have been trained recently.

Plate 4.14: Cross section of Schools (primary, secondary and tertiary) in Oyo State

The table below shows the highest educational qualification of household interviewed.

Table 4.35: Highest Educational Qualification by Age Group of Oyo State Household Population (along the optic fibre routes)

Age Group	No education	Some primary	Completed primary	Some secondary	Completed secondary	More than secondary	Total
15 – 29	3	2	7	0	10	5	27
30 – 44	1	0	12	0	15	13	41
45-59	1	1	7	0	11	6	26
60+	0	1	2	0	3	0	6
Total	**5**	**4**	**28**	**0**	**39**	**24**	**100**

Source: Wordsworth Environ Field survey (2020)

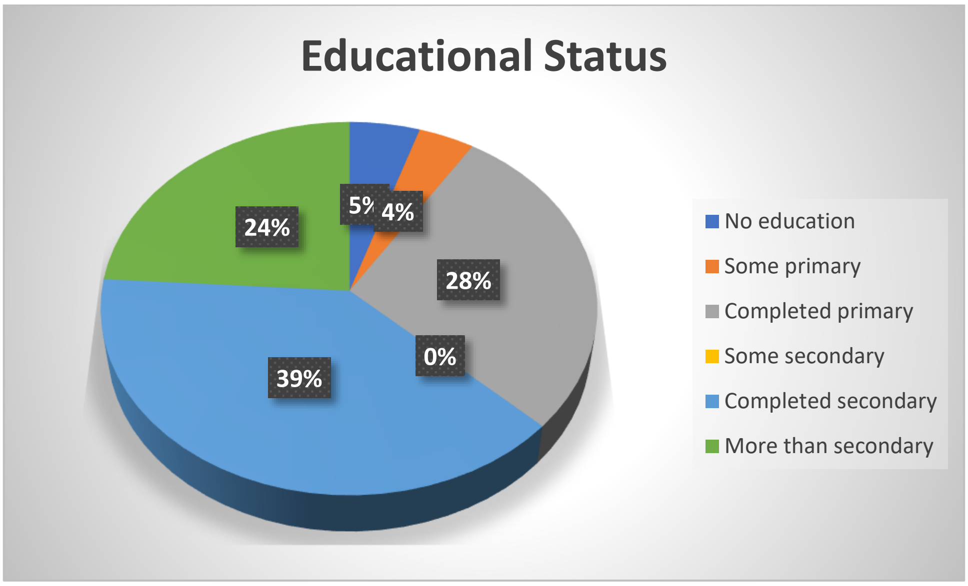


Figure 4.45: Percentage Distribution of Educational Status of Oyo State Household Population

Employment Status of Oyo State Household Population

For this group, the activities do not represent full employment and their labor is not fully utilized. They could be more profitably engaged in other activities. This group and those who in the last six months had had some temporary employment (lasting a one-hour work in a week. The Survey indicates that out of the 100-household population that constitute this age category (15 years and above), 74% of the household population are employed. The main form of occupation is manufacturing and construction as shown in Table 4.36.

Table 4.36: Employment Status by Age Group of Oyo State Household Population (along the optic fibre routes)

Age Group	Employed	Unemployed	Student/ Apprentice	Total
15 – 29	15	6	6	27
30 – 44	37	2	3	42
45-59	19	3	3	25
60+	3	3	0	6
Total	74	14	12	100

Source: Wordsworth Environ Field survey (2020)

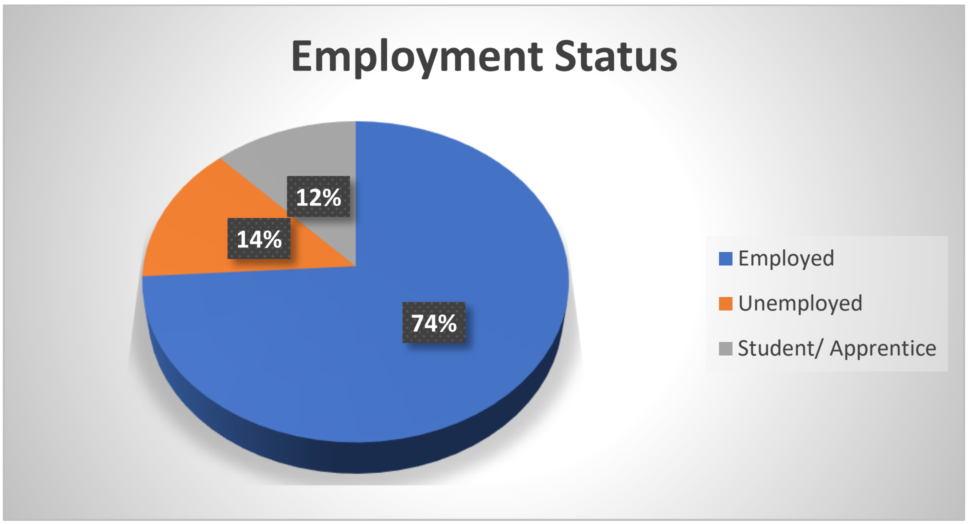


Figure 4.46: Percentage Distribution of Employment Status of Oyo State Household Population

Table 4.37: Activity in the Main Job of Oyo State Household Population (along the optic fibre routes)

Occupation (Main)	Frequency	Percentage
Agriculture, hunting or forestry and fishing	40	40.00
Mining	0	0.00
Manufacturing and Construction	7	7.00
Sales and Services	33	33.00
Others	20	20.00
No Answer	0	0.00
Total	**100**	**100**

Source: Wordsworth Environ Field survey (2020)

Income Level of Sampled Household Population

Three out of the 100 employed household population claimed that they do not actually keep records of their incomes. The breakdown of the income levels is presented in Table 4.38.

Table 4.38: Average Monthly Income Distribution of Oyo State Household Population (along the optic fibre routes)

Income Group	Frequency	Percentage	Type of Occupation
≤₦20,000	75	75.00	Agriculture, hunting or forestry, fishing, Sales and Services, others

₦20,001 – 40,000	18	18.00	Agriculture, hunting or forestry, fishing, Sales and Services Manufacturing, others
₦40,001 – 60,000	5	5.00	Agriculture, hunting or forestry Sales and Services Manufacturing, others
₦60,001 – 80,000	0	0.00	
₦80,001 – 100,000	0	0.00	
Above ₦100,000	0	0.00	
No Record	2	2.00	
Total	**100**	**100**	

Source: Wordsworth Environ Field survey (2020)

Infrastructural Facilities of Household

An analysis of infrastructural facilities in the study population is shown in Table 4.39.

Table 4.39: Infrastructural Facilities of Oyo State Household (along the optic fibre routes)

Facilities	**No. of Household**	**% of total Household**
Power Supply		
Electricity	80	80.00%
Alternative Power Supply		
Generator	69	69.00%
Primary Source of Water Supply (drinking)		
Bore Hole Hand Pump	40	40.00%
Bore Hole	5	5.00%
Well/Spring Protected	5	5.00%
Well/Spring Unprotected	15	15.00%
Rain Water /Streams/Pond/ River	35	35.00%
Tanker/Truck/Vendor	0	0.00%
Type of Refuse Disposal		
Burning	10	10.00%
Burying/Composting	0	0.00%
Open dumping in drains/borrow	60	60.00%

pit/dumpsite		
Government backed operators	25	25.00%
Nearby Bush	0	0.00%
No answer	5	5.00%
Type of Toilet Facility		
None	10	10.00%
Toilet on Water Flush to Sewage/septic	30	30.00%
Pit Latrine	60	60.00%

Source: Wordsworth Environ Field survey (2020)

Some of the households interviewed (80.00%) did have access to electricity from Ibadan Electricity Distribution Company (IBEDC). Even, those who have access to electricity are not satisfied due to regular interruption in power supply. Consequently, (69) 69% out of these households have generator as an alternative source of power supply.

Six main types of primary water supply were utilized by the households. (see table above). Protected and Unprotected well/spring accounts for 20% as their primary water source for drinking; Bore Hole and Bore Hole Hand Pump account for 5% and 40% respectively while rain/stream/river account for 35% as their primary source of drinking. The 60% households surveyed utilize Pit laterin facility while 44% of the household interviewed dispose off their waste through open dumping in drains/borrow pit or dumpsite.

Health and Sanitation

There is Federal Medical Centre in Ibadan and many General Hospitals and primary health centres along the optic fibre routes in Oyo state. There are also several privately owned hospitals.

The most common ailment found in settlements along this route include: malaria, typhoid, rheumatism, high blood pressure, diabetes, among others. There have been few cases of HIV and AIDS. The types of toilet facilities found in settlements along this route include few water closets while most people still use the pit latrine and bushes. The wastes found in the area are mostly domestic wastes ranging from garbage, papers, nylon, food waste and rags. Waste disposal method is mostly by dumping long the road in open space (see plate).

Plate 4.15: Dumping of waste Indiscriminately in Ibadan

Issues Raised by Residents

Residents along this route were very excited about the plan to boost internet services and communication and that it was long over-due. For this reason, they raised neither objection nor complaint but wished that the project will be executed as proposed. They also expressed the hope that the contractor would employ their youths for the optic fibre project and that any property that would be affected should be dully and fully compensated.

4.11.4 Overview of Kogi States

Kogi State Demographics

Kogi State was carved out of the old Kwara and Benue States on 27 August 1991 by the administration of former President Ibrahim Babangida. The area which today forms Kogi State was a colonial formation then known as Kabba Province. Kogi State is made up of the Igala, Kabba, Ebira and Kogi Division of the former Kabba Province. It is the most centrally located State in the country and shares boundaries with the Plateau, Niger and the Federal Capital Territory (FCT), to the North, Benue and the Anambra States to the East and on the West; it is bordered by Ondo, Kwara, Edo and Enugu States.

The State nick named "Confluence State'' because of the confluence of River Niger and River Benue at its capital, Lokoja.

Kogi State Snapshot

- Total land area: 27,747 Km2
- Capital: Lokoja
- Local Government Areas: 21 LGAs: Adavi, Ajaokuta, Ankpa, Bassa, Dekina, Ibaji, Idah, Igalamela-Odolu, Ijumu, Kabba/Bunu, Koton Karfe, Lokoja, Mopa-Muro, Ofu, Ogori/Magongo, Okehi, Okene, Olamaboro, Omala, Yagba East, Yagba West.
- Population: 4,750,115 (Male- 2,422,559 and Female-2,327,557)
- Vegetation: Tropical Savannah
- Major crops: Cassava, Rice, Cashew, Coffee, Cocoa, Palm Oil, Groundnuts, Maize, Yam and Melon.
- Solid minerals: Limestone, Iron Ore, Marble and Gemstone.
- There are four agricultural zones in Kogi state namely Aiyetoro-Gbede, Anyigba, Koton-karfe and Alloma.

Main Investment Opportunities

Opportunities for investment exist in:

- Agribusiness
- Manufacturing
- Healthcare
- Tourism
- Mining

Festivals in Kogi State

Ogidi Day festival is the celebration of the New Yam by the people of Kogi State. This year's celebration was special as one of our own was honored as Aro of Ogidi land. The No. 1 traditional drink, Eagle Schnapps was powerfully represented at the event. Other notable festivals in Kogi State includes: Italo Festival, Ogani Festival and many more.

No shrine or deity was encountered in the course of the ESIA baseline study. Similarly, there were no sacred forests and sites of archaeological interest.

Table 4.40: Population distribution of Kogi State

LGA	POPULATION
Adavi	217,219
Ajaokuta	122,432
Ankpa	266,176

Bassa	139,687
Dekina	260,968
Ibaji	127,572
Idah	79,755
Igalamela-Odolu	147,048
Ijumu	118,593
Kabba/Bunu	144,579
Kogi	115,100
Lokoja	196,643
Mopa-Muro	43,760
Ofu	191,480
Ogori/Magongo	39,807
Okehi	223,574
Okene	325,623
Olamaboro	158,490
Omala	107,968
Yagba East	147,641
Yagba West	139,928

Source: National Population Census, 2006

Settlements Along Route

Adavi, Ajaokuta, Ankpa, Bassa, Dekina, Ibaji, Idah, Igalamela-Odolu, Ijumu, Kabba/Bunu, Kogi, Lokoja, Mopa-Muro, Ofu, Ogori/Magongo, Okehi, Okene, Olamaboro, Omala, Yagba East and Yagba West

4.11.4.1 Socioeconomic Profiles of Kogi State

This section of the report is a summary of the main findings of socio-economic variables which are peculiar to the study area (Kogi State). Data analysed were obtained from questionnaires retrieved from 95-household populations spread across the various communities in the study area.

Table 4.165 shows the percent distribution of the household populations sampled. The study population profile comprised of 30.52% in the age category of 15-29yrs; 38.95% in the age category of 30-44yrs; 22.11% in the age category of 45-59; and 8.42% in the age category of 60yrs and above. The distribution of the household population by gender is depicted in Table 4.165. From 95-household populations considered, the female has 36.85% while the male has 63.15% representation.

Table 4.41 Age Distribution by Sex of Kogi State Household Population(along the optic fibre routes)

Age Range	Male (Frequency)	Percentage	Female (Frequency)	Percentage	Total (Frequency)	Percentage
15-29	20	21.05	9	9.47	29	30.52
30-44	24	25.26	13	13.68	37	38.95
45-59	11	11.58	10	10.53	21	22.11
60+	5	5.26	3	3.16	8	8.42
Total	60.00	63.15	35	36.85	95	100.00

Source: Wordsworth Environ Field survey (2020)

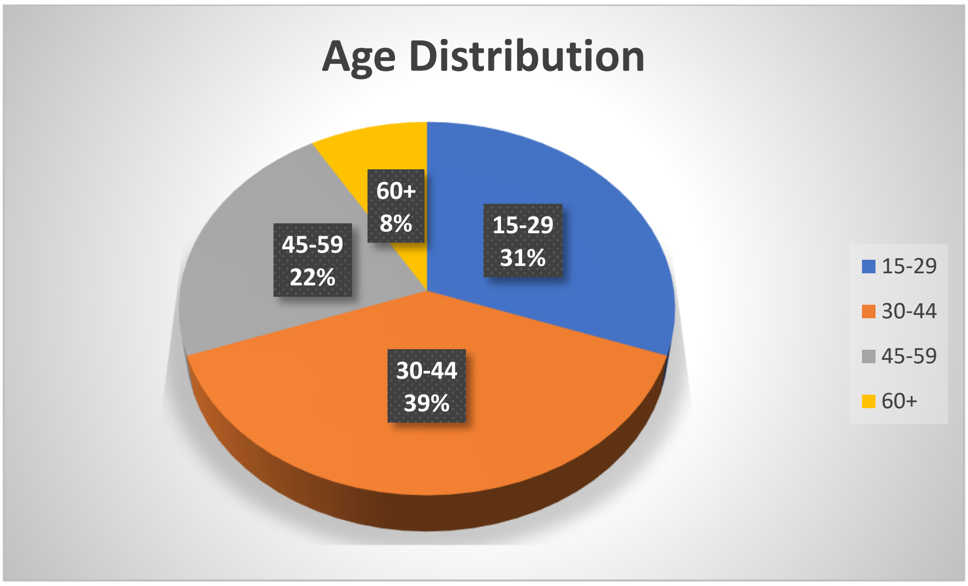


Figure 4.47: Percentage Distribution of Age Range of Kogi State Household Population

Marital Status of Household Population

The marital status of the household population from 15 years old and above indicates that out of the 95-household population that constitutes this age category, fifty-eight (58) of them (61.05%) are married or living together in the family while 34 of the household population representing 35.78% are never married (Figure 4.18). 3 (3.16%) of the household population are widowed. The marital status distribution by age and sex of the household population is shown in Table 4.166 below.

Table 4.42: Marital Status by Age Group and Sex of Kogi State Household Population(along the optic fibre routes)

Age Group	Married		Single		Divorced		Widow(er)		Total	
	F	M	F	M	F	M	F	M	F	M
15 – 29	7	11	4	5	0	0	0	0	11	16
30 – 44	9	13	8	9	0	0	0	0	17	22
45-59	4	11	3	5	0	0	0	0	7	16
60+	0	3	0	0	0	0	0	3	0	6
Sub total	20	38	15	19	0	0	0	3	35	60
Total	58		34		0		3		95	

Source: Wordsworth Environ Field survey (2020)
F= Female; M= Male

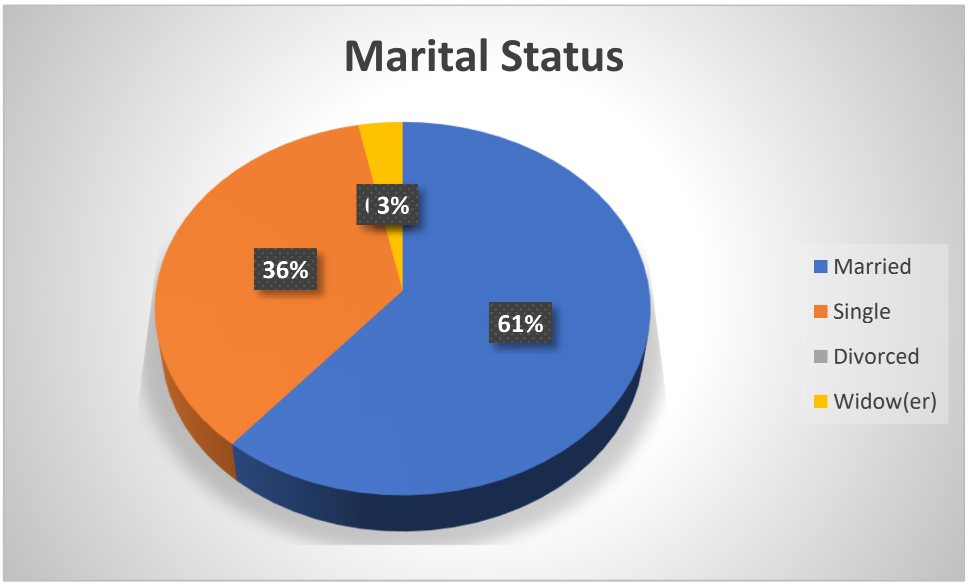


Figure 4.48: Percentage Distribution of Marital Status of Kogi State Household Population

Educational Institutions

There are several public and private owned primary and secondary schools in Kogi State. Also, there are several tertiary institutions in Kogi State which include: Kogi State University, Kogi State Polytechnic, Salem University, School of Midwifery, Kogi State College of Education e.t.c

Plate 4.16: Cross section of Schools (primary, secondary and tertiary) in Kogi State

Table 4.43: Highest Educational Qualification by Age Group of Kogi State Household Population (along the optic fibre routes)

Age Group	No education	Some primary	Completed primary	Some secondary	Completed secondary	More than secondary	Total
15 – 29	3	2	7	0	10	5	27
30 – 44	1	3	9	0	13	13	39
45-59	1	1	6	0	9	6	23
60+	0	1	2	0	3	0	6
Total	5	7	24	0	35	24	95

Source: Wordsworth Environ Field survey (2020)

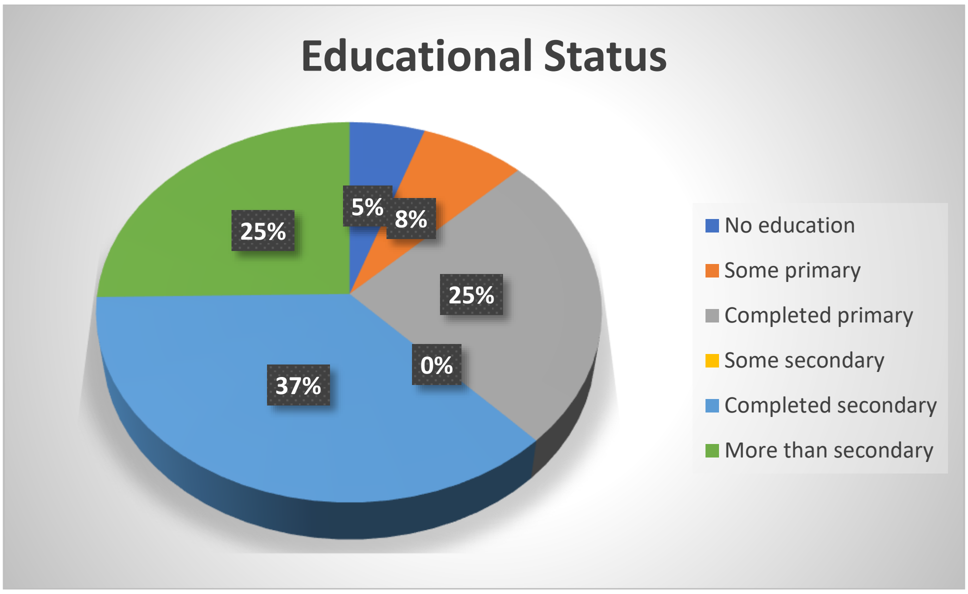


Figure 4.49: Percentage Distribution of Educational Status of Kogi State Household Population

Employment Status of Kogi State Household Population

For this group, the activities do not represent full employment and their labor is not fully utilized. They could be more profitably engaged in other activities. This group and those who in the last six months had had some temporary employment (lasting a one-hour work in a week. The Survey indicates that out of the 95-household population that constitutes this age category (15 years and above), 73% of the household population is employed. The main form of occupation is manufacturing and construction as shown in Table 4.44.

Table 4.44: Employment Status by Age Group of Kogi State Household Population(along the optic fibre routes)

Age Group	Employed	Unemployed	Student/ Apprentice	Total
15 – 29	15	6	6	27
30 – 44	34	2	3	39
45-59	17	3	3	23
60+	3	3	0	6
Total	69	14	12	95

Source: Wordsworth Environ Field survey (2020)

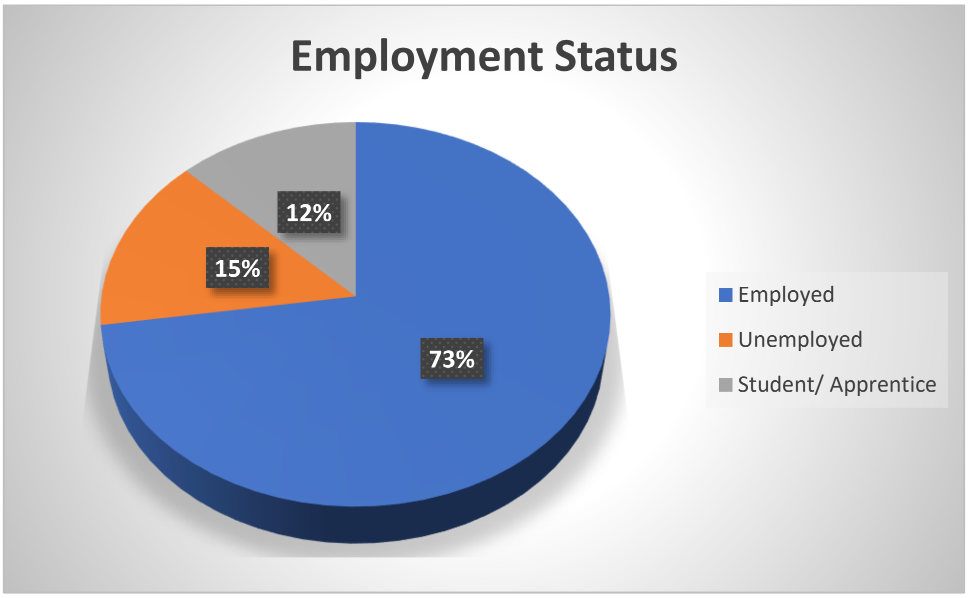


Figure 4.50: Percentage Distribution of Employment Status of Kogi State Household Population

Table 4.45: Activity in the Main Job of Kogi State Household Population(along the optic fibre routes)

Occupation (Main)	Frequency	Percentage
Agriculture, hunting or forestry and fishing	31	32.63
Mining	0	0.00
Manufacturing and Construction	10	10.53
Sales and Services	30	31.58
Others	20	21.05
No Answer	4	4.21
Total	95	100

Source: Wordsworth Environ Field survey (2020)

Income Levels of Sampled Household Population

Three out of the 95 employed household population claimed that they do not keep records of their incomes. The breakdown of the income Levels is presented in Table 4.170.

Table 4.46: Average Monthly Income Distribution of Kogi State Household Population(along the optic fibre routes)

Income Group	Frequency	Percentage	Type of Occupation
≤N20,000	70	73.68	Agriculture, hunting or forestry, fishing, Sales and Services, others
N20,001 – 40,000	19	20.00	Agriculture, hunting or forestry, fishing, Sales and Services Manufacturing, others
N40,001 – 60,000	3	3.16	Agriculture, hunting, or forestry Sales and Services Manufacturing, others
N60,001 – 80,000	0	0.00	
N80,001 – 100,000	0	0.00	
Above N100,000	0	0.00	
No Record	3	3.16	
Total	95	100	

Source: Wordsworth Environ Field survey (2020)

Infrastructural Facilities of Household

An analysis of infrastructural facilities in the study population is shown in Table 4.47.

Table 4.47: Infrastructural Facilities of Kogi State Household(along the optic fibre routes)

Facilities	**No. of Household**	**% of the total Household**
Power Supply		
Electricity	76	83.16%
Alternative Power Supply		
Generator	59	62.11%
Primary Source of Water Supply (drinking)		
Bore Hole Hand Pump	32	33.68%
Bore Hole	9	9.47%
Well/Spring Protected	9	9.47%
Well/Spring Unprotected	24	25.26%
Rain Water /Streams/Pond/ River	21	22.12%

Tanker/Truck/Vendor	0	0.00%
Type of Refuse Disposal		
Burning	22	23.16%
Burying/Composting	0	0.00%
Open dumping in drains/borrow pit/dumpsite	49	51.57%
Government-backed operators	18	18.95%
Nearby Bush	0	0.00%
No answer	6	6.32%
Type of Toilet Facility		
None	30	31.58%
Toilet on Water Flush to Sewage/septic	12	12.63%
Pit Latrine	53	55.79%

Source: Wordsworth Environ Field survey (2020)

Some of the households interviewed (83.16%) did have access to electricity from Abuja Electricity Distribution Company (AEDC). Even, those who have access to electricity are not satisfied due to regular interruption in the power supply. Consequently, (59) 62.11% out of these households have a generator as an alternative source of power supply.

Six main types of primary water supply were utilized by the households. (see table above). Unprotected well/spring accounts for 25.26% as their primary water source for drinking; Bore Hole and Bore Hole Hand Pump account for 9.47% and 33.680% respectively while rain/stream/river account for 22.12% as their primary source of drinking. The 55.79% of households surveyed utilize Pit latrine facility while 51.57% of the household interviewed dispose of their waste through open dumping in drains/borrow pit or dumpsite.

Health and Sanitation

There is Federal Medical Centre in Lokoja and many General Hospitals and primary health centres along the optic fibre routes in Kogi State. There are also several privately owned hospitals.

The most common ailment found in settlements along this route include: malaria, typhoid, rheumatism, high blood pressure, diabetes, among others. There have been few cases of HIV and AIDS. The types of toilet facilities found in settlements along this route include few water closets while most people still use the pit latrine and bushes. The wastes found in the area are mostly domestic wastes ranging from garbage, papers, nylon, food waste and rags.

Waste disposal method is mostly by dumping long the road in open space (see plate).

Plate 4.17: Dumping of waste Indiscriminately at Anyigba town

Issues Raised by Residents

Residents along this route were very excited about the plan to boost internet services and communication and that it was long over-due. For this reason, they raised neither objection nor complaint but wished that the project will be executed as proposed. They also expressed the hope that the contractor would employ their youths for the optic fibre project and that any property that would be affected should be dully and fully compensated.

4.11.5 Overview of Osun States

Osun State Demographics

Osun State, Nigeria came into existence on 27th August, 1991. The state which is one of the then nine newly created states was carved out of the old Oyo State by the then military government of General Ibrahim Babangida's administration. The state covers an area of approximately 9,251 km2 (3,572 sq mi). It is one of the 36 States which make up Nigeria. The 2006 census puts the population of the state at 3.42million. There are more than 200 towns, villages and other settlements in the state. The state has a considerable number of highly urbanized settlements, which included Osogbo, Ile-Ife, Ilesa, Ikirun, Iwo, Ede, Ila-Orangun and Ikire. Others are Ipetumodu, Ejigbo, Ilobu, Gbongan, Okuku, Inisa, Ijebu-Ijesa, Ipetu-Ijesha, Ifon-Osun etc.

Osun State is a landlocked state, having no coastal boundary in southwestern Nigeria, with its capital at Osogbo. It is bounded in the North and Ogun in the South. The state runs an agrarian economy with a vast majority of the populace taking to farming. Osun state is divided into three federal senatorial districts, each of which is composed of two administrative zones.

According to the 2006 National Population Census, Osun State has a population of 3.42 million, ranked 17th of 36 states of Nigeria. The population of Osun State is concentrated in a number of urban centres namely, Osogbo, Ilesha, Ile-ife, Ijebu-Jesa, Ejigbo, Modakeke, Ifetedo, Ede, Ikirun, Ipetu-Ijesa, Ila and Ode Omu. These urban centres are concentrated in the upper half of the state, while the smaller towns and villages are concentrated in the lower half. Even then, there are farm camps between and surrounding the major urban centres of Ile-ife, Ilesa, Ila and Ipetu-jesa. The areas of major population concentration are Ife with population figure of over 185,000, followed by Irepodun and New Orolu Local Governments with populations of over 177,000; Ede has 147,000; Ilesa has 130,000 and Osogbo Local Government comprising mainly the capital, has a population of nearly 101,000.

Osun State Snapshot

- Total land area: 9,026 Km2
- Local Government Areas: 30 LGAs: Aiyedaade, Aiyedire, Atakunmosa East, Atakunmosa West, Boluwaduro, Boripe, Ede North, Ede South, Egbedore, Ejigbo, Ife Central, Ife East, Ife North, Ife South, Ifedayo, Ifelodun, Ila, Ilesa East, Ilesa West, Irepodun, Irewole, Isokan, Iwo, Obokun, Odo Otin, Ola Oluwa, Olorunda, Oriade, Orolu and Osogbo.
- Population: 5,016,593 (Male-2,558,462 and Female-2,458,130)
- Vegetation: Tropical Savannah.
- Major crops: Cashew, Cocoa, Maize, Cassava, Oil Palm, Tobacco.
- Solid minerals: Gold, Clay, Limestone, Kaolin, Granite.

Main Investment Opportunities

Opportunities for investment exist in:

- Agribusiness
- Light Manufacturing
- Healthcare
- Energy
- Mining
- Tourism

Festivals in Osun State

Osun-Osogbo is considered as the biggest annual religious event among the Yoruba people. The event attracts spectators and worshippers from all over the world in the month of August every year. Osun is a goddess of all things feminine; fertility, spirituality, emotions, sensuality, nurture and love. Other notable festivals in Osun State includes: Egungun Festival, Olojo Festival in Ile-Ife, Sango Festival in Ede and many more.

No shrine or deity was encountered in the course of the ESIA baseline study. Similarly, there were no sacred forests and sites of archaeological interest.

Table 4.48: Population distribution of Osun State

LGA	Population
Aiyedaade	149,569
Aiyedire	76,309
Atakunmosa East	76,105
Atakunmosa West	68,350
Boluwaduro	70,954
Boripe	138,742
Ede North	83,818
Ede South	75,489
Egbedore	73,969
Ejigbo	132,515
Ife Central	167,204
Ifedayo	37,508
Ife East	188,614
Ifelodun	96,444
Ife North	153,274
Ife South	134,490
Ila	62,054
Ilesha East	105,416
Ilesha West	106,809
Irepodun	119,590
Irewole	142,806
Isokan	102,060

Iwo	191,348
Obokun	116,850
Odo-Otin	132,078
Ola-Oluwa	76,227
Olorunda	131,649
Oriade	148,379
Orolu	102,832
Osogbo	155,507

Source: National Population Census

Settlements Along Route

Aiyedaade, Aiyedire, Atakunmosa East,Atakunmosa West, Boluwaduro, Boripe, Ede North, Ede South, Egbedore, Ejigbo, Ife Central, Ifedayo, Ife East, Ifelodun, Ife North, Ife South, Ila, Ilesha East, Ilesha West, Irepodun, Irewole, Isokan, Iwo, Obokun, Odo-Otin, Ola-Oluwa, Olorunda, Oriade, Orolu, Osogbo

4.11.5.1 Socioeconomic Profiles of Osun State

This section of the report is a summary of the main findings of socio-economic variables which are peculiar to the study area (Osun State). Data analysed were obtained from questionnaires administered and retrieved from 115-household population spread across the various communities in the study area.

Table 4.272 shows the percent distribution of the household populations sampled. The study population profile comprised of 21.747% in the age category of 15-29yrs; 51.30% in the age category of 30-44yrs; 22.61% in the age category of 45-59; and 4.35% in the age category of 60yrs and above. The distribution of the household population by gender is depicted in Table 4.272. From 115-household populations considered, the female has 40% while the male has 60% representation.

Table 4.49: Age Distribution by Sex of Osun State Household Population(along the optic fibre routes)

Age Range	Male (Frequency)	Percentage	Female (Frequency)	Percentage	Total (Frequency)	Percentage
15-29	15	13.04	10	8.69	25	21.74

30-44	36	31.30	23	20.0	59	51.30
45-59	15	13.04	11	9.57	26	22.61
60+	3	2.62	2	1.74	5	4.35
Total	69	60.00	46	40.00	115	100.00

Source: Wordsworth Environ Field survey (2020)

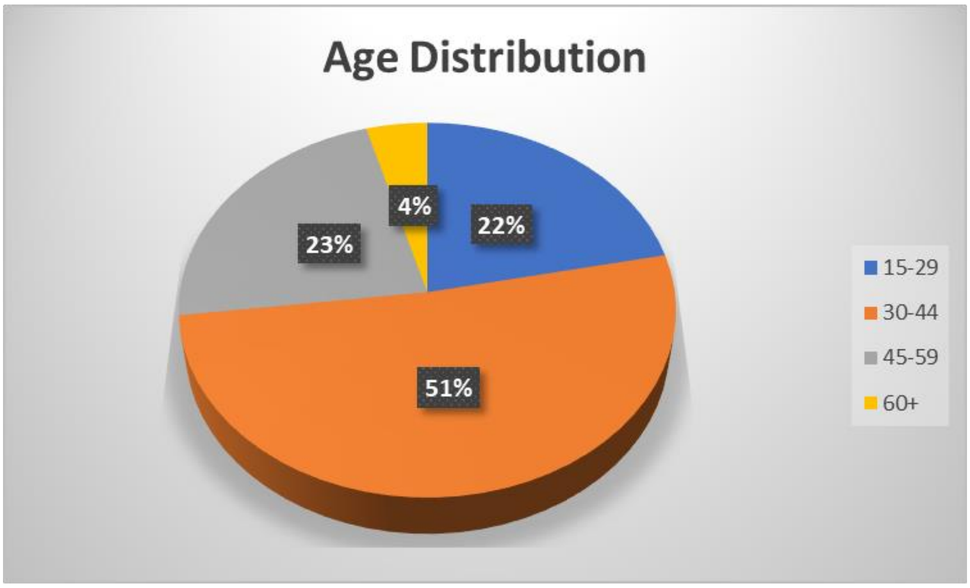


Figure 4.51: Percentage Distribution of Age Range of Osun State Household Population

Marital Status of Household Population

The marital status of household population from 15 years old and above indicates that out of the 115-household population that constitute this age category, one hundred and two (126) of them (87%) are married or living together in the family while 19 of the household population representing 13% are never married (Figure 4.34). The marital status distribution by age and sex of household population is shown in Table 4.50 below.

Table 4.50: Marital Status by Age Group and Sex of Osun State Household Population(along the optic fibre routes)

Age Group	Married		Single		Divorced		Widow(er)		Total	
	F	M	F	M	F	M	F	M	F	M
15 – 29	6	10	4	5	0	0	0	0	10	15
30 – 44	18	30	5	6	0	0	0	0	23	36
45-59	11	15	0	0	0	0	0	0	11	15
60+	2	3	0	0	0	0	0	0	2	3

Sub total	37	58	9	11	0	0	0	0	46	69
Total	95		20		0		0		115	

Source: Wordsworth Environ Field survey (2020)
F= Female; M= Male

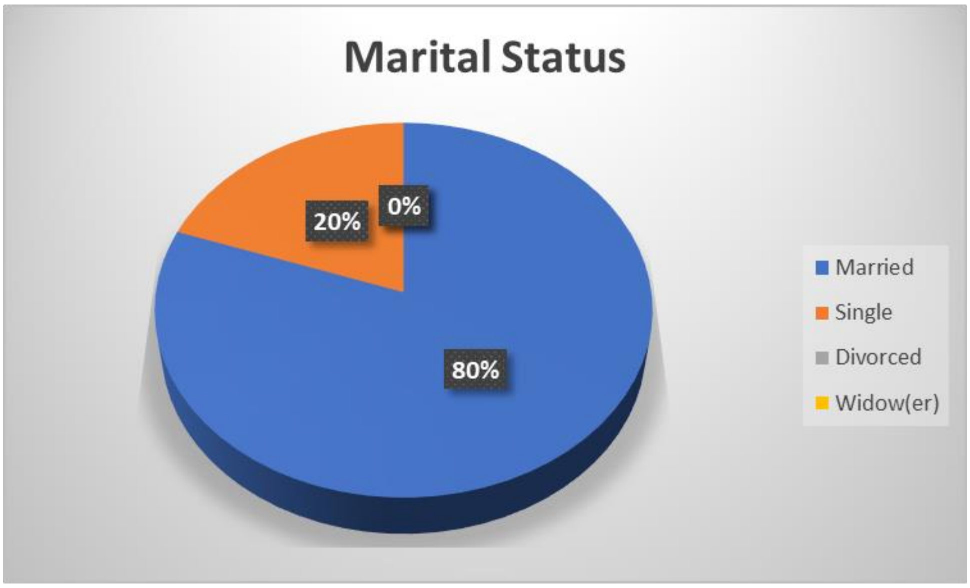


Figure 4.52: Percentage Distribution of Marital Status of Osun State Household Population

Educational Institutions

There are several public and private owned primary and secondary schools in Osun State. Also, there are several tertiary institutions in Osun State which include: Osun state University, Osun State College of Technology, Esa-Oke, Obafemi Awolowo University, Bowen University, Redeemers University, Joseph Ayo Babalola University, Fountain University, Oduduwa University, Adeleke University

Plate 4.18: Cross section of Schools (primary, secondary and tertiary) in Osun State

The table below shows the highest educational qualification of household interviewed.

Table 4.51: Highest Educational Qualification by Age Group of Osun State Household Population(along the optic fibre routes)

Age Group	No education	Some primary	Completed primary	Some secondary	Completed secondary	More than secondary	Total
15 – 29	3	0	5	0	11	6	25
30 – 44	3	0	13	0	28	15	59
45-59	1	0	5	0	15	5	26
60+	0	0	2	0	3	0	5
Total	7	0	25	0	57	26	115

Source: Wordsworth Environ Field survey (2020)

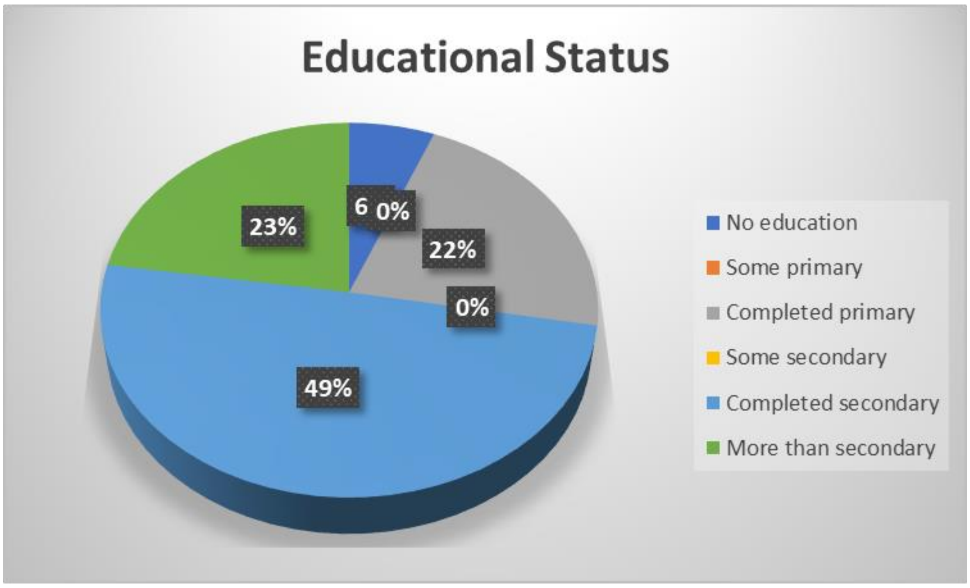


Figure 4.53: Percentage Distribution of Educational Status of Osun State Household Population

Employment Status of Osun State Household Population

For this group, the activities do not represent full employment and their labor is not fully utilized. They could be more profitably engaged in other activities. This group and those who in the last six months had had some temporary employment (lasting a one-hour work in a week. The Survey indicates that out of the 115-household population that constitute this age category (15 years and above), 74% of the household population are employed. The main form of occupation is agriculture as shown in Table 4.52.

Table 4.52: Employment Status by Age Group of Osun State Household Population (along the optic fibre routes)

Age Group	Employed	Unemployed	Student/ Apprentice	Total
15 – 29	13	5	7	25
30 – 44	48	6	5	59
45-59	20	6	0	26
60+	4	1	0	5
Total	85	18	12	115

Source: Wordsworth Environ Field survey (2020)

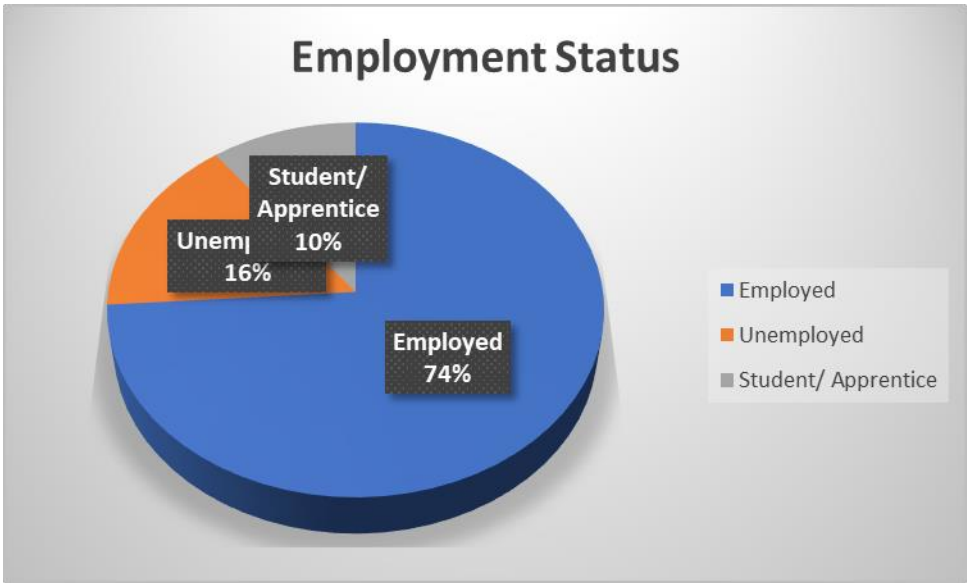


Figure 4.54: Percentage Distribution of Employment Status of Osun State Household Population

Table 4.53: Activity in the Main Job of Osun State Household Population(along the optic fibre routes)

Occupation (Main)	Frequency	Percentage
Agriculture, hunting or forestry and fishing	87	75.65
Mining	0	0.00
Manufacturing and Construction	5	4.35
Sales and Services	18	15.65
Others	5	4.35
No Answer	0	0.00
Total	115	100

Source: Wordsworth Environ Field survey (2020)

Income Level of Sampled Household Population

Three out of the 115 employed household population claimed that they do not actually keep records of their incomes. The breakdown of the income levels is presented in Table 4.54.

Table 4.54: Average Monthly Income Distribution of Osun State Household Population (along the optic fibre routes)

Income Group	Frequency	Percentage	Type of Occupation
≤N20,000	81	70.43	Agriculture, hunting or forestry, fishing, Sales and Services, others
N20,001 – 40,000	23	20.00	Agriculture, hunting or forestry, fishing, Sales and Services Manufacturing, others
N40,001 – 60,000	11	9.57	Agriculture, hunting or forestry Sales and Services Manufacturing, others
N60,001 – 80,000	0	0.00	
N80,001 – 100,000	0	0.00	
Above N100,000	0	0.00	
No Record	0	0.00	
Total	115	100	

Source: Wordsworth Environ Field survey (2020)

Infrastructural Facilities of Household

An analysis of infrastructural facilities in the study population is shown in Table 4.55.

Table 4.55: Infrastructural Facilities of Osun State Household

Facilities	No. of Household	% of total Household
Power Supply		
Electricity	95	82.61%
Alternative Power Supply		
Generator	72	62.61%
Primary Source of Water Supply (drinking)		
Bore Hole Hand Pump	33	28.70%
Bore Hole	20	17.39%
Well/Spring Protected	62	53.91%
Well/Spring Unprotected	0	0.00%

Rain Water /Streams/Pond/ River	0	0.00%
Tanker/Truck/Vendor	0	0.00%
Type of Refuse Disposal		
Burning	10	8.90%
Burying/Composting	0	0.00%
Open dumping in drains/borrow pit/dumpsite	83	72.17%
Government backed operators	22	19.13%
Nearby Bush	0	0.00%
No answer	0	0.00%
Type of Toilet Facility		
None	4	3.48%
Toilet on Water Flush to Sewage/septic	30	26.09%
Pit Latrine	81	70.43%

Source: Wordsworth Environ Field survey (2020)

Some of the households interviewed (82.61%) did have access to electricity from Ibadan Electricity Distribution Company (IBEDC). Even, those who have access to electricity are not satisfied due to regular interruption in power supply. Consequently, 62.61% out of these households have generator as an alternative source of power supply.

Six main types of primary water supply were utilized by the households. (see table above). Bore Hole and Bore Hole Hand Pump account for 17.39% and 28.70% respectively, Well account for 53.91% as their primary source of drinking. The 70.43% households surveyed utilize Pit laterin facility while 72.17% of the household interviewed dispose off their waste through open dumping in drains/borrow pit/dumpsite.

Health and Sanitation

There is Federal Medical Centre in Ile-Ife and many General Hospitals and primary health centres along the optic fibre routes in Osun State. There are also several privately owned hospitals.

The most common ailment found in settlements along this route include: malaria, typhoid, rheumatism, high blood pressure, diabetes, among others. There have been few cases of HIV and AIDS. The types of toilet facilities found in settlements along this route include few water closets while most people still use the pit latrine and bushes. The wastes found in the area are mostly domestic wastes ranging from garbage, papers, nylon, food waste and rags.

Waste disposal method is mostly by dumping long the road in open space (see plate).

Plate 4.19: Dumping of waste Indiscriminately at Ile-Ife town

Issues Raised by Residents

Residents along this route were very excited about the plan to boost internet services and communication and that it was long over-due. For this reason, they raised neither objection nor complaint but wished that the project will be executed as proposed. They also expressed the hope that the contractor would employ their youths for the optic fibre project and that any property that would be affected should be dully and fully compensated.

4.11.6 Overview of Kwara States

Kwara State Demographics

Kwara State was created on 27 May 1967, when the Federal Military Government of General Yakubu Gowon broke the four regions that then constituted the Federation of Nigeria into 12 states. At its creation, the state was made up of the former Ilorin and Kabba provinces of the then Northern Region and was initially named the West Central State but later changed to "Kwara", a local name for the River Niger.

The State nick named ''State of Harmony'' shares boundaries with the Republic of Benin at the West and the Niger River at the North, Kogi to the East, and Ekiti and Osun to the South.

Farming is the major occupation of the people, as agriculture is the main source of the state's economy.

Kwara State Snapshot

- Total land area: 35,705Km2
- Capital: Ilorin

- Local Government Areas: 16 LGAs: Asa, Baruten, Edu, Ekiti, Ifelodun, Ilorin East, Ilorin South, Ilorin West, Irepodun, Isin, Kaiama, Moro, Offa, Oke Ero, Oyun, Pategi
- Population: 3,390,330 (Male- 1,729,068 and Female- 1,661,262)
- Vegetation: Tropical Savannah
- Major crops: Rice, Cotton, Cocoa, Tomato, Sugarcane, Millet, Cassava, Soya Bean, Maize, Beniseed, Palm Produce and Ginger.
- Solid minerals: Quartz, Limestone, Marble, Feldspar, Clay, Kaolin, Granite Rocks, Silica Sand and Dolomite.

Main Investment Opportunities

Opportunities for investment exist in:

- Agribusiness
- Manufacturing
- Tourism
- Mining

Festivals in Kwara State

The Moremi or Onimoka festival features a wrestling match between the traditional ruler of Offa and his second-in-command. Although the influence of Christianity and Islam has greatly affected the annual celebration of the festival, efforts are in place to revive it. It takes place at Offa in the Offa LGA between July and August every year. Other notable festivals in Kwara State includes: Agan Festival, Patigi Regatta Festival, Awonga Festival and many more.

No shrine or deity was encountered in the course of the ESIA baseline study. Similarly, there were no sacred forests and sites of archaeological interest.

Table 4.56: Population distribution of Kwara State

LGA	POPULATION
Asa	124,668
Baruten	206,679
Edu	201,642
Ekiti	54,399
Ifelodun	204,975
Ilorin East	207,462
Ilorin South	209,251
Ilorin West	365,221
Irepodun	147,594
Isin	59,481
Kaiama	124,015
Moro	108,715

Offa	88,975
Oke-Ero	56,970
Oyun	94,454
Pategi	110,852

Source: National Population Census

Settlements Along Route

Asa, Baruten, Edu, Ekiti, Ifelodun, Ilorin East, Ilorin South, Ilorin West, Irepodun, Isin, Kaiama, Moro, Offa, Oke-Ero, Oyun and Pategi

4.11.6.1 Socioeconomic Profiles of Kwara State

This section of the report is a summary of the main findings of socio-economic variables which are peculiar to the study area (Kwara State). Data analysed were obtained from questionnaires administered and retrieved from 70 household population spread across the various communities in the study area.

Table 4.251 shows the percent distribution of the household populations sampled. The study population profile comprised of 24.29% in the age category of 15-29yrs; 52.86% in the age category of 30-44yrs; 15.71% in the age category of 45-59; and 7.14% in the age category of 60yrs and above. The distribution of the household population by gender is depicted in Table 4.57. From 70-household populations considered, the female has 33.87% while the male has 66.13% representation.

Table 4.57: Age Distribution by Sex of Kwara State Household Population (along the optic fibre routes)

Age Range	Male (Frequency)	Percentage	Female (Frequency)	Percentage	Total (Frequency)	Percentage
15-29	12	17.14	5	7.14	17	24.29
30-44	25	35.71	12	17.14	37	52.86
45-59	7	10.00	4	5.72	11	15.71
60+	3	4.29	2	2.86	5	7.14

Total	47	67.14	23	32.86	70	100.00

Source: Wordsworth Environ Field survey (2020)

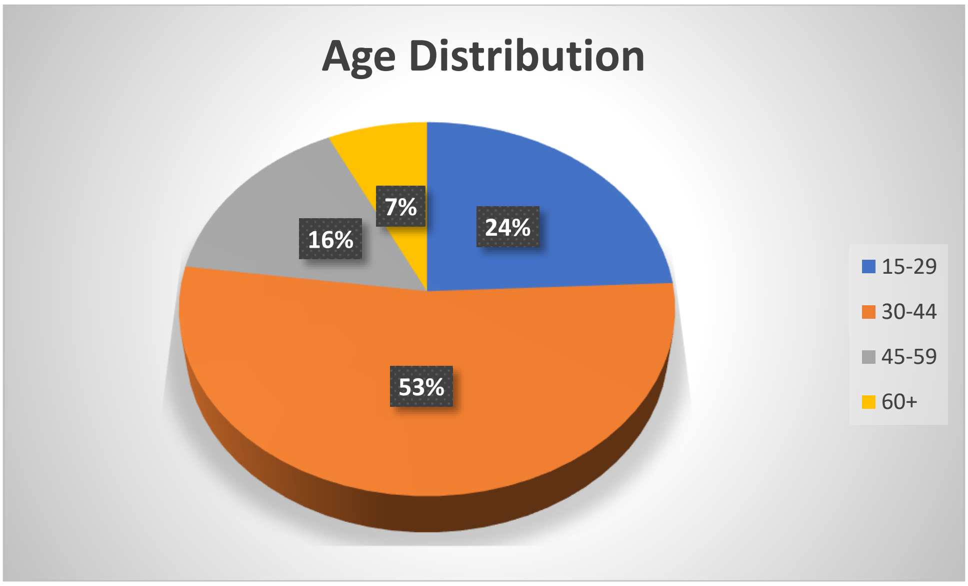


Figure 4.55: Percentage Distribution of Age Range of Kwara State Household Population

Marital Status of Household Population

The marital status of households' population from 15 years old and above indicates that out of the 70-household population that constitute this age category, two hundred and forty-nine (49) of them (70%) are married or living together in the family while 18 of the household population representing 26% are never married (Figure 4.22). 3 (4%) of the household population are widowed. The marital status distribution by age and sex of household population is shown in Table 4.58 below.

Table 4.58: Marital Status by Age Group and Sex of Kwara State Household Population (along the optic fibre routes)

Age Group	Married		Single		Divorced		Widow(er)		Total	
	F	M	F	M	F	M	F	M	F	M
15 – 29	3	6	2	6	0	0	0	0	5	12
30 – 44	10	18	2	7	0	0	0	0	12	25

45-59	4	6	0	1	0	0	0	0	4	7
60+	1	1	0	0	0	0	1	2	2	3
Sub total	18	31	4	14	0	0	1	2	23	47
Total	49		18		0		3		70	

Source: Wordsworth Environ Field survey (2020)
F= Female; M= Male

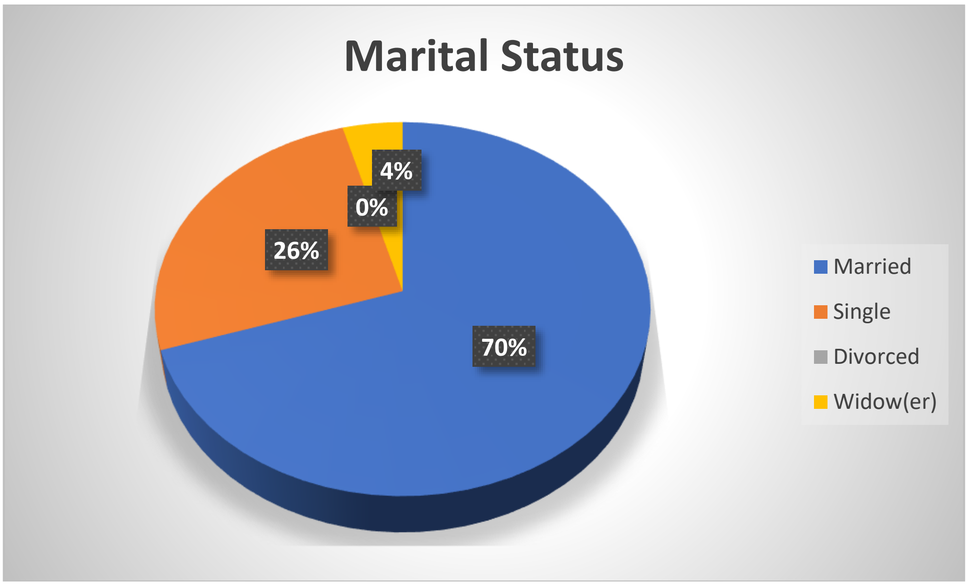


Figure 4.56: Percentage Distribution of Marital Status of Kwara State Household Population

Educational Institutions

There are several public and private owned primary and secondary schools in Kwara State. Also, there are several tertiary institutions in Kwara State which include: Kwara State University, Kwara State Polytechnic, University of Ilorin, Federal Polytechnic e.t.c

Plate 4.20: Cross section of Schools (primary, secondary and tertiary) in Kwara State

Highest Educational Qualification of Household Population

The table below shows the highest educational qualification of household interviewed.

Table 4.59: Highest Educational Qualification by Age Group of Kwara State Household Population (along the optic fibre routes)

Age Group	No education	Some primary	Completed primary	Some secondary	Completed secondary	More than secondary	Total
15 – 29	2	0	8	0	7	0	17
30 – 44	5	0	17	4	10	1	37
45-59	0	0	2	2	7	0	11
60+	1	0	1	2	1	0	5
Total	52	33	128	0	100	59	70

Source: Wordsworth Environ Field survey (2020)

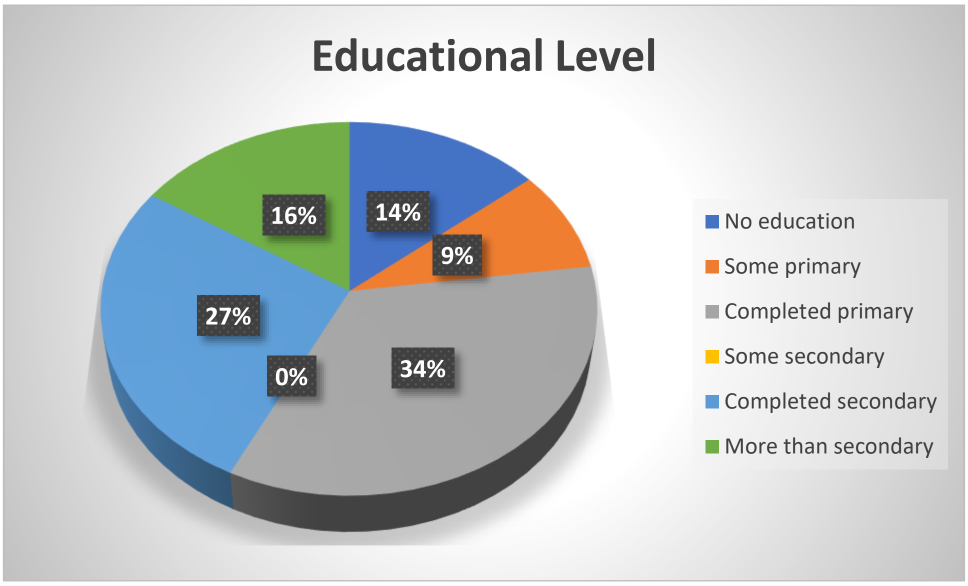


Figure 4.57: Percentage Distribution of Educational Status of Kwara State Household Population

Employment Status of Kwara State Household Population

For this group, the activities do not represent full employment and their labor is not fully utilized. They could be more profitably engaged in other activities. This group and those who in the last six months had had some temporary employment (lasting a one-hour work in a week. The Survey indicates that out of the 70-household population that constitute this age category (15 years and above), 76% of the household population are employed. The main form of occupation is manufacturing and construction as shown in Table 4.60.

Table 4.60: Employment Status by Age Group of Kwara State Household Population (along the optic fibre routes)

Age Group	Employed	Unemployed	Student/ Apprentice	Total
15 – 29	14	2	1	17
30 – 44	27	8	2	37
45-59	9	2	0	11
60+	3	2	0	5
Total	53	14	3	70

Source: Wordsworth Environ Field survey (2020)

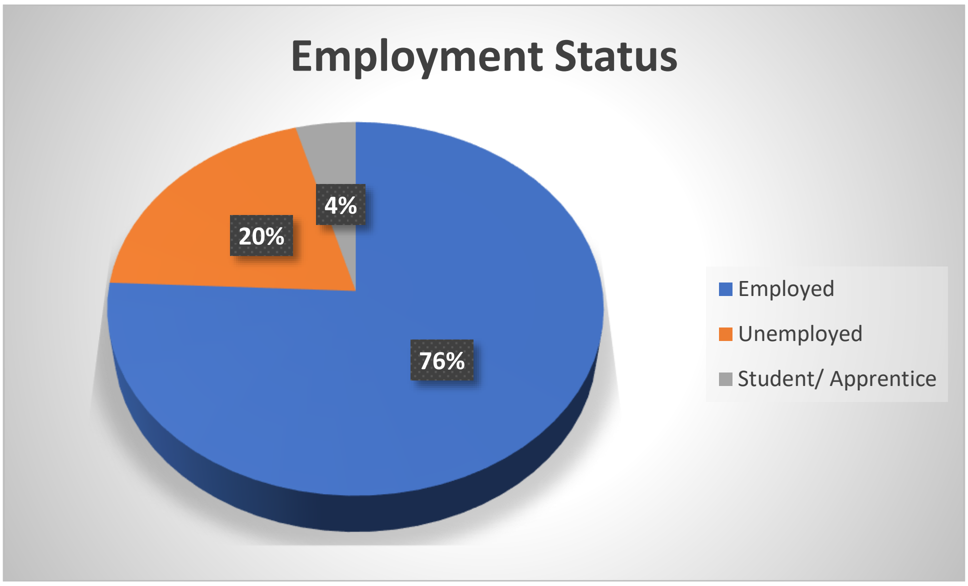


Figure 4.58: Percentage Distribution of Employment Status of Kwara State Household Population

Table 4.61: Activity in the Main Job of Kwara State Household Population (along the optic fibre routes)

Occupation (Main)	Frequency	Percentage
Agriculture, hunting or forestry and fishing	38	54.29
Mining	0	0.00
Manufacturing and Construction	4	5.71
Sales and Services	10	14.29
Others	11	15.71
No Answer	7	10.00
Total	70	100

Source: Wordsworth Environ Field survey (2020)

Income Level of Sampled Household Population

The breakdown of the income levels is presented in Table 4.62.

Table 4.62: Average Monthly Income Distribution of Kwara State Household Population (along the optic fibre routes)

Income Group	Frequency	Percentage	Type of Occupation
≤N20,000	32	45.71	Agriculture, hunting or forestry, fishing, Sales and Services, others
N20,001 – 40,000	29	41.43	Agriculture, hunting or forestry, fishing, Sales and Services Manufacturing, others
N40,001 – 60,000	9	12.86	Agriculture, hunting or forestry

			Sales and Services Manufacturing, others
N60,001 – 80,000	0	0.00	
N80,001 – 100,000	0	0.00	
Above N100,000	0	0.00	
No Record	0	0.00	
Total	70	100	

Source: Wordsworth Environ Field survey (2020)

Infrastructural Facilities of Household

An analysis of infrastructural facilities in the study population is shown in Table 4.63.

Table 4.63: Infrastructural Facilities of Kwara State Household

Facilities	**No. of Household**	**% of total Household**
Power Supply		
Electricity	51	72.86%
Alternative Power Supply		
Generator	39	55.71%
Primary Source of Water Supply (drinking)		
Bore Hole Hand Pump	22	31.43%
Bore Hole	5	7.14%
Well/Spring Protected	4	5.71%
Well/Spring Unprotected	9	12.86%
Rain Water /Streams/Pond/ River	30	42.86%
Tanker/Truck/Vendor	0	0.00%
Type of Refuse Disposal		
Burning	15	21.43%
Burying/Composting	0	0.00%
Open dumping in drains/borrow pit/dumpsite	36	51.43%
Government backed operators	8	11.43%
Nearby Bush	9	12.86%
No answer	2	2.86%
Type of Toilet Facility		
None	13	18.57%
Toilet on Water Flush to Sewage/septic	10	14.29%
Pit Latrine	47	67.14%

Source: Wordsworth Environ Field survey (2020)

72.86% of the households have access to electricity from Jos Electricity Distribution Plc but not all are satisfying with their power supply from JED due to interruption in power supply. Consequently, (39) 55.71% of the households have generator as an alternative source of power supply.

Six main types of primary water supply were utilized by the households. (see table above). Unprotected well/spring accounts for 12.86% as their primary water source for drinking; Bore Hole and Bore Hole Hand Pump account for 7.14% and 31.434% respectively while rain/stream/river account for 42.86% as their primary source of drinking. The 67.14% households surveyed utilize Pit laterin facility while 51.43% of the household interviewed dispose off their waste through open dumping in drains/borrow pit or dumpsite.

Health and Sanitation

There is Federal Medical Centre in Ilorin and many General Hospitals and primary health centres along the optic fibre routes in Kwara State. There are also several privately owned hospitals.

The most common ailment found in settlements along this route include: malaria, typhoid, rheumatism, high blood pressure, diabetes, among others. There have been few cases of HIV and AIDS. The types of toilet facilities found in settlements along this route include few water closets while most people still use the pit latrine and bushes. The wastes found in the area are mostly domestic wastes ranging from garbage, papers, nylon, food waste and rags. Waste disposal method is mostly by dumping long the road in open space (see plate).

Plate 4.21: Dumping of waste Indiscriminately at Ilorin town

Issues Raised by Residents

Residents along this route were very excited about the plan to boost internet services and communication and that it was long over-due. For this reason, they raised neither objection nor complaint but wished that the project will be executed as proposed. They also expressed the hope that the contractor would employ their youths for the optic fibre project and that any property that would be affected should be dully and fully compensated.

4.11.7 Overview of Ekiti States

Ekiti State Demographics

Ekiti State is a landlocked state, having no coastal boundary in south-western Nigeria, with its capital at Ado-Ekiti. It is bounded in the north by Kwara and Kogi States, in the west by Osun State, to its east is Edo State, while it is bounded in the south by Ondo State.

Ekiti State is one of the six new states created on 1st October 1996 by the then Provisional Ruling Council and announced by the then Head of State, General Sani Abacha in a national broadcast to mark Nigeria's 36th independence anniversary. This makes Ekiti State one of the thirty-six states of the Federal Republic of Nigeria today. It was carved out of the former Ondo State, which itself came out of the old Western State created in 1967. It is now made up of Ekiti Central, Ekiti North, Ekiti South and Ekiti West Divisions. Ekiti State has 16 Local Government Councils. It is located between longitudes 40 5’ and 50 45’ East of the Greenwich Meridian and latitudes 70 15’ and 80 5’ North of the Equator.

Mainly an upland zone rising over 250 metres above sea level, Ekiti has a rhythmically undulating surface. The landscape consists of ancient plains broken by steep-sided outcropping dome rocks. These rocks may occur singularly or in groups or ridges and the most notable of these are to be found in Efon-Alaaye, Ikere-Ekiti and Okemesi-Ekiti. The large numbers of hills in Ekiti State are often the site of towns in which much of the population resides. In fact, the word 'Ekiti' was derived from the local term for hill, ‘Okiti’. Ekiti has festivals which are being celeberated every year like Olosunta festival in Ikere-Ekiti and Udiroko festival in Ado-Ekiti to mention a few. Also, In the area of Telecommunication, there are radio stations in Ekiti State like Broadcasting Service of Ekiti State (BSES), Radio Nigeria 100.5FM, Ayoba FM AND Voice FM 88.9 to mention a few.

The State enjoys a tropical climate with two distinct seasons. These are the rainy season (April - October) and the dry season (November - March). Temperature ranges between 210C and 280C with high humidity. The south - westerly winds and the North East Trade winds blow in the raining and dry (Harmattan) seasons respectively. Tropical Forest exists in the south, while guinea savanna predominates in the northern peripheries.

Ekiti State Snapshot

- Total land area: 5,434 Km2
- Local Government Areas: 16 LGAs: Ado-Ekiti, Efon, Ekiti West, Ikole, Ise/Orun, Ikere, Ekiti East, Emure, Ilejemeje, Moba, Oye, Ekiti South-West, Ido-Osi, Irepodun/Ifelodun, Aiyekire and Ijero.
- Population: 3,480,006 (Male-1,774,803 and Female-1,705,203)
- Vegetation: Tropical Savannah.
- Major crops: Yam, Cocoa, Oil Palm, Rice, Cassava, Maize and Cashew.
- Solid minerals: Tin-Ore, Bauxite, Tantalite, Granite and Timber.

Main Investment Opportunities

Opportunities for investment exist in:

- Agribusiness
- Light Manufacturing
- Healthcare
- Energy
- Mining
- Tourism

Festivals in Ekiti State

he Udiroko festival is celebrated in Ado-Ekiti. It is the only festival apart from Ogun or Oitado according to Ado-Ekiti tradition that brings all Ado-Ekiti citizens both at home and in the diaspora together. It was established around 1310 AD during the reign of Oba Awamaro, the first Ewi (king) of present-day Ado-Ekiti and marks the first day of the year for the town’s inhabitants.

It is a day people set aside to give thanks for their creator Olorun (hence its nickname, the Olorunborun festival). The name udiroko is derived from the venue of the festival, which is beneath the big Uroko (Iroko) tree at the Ewi’s palace. Other notable festivals in Ekiti State includes: Okorobo festival (held in Ifaki-Ekiti), Ajagbo Dance (Isinbode-Ekiti), Ladunwo Masquerade (Oke-Imesi), Iromo Igede festival (Igede-Ekiti) Annually, Odun Ifa, Aeregbe Afao, Igbara-Odo, Emure August, Annually, Epa (Masquerade) Isan May, Annually, Ikereje, Ilawe December, Annually, Alayere, Igbara-Odo December, Annually, Ayan, OmuoAdo Annually, Oro Ibeji Igara-Odo August, Annually, Obanifon Ogotun, Are, Esure December/June/February, Annually, Elefon Ikoro February, Annually, Olua Epa, Eyio, Ilu-Omoba June/August, Annually, Okudi Iyin July, August, Annually, Eegun Ijan July, August, Annually, Olosunta Ikere Annually, Egungun/ImaleIdiroko All parts of the state Annually, Oodun Iyin June, July, Annually, Odun Opa Iyin Annually, Amomo Ise Annually and many more.

No shrine or deity was encountered in the course of the ESIA baseline study. Similarly, there were no sacred forests and sites of archaeological interest.

Table 4.64: Population distribution of Ekiti State

LGA	Population
Ado Ekiti	313,690
Aiyekire (Gbonyin)	147,999
Efon	87,187
Ekiti East	138,340
Ekiti South West	165,087
Ekiti West	179,600
Emure	94,264
Ido-Osi	160,001
Ijero	221,873
Ikere	148,558
Ikole	170,414
Ilejemeje	43,459
Irepodun/Ifelodun	131,330
Ise/Orun	113,951
Moba	145,408
Oye	137,796

Source: National Population Census

Settlements Along Route

Ado Ekiti, Aiyekire (Gbonyin), Efon, Ekiti East, Ekiti South West, Ekiti West, Emure, Ido-Osi, Ijero, Ikere, Ikole, Ilejemeje, Irepodun/Ifelodun, Ise/Orun, Moba and Oye

4.11.7.1 Socioeconomic Profiles of Ekiti State

This section of the report is a summary of the main findings of socio-economic variables which are peculiar to the study area (Ekiti State). Data analysed were obtained from questionnaires administered and retrieved from 145-household population spread across the various communities in the study area.

Table 4.65 shows the percent distribution of the household populations sampled. The study population profile comprised of 22.07% in the age category of 15-29yrs; 52.41% in the age category of 30-44yrs; 20.69% in the age category of 45-59; and 4.83% in the age category of 60yrs and above. The distribution of the household population by gender is depicted in Table 4.65. From 145-household populations considered, the female has 42.08% while the male has 57.92% representation.

Table 4.65: Age Distribution by Sex of Ekiti State Household Population (along the optic fibre routes)

Age Range	Male (Frequency)	Percentage	Female (Frequency)	Percentage	Total (Frequency)	Percentage
15-29	21	14.48	11	7.59	32	22.07
30-44	42	28.96	34	23.45	76	52.41
45-59	17	11.72	13	8.97	30	20.69
60+	4	2.76	3	2.07	7	4.83
Total	**84**	**57.92**	**61**	**42.08**	**145**	**100.00**

Source: Wordsworth Environ Field survey (2020)

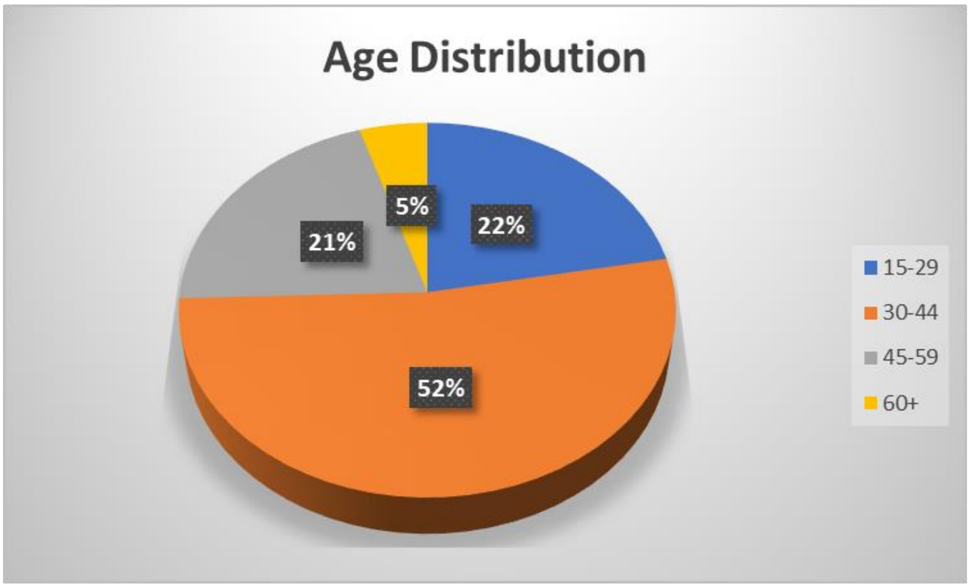


Figure 4.59: Percentage Distribution of Age Range of Ekiti State Household Population

Marital Status of Household Population

The marital status of household population from 15 years old and above indicates that out of the 145-household population that constitute this age category, one hundred and two (126) of them (87%) are married or living together in the family while 19 of the household population representing 13% are never married (Figure 4.34). The marital status distribution by age and sex of household population is shown in Table 4.66 below.

Table 4.66: Marital Status by Age Group and Sex of Ekiti State Household Population (along the optic fibre routes)

Age Group	Married		Single		Divorced		Widow(er)		Total	
	F	M	F	M	F	M	F	M	F	M
15 – 29	6	16	5	5	0	0	0	0	11	21
30 – 44	30	37	4	5	0	0	0	0	34	42
45-59	13	17	0	0	0	0	0	0	13	17
60+	3	4	0	0	0	0	0	0	3	4
Sub total	52	74	9	10	0	0	0	0	**61**	**84**
Total	**126**		**19**		**0**		**0**		**145**	

Source: Wordsworth Environ Field survey (2020)

F= Female; M= Male

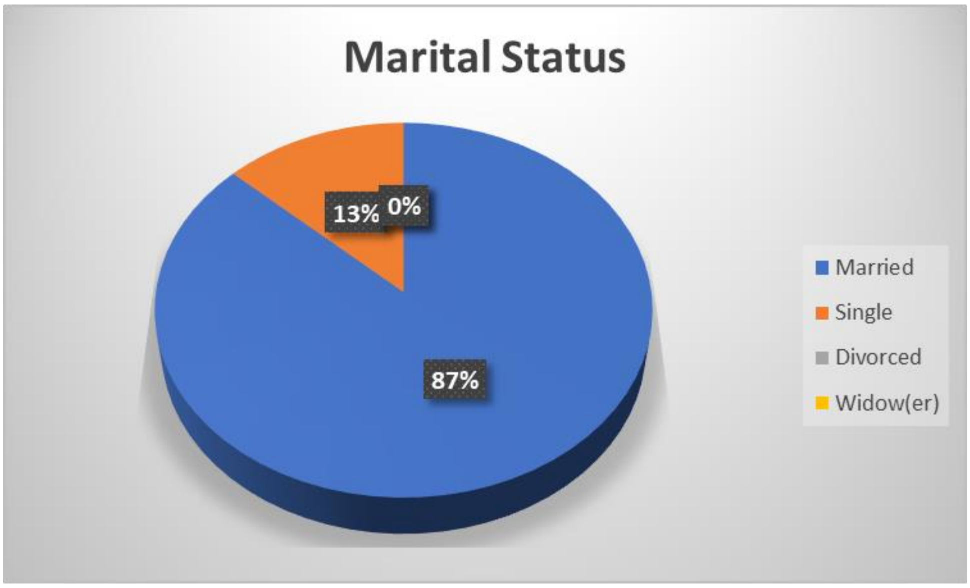


Figure 4.60: Percentage Distribution of Marital Status of Ekiti State Household Population

Educational Institutions

There are several public and private owned primary and secondary schools in Ekiti State. Also, there are several tertiary institutions in Ekiti State which include: Federal University of Technology, Oye, Afe Babalola University, Federal Polytechnic, Ado, Ekiti State University.

Plate 4.22: Cross section of Schools (primary, secondary and tertiary) in Ekiti State

The table below shows the highest educational qualification of household interviewed.

Table 4.67: Highest Educational Qualification by Age Group of Ekiti State Household Population (along the optic fibre routes)

Age Group	No education	Some primary	Completed primary	Some secondary	Completed secondary	More than secondary	Total
15 – 29	0	0	7	0	17	8	32
30 – 44	0	0	13	0	30	33	76
45-59	0	0	10	0	9	11	30
60+	0	0	2	0	3	2	7
Total	0	0	32	0	59	54	**145**

Source: Wordsworth Environ Field survey (2020)

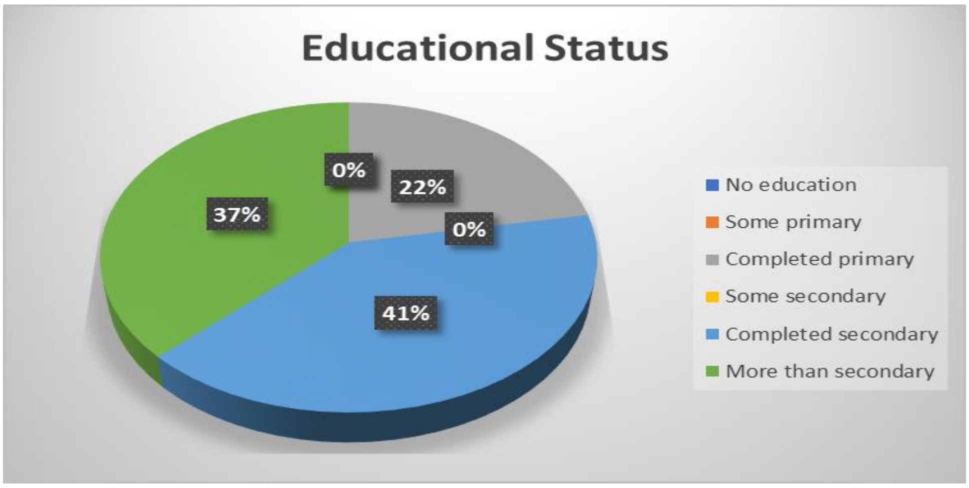


Figure 4.61: Percentage Distribution of Educational Status of Ekiti State Household Population

Employment Status of Ekiti State Household Population

For this group, the activities do not represent full employment and their labor is not fully utilized. They could be more profitably engaged in other activities. This group and those who in the last six months had had some temporary employment (lasting a one-hour work in a week. The Survey indicates that out of the 145-household population that constitute this age category (15 years and above), 79% of the household population are employed. The main form of occupation is agriculture as shown in Table 4.68.

Table 4.68: Employment Status by Age Group of Ekiti State Household Population (along the optic fibre routes)

Age Group	Employed	Unemployed	Student/ Apprentice	Total
15 – 29	20	5	7	32
30 – 44	66	5	5	76
45-59	24	6	0	30
60+	5	2	0	7
Total	115	18	12	**145**

Source: Wordsworth Environ Field survey (2020)

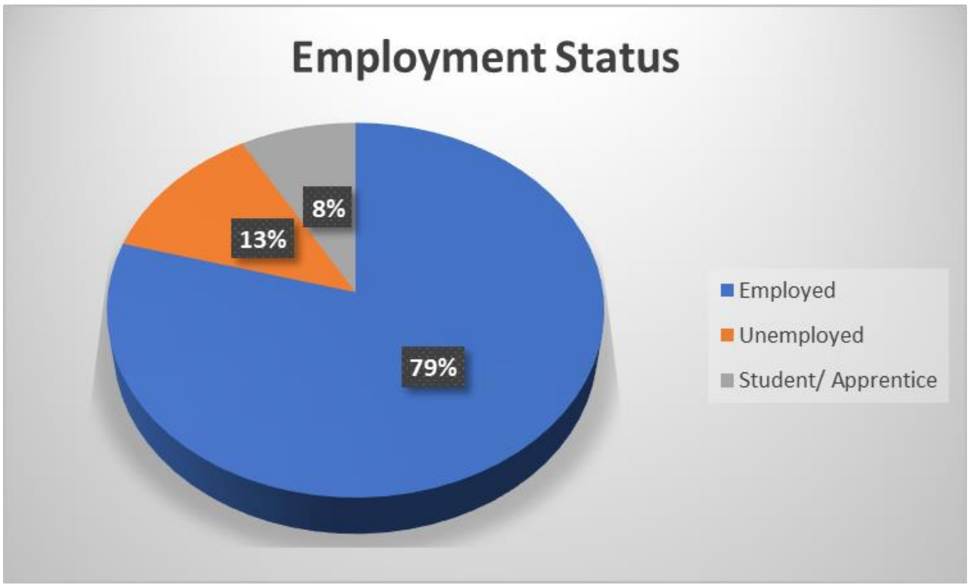


Figure 4.62: Percentage Distribution of Employment Status of Ekiti State Household Population

Table 4.69: Activity in the Main Job of Ekiti State Household Population(along the optic fibre routes)

Occupation (Main)	Frequency	Percentage
Agriculture, hunting or forestry and fishing	105	72.41
Mining	0	0.00
Manufacturing and Construction	15	10.35
Sales and Services	20	13.79
Others	5	3.45
No Answer	0	0.00
Total	**145**	**100**

Source: Wordsworth Environ Field survey (2020)

Income Level of Sampled Household Population

Three out of the 145 employed household population claimed that they do not actually keep records of their incomes. The breakdown of the income levels is presented in Table 4.70.

Table 4.70: Average Monthly Income Distribution of Ekiti State Household Population (along the optic fibre routes)

Income Group	Frequency	Percentage	Type of Occupation
≤₦20,000	95	65.52	Agriculture, hunting or forestry, fishing, Sales and Services, others
₦20,001 – 40,000	40	27.59	Agriculture, hunting or forestry, fishing, Sales and Services Manufacturing, others
₦40,001 – 60,000	10	6.89	Agriculture, hunting or forestry Sales and Services Manufacturing, others
₦60,001 – 80,000	0	0.00	
₦80,001 – 100,000	0	0.00	
Above ₦100,000	0	0.00	
No Record	0	0.00	
Total	**145**	**100**	

Source: Wordsworth Environ Field survey (2020)

Infrastructural Facilities of Household

An analysis of infrastructural facilities in the study population is shown in Table 4.71.

Table 4.71: Infrastructural Facilities of Ekiti State Household (along the optic fibre routes)

Facilities	**No. of Household**	**% of total Household**
Power Supply		
Electricity	122	84.14%
Alternative Power Supply		
Generator	117	80.69%
Primary Source of Water Supply (drinking)		
Bore Hole Hand Pump	38	26.20%
Bore Hole	35	24.14%
Well/Spring Protected	72	49.66%
Well/Spring Unprotected	0	0.00%

Rain Water /Streams/Pond/ River	0	0.00%
Tanker/Truck/Vendor	0	0.00%
Type of Refuse Disposal		
Burning	10	6.90%
Burying/Composting	0	0.00%
Open dumping in drains/borrow pit/dumpsite	90	62.07%
Government backed operators	45	31.03%
Nearby Bush	0	0.00%
No answer	0	0.00%
Type of Toilet Facility		
None	0	0.00%
Toilet on Water Flush to Sewage/septic	35	24.14%
Pit Latrine	110	75.86%

Source: Wordsworth Environ Field survey (2020)

Some of the households interviewed (84.14%) did have access to electricity from Benin Electricity Distribution Company (BEDC). Even, those who have access to electricity are not satisfied due to regular interruption in power supply. Consequently, 80.69% out of these households have generator as an alternative source of power supply.

Six main types of primary water supply were utilized by the households. (see table above). Bore Hole and Bore Hole Hand Pump account for 24.14% and 26.20% respectively, Well account for 49.66% as their primary source of drinking. The 75.86% households surveyed utilize Pit laterin facility while 62.07% of the household interviewed dispose off their waste through open dumping in drains/borrow pit/dumpsite.

Health and Sanitation

There is Federal Medical Centre in Ido Ekiti and many General Hospitals and primary health centres along the optic fibre routes in Ekiti State. There are also several privately owned hospitals.

The most common ailment found in settlements along this route include: malaria, typhoid, rheumatism, high blood pressure, diabetes, among others. There have been few cases of HIV and AIDS. The types of toilet facilities found in settlements along this route include few water closets while most people still use the pit latrine and bushes. The wastes found in the area are mostly domestic wastes ranging from garbage, papers, nylon, food waste and rags. Waste disposal method is mostly by dumping long the road in open space (see plate).

Plate 4.23: Dumping of waste Indiscriminately at Ado Ekiti the state capital of Ekiti State

Issues Raised by Residents

Residents along this route were very excited about the plan to boost internet services and communication and that it was long over-due. For this reason, they raised neither objection nor complaint but wished that the project will be executed as proposed. They also expressed the hope that the contractor would employ their youths for the optic fibre project and that any property that would be affected should be dully and fully compensated.

4.11.8 Overview of Ondo States

Ondo State Demographics

Ondo State is located in the Southwestern geopolitical zone of Nigeria and bounded in the North by Ekiti and Kogi States, in the East by Edo State, in the west by Osun and Ogun states and in the south by the Atlantic Ocean. Ondo State is located entirely within the tropics. It was created in February 1976 from the former Western region. The 2006 census recorded a total population of 3,440,000 residents.

Agriculture is the mainstay of the economy, and the chief products are cotton and tobacco from the north, cacao from the central part, and rubber and timber (teak and hardwoods) from the south and east; palm oil and kernels are cultivated for export throughout the state. Ondo is Nigeria's chief cocoa-producing state. Other crops include rice, yams, corn (maize), coffee, taro, cassava (manioc), vegetables, and fruits. Traditional industries include pottery making, cloth weaving, tailoring, carpentry, and blacksmithing. Mineral deposits include kaolin, pyrites, iron ore, petroleum, and coal. There is a textile mill located at Ado-Ekiti and a palm-oil processing plant at Okitipupa.

The state, primarily inhabited by the Yoruba, a people with a tradition of living in towns, has a high proportion of urban dwellers. Akure, the state capital, is rapidly developing into a commercial and industrial centre and is the site of a federal university of technology. The main highway from Benin City to Lagos crosses the southern part of the state. Area 5,639 square miles (14,606 square km).

Ondo State Snapshot

- Total land area: 15,820 Km^2
- Local Government Areas: 18 LGAs: Akoko North-East, Akoko North-West, Akoko South-East, Akoko South-West, Akure North, Akure South, Ese Odo, Idanre, Ifedore, Ilaje, Okeigbo, Irele, Odigbo, Okitipupa, Ondo East, Ondo West, Ose and Owo.
- Population: 4,960,577 (Male- 2,529,894 and Female- 2,430,683)
- Vegetation: Tropical Savannah and Monsoon.
- Major crops: Cocoyam, Rubber, Oil Palm, Cashew, Cocoa.
- Mineral Resources: Bitumen, Timber, Crude oil, Limestone, Granite, Coal, Columbine.

Main Investment Opportunities

Opportunities for investment exist in:

- Agribusiness
- Light Manufacturing
- Healthcare
- Tourism
- Energy
- Mining
- Logistics

Festivals in Ondo State

Ogun Festival is an annual festival observed by the Yoruba people of Ondo State, Nigeria in honour of Ogun, a warrior and powerful spirit of metal work believed by the Yoruba to be the first god to arrive on earth. Other notable festivals in Ondo State includes: AlémọSóko Festival, Ariginyan Festival, Ekimogun Festival, Egungun Festival, and many more.

No shrine or deity was encountered in the course of the ESIA baseline study. Similarly, there were no sacred forests and sites of archaeological interest.

Table 4.72: Population distribution of Ondo State

Local government area	Total
Akoko North-West	213,792
Akoko North-East	175,409
Akoko South-East	82,426
Akoko South-West	229,486
Ose	144,901
Owo	218,886
Akure North	131,587
Akure South	353,211
Ifedore	176,327
Ile Oluji/Okeigbo	172,870
Ondo West	283,672
Ondo East	74,758
Idanre	129,024
Odigbo	230,351
Okitipupa	233,565
Irele	145,166
Ese Odo	154,978
Ilaje	290,615
Total	**3,441,024**

Source: National Population Census, 2006

Settlements Along Route

Akoko North-West, Akoko North-East, Akoko South-East, Akoko South-West, Ose, Owo, Akure North, Akure South, Ifedore, Ile Oluji/Okeigbo, Ondo West, Ondo East, Idanre, Odigbo, Okitipupa, Irele, Ese Odo and Ilaje

4.11.8.1 Socioeconomic Profiles of Ondo State

This section of the report is a summary of the main findings of socio-economic variables which are peculiar to the study area (Ondo State). Data analysed were obtained from questionnaires administered and retrieved from 100-

household population spread across the various communities in the study area.

Table 4.73 shows the percent distribution of the household populations sampled. The study population profile comprised of 29% in the age category of 15-29yrs; 41% in the age category of 30-44yrs; 22% in the age category of 45-59; and 8% in the age category of 60yrs and above. The distribution of the household population by gender is depicted in Table 4.73. From 100-household populations considered, the female has 35% while the male has 65% representation.

Table 4.73 Age Distribution by Sex of Ondo State Household Population (along the optic fibre routes)

Age Range	Male (Frequency)	Percentage	Female (Frequency)	Percentage	Total (Frequency)	Percentage
15-29	20	20.00	9	9.00	29	29.00
30-44	28	28.00	13	13.00	41	41.00
45-59	12	12.00	10	10.00	22	22.00
60+	5	5.00	3	3.00	8	8.00
Total	**65**	**65.00**	**35**	**35.00**	**100**	**100.00**

Source: Wordsworth Environ Field survey (2020)

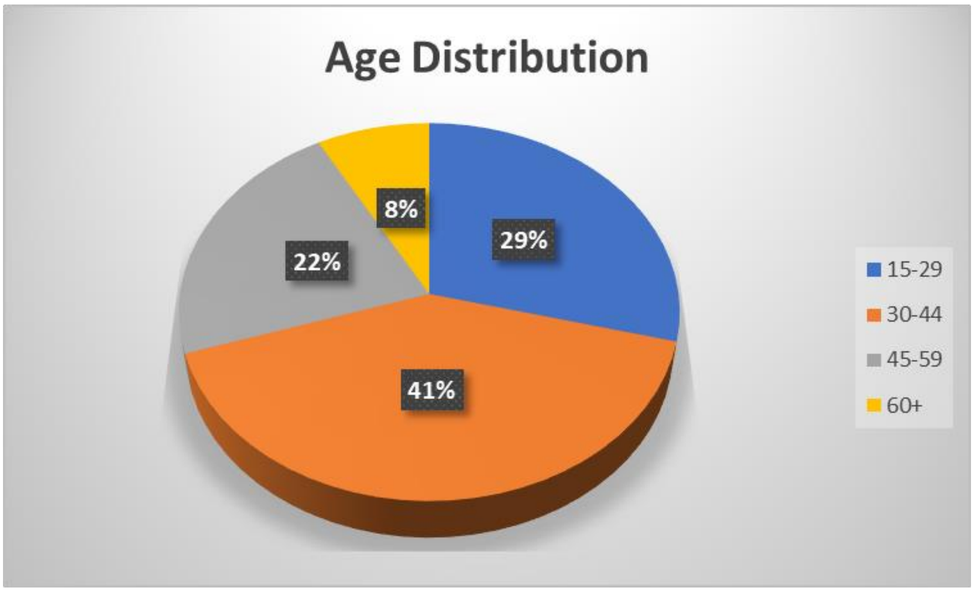


Figure 4.63: Percentage Distribution of Age Range of Ondo State Household Population

Marital Status of Household Population

The marital status of household population from 15 years old and above indicates that out of the 100-household population that constitute this age category, sixty-eight (68) of them (68%) are married or living together in the family while 32 of the household population representing 32% are never married (Figure 4.30). The marital status distribution by age and sex of household population is shown in Table 4.74 below.

Table 4.74: Marital Status by Age Group and Sex of Ondo State Household Population (along the optic fibre routes)

Age Group	Married		Single		Divorced		Widow(er)		Total	
	F	M	F	M	F	M	F	M	F	M
15 – 29	7	11	2	9	0	0	0	0	9	20
30 – 44	9	19	4	9	0	0	0	0	13	28
45-59	7	7	3	5	0	0	0	0	10	12
60+	3	5	0	0	0	0	0	0	3	5
Sub total	26	42	9	23	0	0	0	0	**32**	**68**
Total	**68**		**32**		**0**		**0**		**100**	

Source: Wordsworth Environ Field survey (2020)

F= Female; M= Male

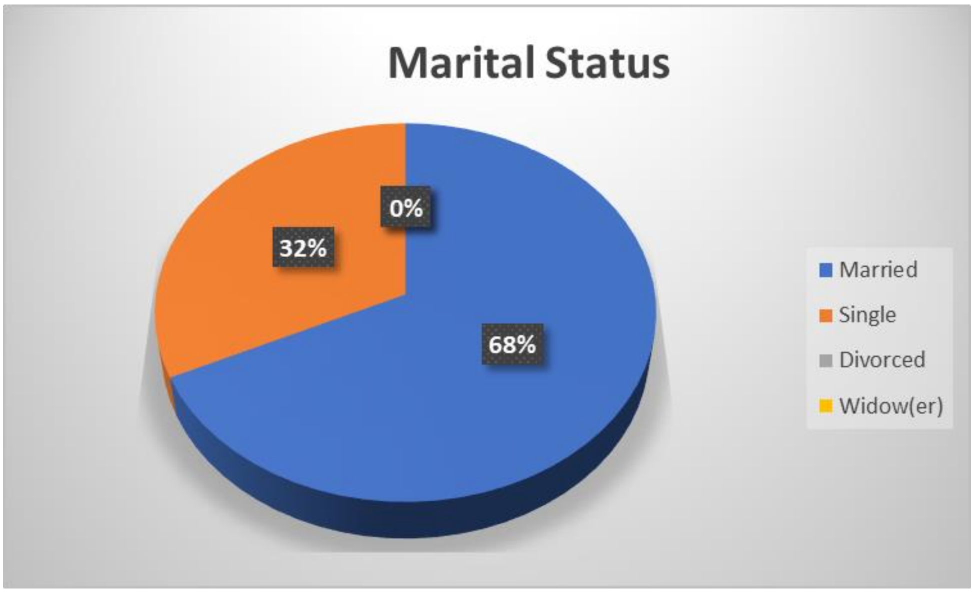


Figure 4.64: Percentage Distribution of Marital Status of Ondo State Household Population

Educational Institutions

There are several public and private owned primary and secondary schools in Ondo state. Under Ondo SUBEB, we have a total of 1,233 primary schools distributed across the 18 Local Government Areas with 18 Local Government Education Secretaries for each local government respectively. Also, there are several tertiary institutions in Ondo state which include: Achievers University, Adekunle Ajasin University, Elizade University, Federal University of Technology, Akure, Ondo City Polytechnic, Ondo City, Ondo State University of Science and Technology, Rufus Giwa Polytechnic, University of Medical Sciences, Ondo, Wesley University of Science and Technology to mention but few.

Plate 4.24: Cross section of Schools (primary, secondary and tertiary) in Oyo State

The table below shows the highest educational qualification of household interviewed.

Table 4.75: Highest Educational Qualification by Age Group of Ondo State Household Population (along the optic fibre routes)

Age Group	No education	Some primary	Completed primary	Some secondary	Completed secondary	More than secondary	Total
15 – 29	8	0	7	0	11	3	29
30 – 44	13	3	9	0	13	3	41
45-59	5	1	6	0	9	1	22
60+	0	0	2	0	6	0	8
Total	26	4	24	0	39	7	**100**

Source: Wordsworth Environ Field survey (2020)

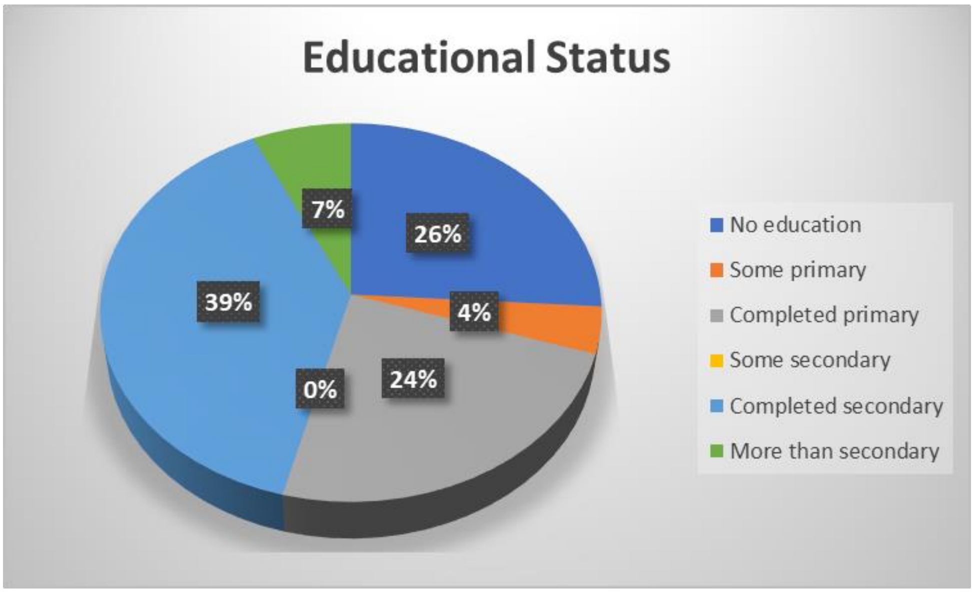


Figure 4.65: Percentage Distribution of Educational Status of Ondo State Household Population

Employment Status of Ondo State Household Population

For this group, the activities do not represent full employment and their labor is not fully utilized. They could be more profitably engaged in other activities. This group and those who in the last six months had had some temporary employment (lasting a one-hour work in a week. The Survey indicates that out of the 100-household population that constitute this age category (15 years and above), 70% of the household population are employed. The main form of occupation is manufacturing and construction as shown in Table 4.76.

Table 4.76: Employment Status by Age Group of Ondo State Household Population (along the optic fibre routes)

Age Group	Employed	Unemployed	Student/ Apprentice	Total
15 – 29	17	6	6	29
30 – 44	34	2	5	41
45-59	16	3	3	22
60+	3	5	0	8
Total	70	16	14	**100**

Source: Wordsworth Environ Field survey (2020)

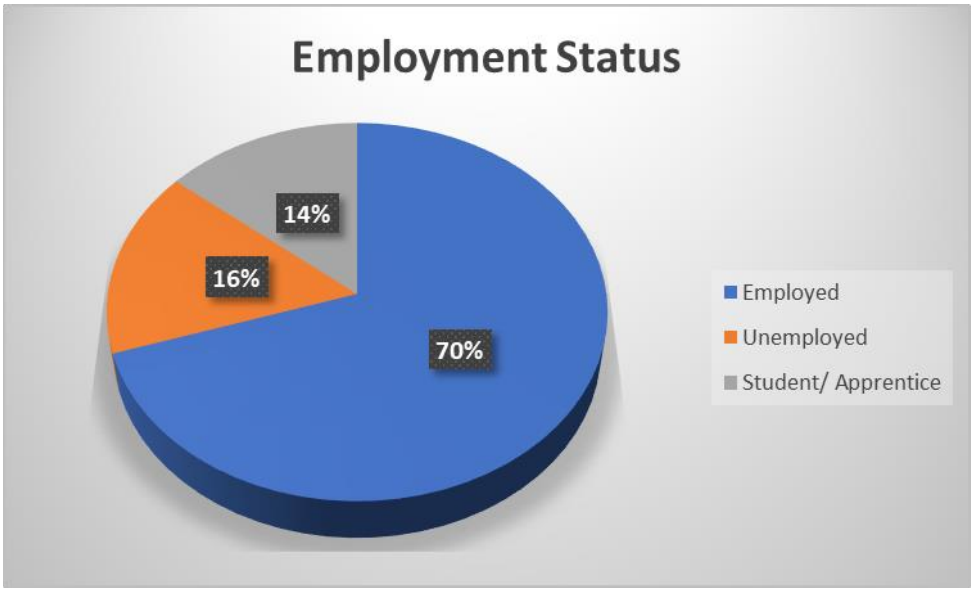


Figure 4.66: Percentage Distribution of Employment Status of Ondo State Household Population

Table 4.77: Activity in the Main Job of Ondo State Household Population (along the optic fibre routes)

Occupation (Main)	Frequency	Percentage
Agriculture, hunting or forestry and fishing	54	54.00
Mining	0	0.00

Manufacturing and Construction	5	5.00
Sales and Services	31	31.00
Others	10	10.00
No Answer	0	0.00
Total	**100**	**100**

Source: Wordsworth Environ Field survey (2020)

Income Level of Sampled Household Population

Three out of the 100 employed household population claimed that they do not actually keep records of their incomes. The breakdown of the income levels is presented in Table 4.78.

Table 4.78: Average Monthly Income Distribution of Ondo State Household Population (along the optic fibre routes)

Income Group	Frequency	Percentage	Type of Occupation
≤₦20,000	71	71.00	Agriculture, hunting or forestry, fishing, Sales and Services, others
₦20,001 – 40,000	25	25.00	Agriculture, hunting or forestry, fishing, Sales and Services Manufacturing, others
₦40,001 – 60,000	4	4.00	Agriculture, hunting or forestry Sales and Services Manufacturing, others
₦60,001 – 80,000	0	0.00	
₦80,001 – 100,000	0	0.00	
Above ₦100,000	0	0.00	
No Record	0	0.00	
Total	**100**	**100**	

Source: Wordsworth Environ Field survey (2020)

Infrastructural Facilities of Household

An analysis of infrastructural facilities in the study population is shown in Table 4.79.

Table 4.79: Infrastructural Facilities of Ondo State Household (along the optic fibre routes)

Facilities	No. of Household	% of total Household
Power Supply		
Electricity	89	89.00%
Alternative Power Supply		
Generator	79	79.00%
Primary Source of Water Supply (drinking)		
Bore Hole Hand Pump	29	29.00%
Bore Hole	9	9.00%
Well/Spring Protected	9	9.00%
Well/Spring Unprotected	18	18.00%
Rain Water /Streams/Pond/ River	35	35.00%
Tanker/Truck/Vendor	0	0.00%
Type of Refuse Disposal		
Burning	24	24.00%
Burying/Composting	0	0.00%
Open dumping in drains/borrow pit/dumpsite	57	57.00%
Government backed operators	11	11.00%
Nearby Bush	0	0.00%
No answer	8	8.00%
Type of Toilet Facility		
None	18	18.00%
Toilet on Water Flush to Sewage/septic	11	11.00%
Pit Latrine	71	71.00%

Source: Wordsworth Environ Field survey (2020)

Some of the households interviewed (89%) did have access to electricity from Benin Electricity Distribution Company (BEDC). Even, those who have access to electricity are not satisfied due to regular interruption in power supply. Consequently, 79% out of these households have generator as an alternative source of power supply.

Six main types of primary water supply were utilized by the households. (see table above). Unprotected well/spring accounts for 18% as their primary water source for drinking; Bore Hole and Bore Hole Hand Pump account for 9% and 29% respectively while rain/stream/river account for 35% as their primary source of drinking. The 71% households surveyed utilize Pit laterin facility while 57% of the household interviewed dispose off their waste through open dumping in drains/borrow pit or dumpsite.

Health and Sanitation

There is Federal Medical Centre in Owo and many General Hospitals and primary health centres along the optic fibre routes in Ondo state. There are also several privately owned hospitals.

The most common ailment found in settlements along this route include: malaria, typhoid, rheumatism, high blood pressure, diabetes, among others. There have been few cases of HIV and AIDS. The types of toilet facilities found in settlements along this route include few water closets while most people still use the pit latrine and bushes. The wastes found in the area are mostly domestic wastes ranging from garbage, papers, nylon, food waste and rags. Waste disposal method is mostly by dumping long the road in open space (see plate).

Plate 4.25: Dumping of waste Indiscriminately in Ondo town and Akure, the state capital

Issues Raised by Residents

Residents along this route were very excited about the plan to boost internet services and communication and that it was long over-due. For this reason, they raised neither objection nor complaint but wished that the project will be executed as proposed. They also expressed the hope that the contractor would employ their youths for the optic fibre project and that any property that would be affected should be dully and fully compensated.

4.11.9 Overview of Lagos States

Lagos State Demographics

Lagos, usually referred to as Lagos State to distinguish it from the city of Lagos, is a state located in the southwestern geopolitical zone of Nigeria. The smallest in area of Nigeria's 36 states, Lagos State is arguably the most economically important state of the country, containing Lagos, the nation's largest urban area. The actual population total is disputed between the official Nigerian Census of 2006, and a much higher figure claimed by the Lagos State Government. Lagos State is located in the south-western part of the Nigerian Federation. On the North and East it is bounded by Ogun State. In the West it shares boundaries with the Republic of Benin. Behind its southern borders lies the Atlantic Ocean. 22% of its 3,577 km^2 are lagoons and creeks.

Lagos state is essentially a Yoruba-speaking environment, and a socio-cultural melting pot attracting both Nigerians and foreigners alike.Indigenous inhabitants include the Aworis and Egus in Ikeja and Badagry Divisions respectively, with the Egus being found mainly in Badagry.There is also an admixture of other pioneer settlers collectively known as the Ekos.The indigenes of Ikorodu and Epe Divisions are mainly the Ijebus with pockets of Eko-Awori settlers along the coastland and riverine areas.

According to Lagos State Household survey 2010, Yoruba tribe remains the largest group (75.4%). It is followed by households of Igbo origin (14.5%), Hausa tribe households constituted 2.2% while other tribes accounted for 8.2 percent of the sampled households' members. The report further revealed that that three out of every five households' members (59.8%) were born in Lagos State while the remaining 39.9% percent were from other States.
Lagos State is Nigeria's most industrialized State. It accounts for over 60% of the Federation's total industrial investment. The largest concentrations of industries in Lagos State are in Ikeja, Alimoso and Kosofe Local Government Areas. Other specific locations of numerous industries include Apapa, Surulere, Shomolu, Mushin, Oshodi-Isolo, Agege, Amuwo-Odofin, and Ikorodu. The industries in Lagos State provide employment for over 1 million persons directly.

Primary agricultural production typifies the rural economy of Lagos State with industrial activities. There are a number of other socio-economic undertakings with high employment activities. These include the Federal and State Civil Service, numerous white-collar-job establishments, wholesale and retail trading. The informal private sector also constitutes a significant portion of the economic activities. These include transporters, artisans (carpenters, masons, painters, auto-mechanics, etc) and labourers.

The main religions are Christianity, Islam and Traditional Religion. Lagos state is profusely endowed with diverse traditional festivals. Most of these festivals have their roots in traditional religions of the people. Major traditional festivals are Egungun, Oro, Igunnuko, Ogun, Agemo, Zangheto, Olokun, Eyo amongst several others. Some of these festivals do attracts international attention especially the Eyo festival which enjoys state Government support.

Lagos State Snapshot

- Total land area: 3,671 Km^2
- Capital: Ikeja
- Local Government Areas: 20 LGAs: Agege, Ajeromi Ifelodun Ajegunle, Alimosho, Amuwo Odofin, Apapa, Badagry, Epe, Ibeju-Lekki, Ifako Ijaye, Ikeja, Ikorodu, Kosofe, Lagos Island Isale-Eko, Lagos Mainland, Mushin, Ojo, Oshodi Isolo, Shomolu, and Surulere.
- Population: 13,380,098 (Male- 6,823,850 and Female- 6,556,248)
- Vegetation: Tropical Savannah.
- Major crops: Yam, Coconut, Oil Palm
- Solid minerals: Silica Sand, Bitumen and Clay

Main Investment Opportunities

Opportunities for investment exist in:

- Agribusiness
- Light Manufacturing
- Healthcare
- Tourism
- Energy
- Mining

Festivals in Lagos State

The Eyo Festival, otherwise known as the Adamu Orisha Play, is a Yoruba festival unique to Lagos, Nigeria. In modern times, it is presented by the people of Lagos as a tourist event and due to its history, is traditionally performed on Lagos Island. Other notable festivals in Lagos State includes: Lagos Seafood Festival, Black Heritage Festival and many more.

No shrine or deity was encountered in the course of the ESIA baseline study. Similarly, there were no sacred forests and sites of archaeological interest.

Table 4.80: Population distribution of Lagos State

LGA	Population
Alimosho	11,456,783
Ajeromi-Ifelodun	2,000,346
Kosofe	665,421
Mushin	633,543
Oshodi-Isolo	10,621,789
Ojo	598,336
Ikorodu	535,811
Surulere	504,409
Agege	461,123
Ifako-Ijaiye	428,812
Somolu	402,992
Amuwo-Odofin	318,576
Lagos Mainland	317,980
Ikeja	313,333
Eti-Osa	287,958
Badagry	241,437
Apapa	217,661
Lagos Island	209,665
Epe	181,715
Ibeju-Lekki	117,54

Source: National Population Census, 2006

Settlements Along Route

Alimosho, Ajeromi-Ifelodun, Kosofe, Mushin, Oshodi-Isolo, Ojo, Ikorodu, Surulere, Agege, Ifako-Ijaiye, Somolu, Amuwo-Odofin, Lagos Mainland, Ikeja, Eti-Osa, Badagry, Apapa, Lagos Island, Epe and Ibeju-Lekki

4.11.9.1 Socioeconomic Profiles of Lagos State

This section of the report is a summary of the main findings of socio-economic variables which are peculiar to the study area (Lagos State). Data analysed were obtained from questionnaires administered and retrieved from 80-household population spread across the various communities in the study area.

Table 4.81 shows the percent distribution of the household populations sampled. The study population profile comprised of 26.25% in the age category of 15-29yrs; 42.50% in the age category of 30-44yrs; 25% in the age category of 45-59; and 6.25% in the age category of 60yrs and above. The distribution of the household population by gender is depicted in Table 4.81. From 80-household populations considered, the female has 40% while the male has 60% representation.

Table 4.81: Age Distribution by Sex of Lagos State Household Population (along the optic fibre routes)

Age Range	Male (Frequency)	Percentage	Female (Frequency)	Percentage	Total (Frequency)	Percentage
15-29	12	15.00	9	11.25	21	26.25
30-44	23	28.75	11	13.75	34	42.50
45-59	10	12.50	10	12.50	20	25.00
60+	3	3.75	2	2.50	5	6.25
Total	**48**	**60.00**	**32**	**40.00**	**80**	**100.00**

Source: Wordsworth Environ Field survey (2020)

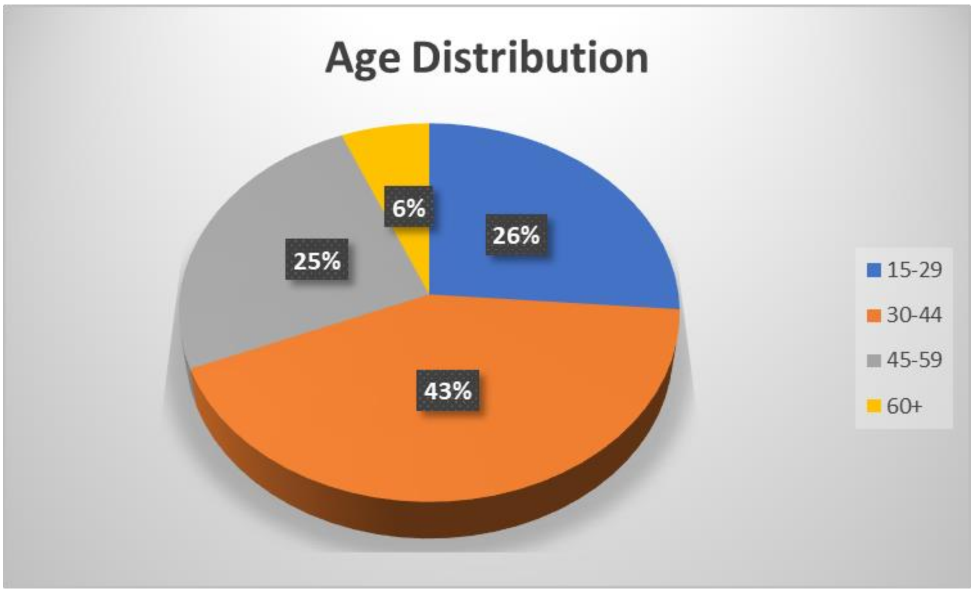


Figure 4.67: Percentage Distribution of Age Range of Lagos State Household Population

Marital Status of Household Population

The marital status of household population from 15 years old and above indicates that out of the 80-household population that constitute this age category, sixty (60) of them (75%) are married or living together in the family while 17 of the household population representing 21% are never married (Figure 4.34). The marital status distribution by age and sex of household population is shown in Table 4.82 below.

Table 4.82: Marital Status by Age Group and Sex of Lagos State Household Population (along the optic fibre routes)

Age Group	Married		Single		Divorced		Widow(er)		Total	
	F	M	F	M	F	M	F	M	F	M
15 – 29	7	8	2	4	0	0	0	0	9	12
30 – 44	9	15	2	8	0	0	0	0	11	23
45-59	9	10	1	0	0	0	0	0	10	10
60+	1	1	0	0	0	0	1	2	2	3
Sub total	26	34	5	12	0	0	1	2	**32**	**48**
Total	**60**		**17**		**0**		**3**		**80**	

Source: Wordsworth Environ Field survey (2020)

F= Female; M= Male

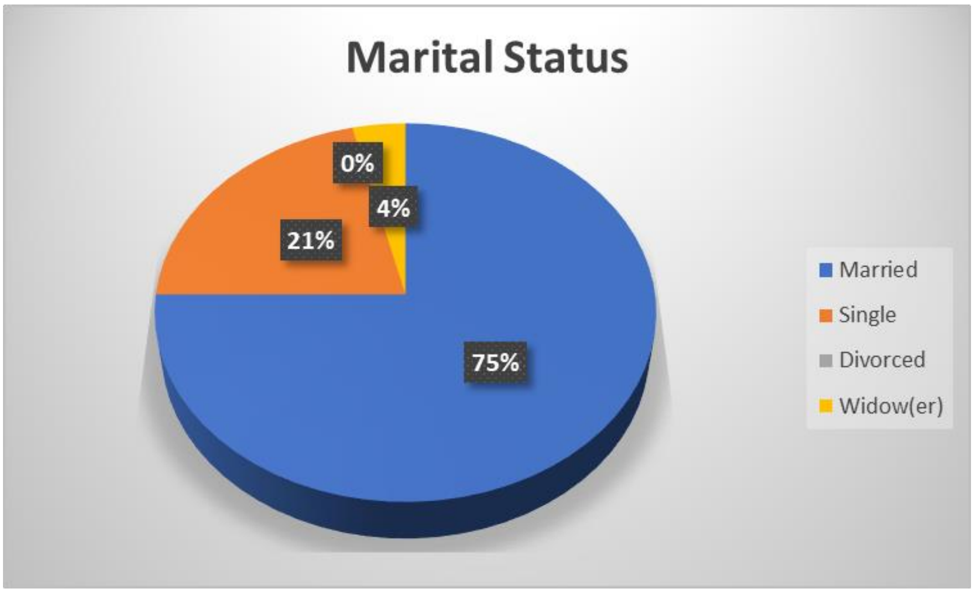


Figure 4.68: Percentage Distribution of Marital Status of Lagos State Household Population

Educational Institutions

There are several public and private owned primary and secondary schools in Lagos State. Also, there are several tertiary institutions in Lagos State which include: University of Lagos, Lagos State University, Lagos State Polytechnic, Anchor University to mention but few. Presently, Lagos provides free education to over One Million pupils/students in 1,010 primary schools with a population of about 497,318 pupils; 670 Junior and Senior Secondary Schools with a population of about 564,758 students and 5 Technical and Vocational Schools across the state.

Plate 4.26: Cross section of Schools (primary, secondary and tertiary) in Lagos State

The table below shows the highest educational qualification of household interviewed.

Table 4.83: Highest Educational Qualification by Age Group of Lagos State Household Population (along the optic fibre routes)

Age Group	No education	Some primary	Completed primary	Some secondary	Completed secondary	More than secondary	Total
15 – 29	3	0	3	3	7	5	21
30 – 44	4	3	4	4	10	9	34
45-59	3	0	6	0	9	2	20
60+	0	0	2	0	3	0	5
Total	10	3	15	7	29	16	**80**

Source: Wordsworth Environ Field survey (2020)

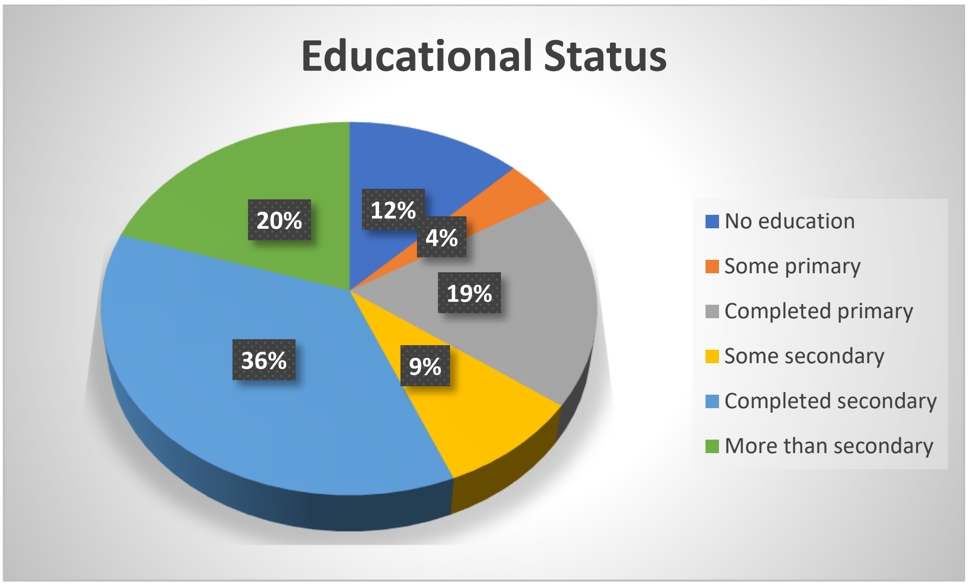


Figure 4.69: Percentage Distribution of Educational Status of Lagos State Household Population

Employment Status of Lagos State Household Population

For this group, the activities do not represent full employment and their labor is not fully utilized. They could be more profitably engaged in other activities. This group and those who in the last six months had had some temporary employment (lasting a one-hour work in a week. The Survey indicates that out of the 80-household population that constitute this age category (15 years and above), 70% of the household population are employed. The main form of occupation is manufacturing and construction as shown in Table 4.84.

Table 4.84: Employment Status by Age Group of Lagos State Household Population (along the optic fibre routes)

Age Group	Employed	Unemployed	Student/ Apprentice	Total
15 – 29	15	3	3	21
30 – 44	28	4	2	34
45-59	20	0	0	20
60+	3	2	0	5
Total	66	9	5	**80**

Source: Wordsworth Environ Field survey (2020)

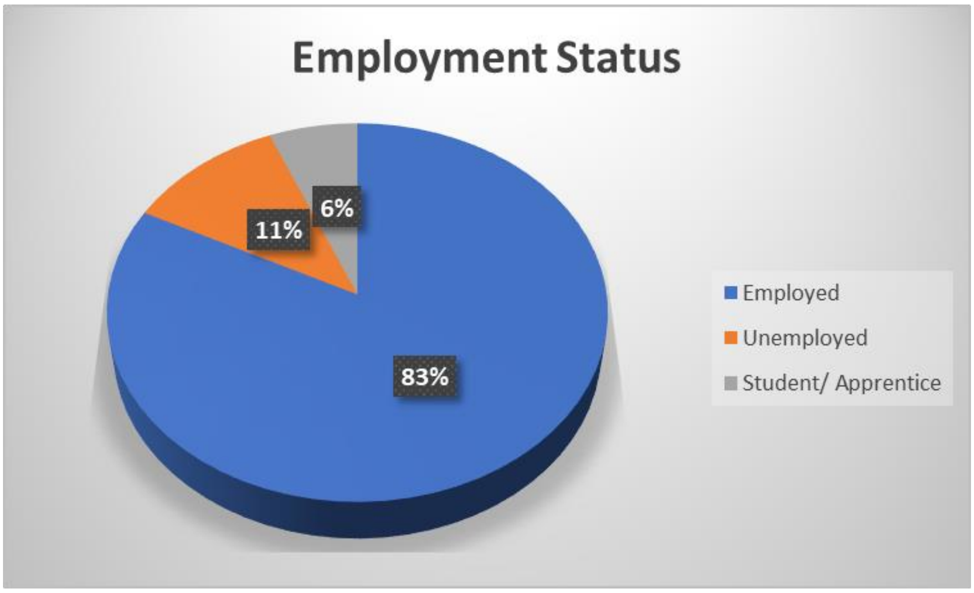


Figure 4.70: Percentage Distribution of Employment Status of Lagos State Household Population

Table 4.85: Activity in the Main Job of Lagos State Household Population (along the optic fibre routes)

Occupation (Main)	Frequency	Percentage
Agriculture, hunting or forestry and fishing	34	42.50
Mining	0	0.00
Manufacturing and Construction	5	6.25
Sales and Services	22	27.50
Others	10	12.50
No Answer	9	11.25
Total	**80**	**100**

Source: Wordsworth Environ Field survey (2020)

Income Level of Sampled Household Population

Three out of the 80 employed household population claimed that they do not actually keep records of their incomes. The breakdown of the income levels is presented in Table 4.86.

Table 4.86: Average Monthly Income Distribution of Lagos State Household Population

Income Group	Frequency	Percentage	Type of Occupation
≤₦20,000	57	71.25	Agriculture, hunting or forestry, fishing, Sales and Services, others
₦20,001 – 40,000	16	20.00	Agriculture, hunting or forestry, fishing, Sales and Services Manufacturing, others
₦40,001 – 60,000	4	5.00	Agriculture, hunting or forestry Sales and Services Manufacturing, others
₦60,001 – 80,000	0	0.00	
₦80,001 – 100,000	0	0.00	
Above ₦100,000	0	0.00	
No Record	3	3.75	
Total	**80**	**100**	

Source: Wordsworth Environ Field survey (2020)

Infrastructural Facilities of Household

An analysis of infrastructural facilities in the study population is shown in Table 4.87.

Table 4.87: Infrastructural Facilities of Lagos State Household (along the optic fibre routes)

Facilities	**No. of Household**	**% of total Household**
Power Supply		
Electricity	78	97.5%
Alternative Power Supply		
Generator	75	93.7%
Primary Source of Water Supply (drinking)		
Bore Hole Hand Pump	10	12.50%
Bore Hole	35	43.75%
Well/Spring Protected	20	25.00%
Well/Spring Unprotected	0	0.00%
Rain Water /Streams/Pond/ River	0	0.00%
Tanker/Truck/Vendor	15	18.75%

Type of Refuse Disposal		
Burning	0	0.00%
Burying/Composting	0	0.00%
Open dumping in drains/borrow pit/dumpsite	5	6.25%
Government backed operators	75	93.75%
Nearby Bush	0	0.00%
No answer	0	6.25%
Type of Toilet Facility		
None	0	0.00%
Toilet on Water Flush to Sewage/septic	30	37.5%
Pit Latrine	50	62.5%

Source: Wordsworth Environ Field survey (2020)

Some of the households interviewed (97.5%) did have access to electricity from Ikeja Electricity Distribution Company (IKEDC) and Eko Electricity Distribution Company (EKEDP). Even, those who have access to electricity are not satisfied due to regular interruption in power supply. Consequently, 93.7% out of these households have generator as an alternative source of power supply.

Six main types of primary water supply were utilized by the households. (see table above). Bore Hole and Bore Hole Hand Pump account for 12.5% and 43.75% respectively Well account for 25% as their primary source of drinking. The 62.5% households surveyed utilize Pit laterin facility while 93.75% of the household interviewed dispose off their waste through government backed operators.

Health and Sanitation

There is Federal Medical Centre in Oyingbo and many General Hospitals and primary health centres along the optic fibre routes in Lagos State. There are also several privately owned hospitals.

The most common ailment found in settlements along this route include: malaria, typhoid, rheumatism, high blood pressure, diabetes, among others. There have been few cases of HIV and AIDS. The types of toilet facilities found in settlements along this route include few water closets while most people still use the pit latrine and bushes. The wastes found in the area are mostly domestic wastes ranging from garbage, papers, nylon, food waste and rags. Waste disposal method is mostly by waste managers known as PSP. (see plate).

Plate 4.27: Dumping of waste Indiscriminately at Mushin town and Oshodi area of Lagos State

Issues Raised by Residents

Residents along this route were very excited about the plan to boost internet services and communication and that it was long over-due. For this reason, they raised neither objection nor complaint but wished that the project will be executed as proposed. They also expressed the hope that the contractor would employ their youths for the optic fibre project and that any property that would be affected should be dully and fully compensated.

4.11.10 Overview of Ogun States

Ogun State Demographics

Ogun State referred to as the "Gateway State" is located in the South-Western region of Nigeria was created on 3 February 1976. It borders Lagos State to the South, Oyo and Osun states to the North, Ondo to the East and the Republic of Benin to the West.

The state has the largest deposit of limestone in Nigeria. Its unique comparative advantage is its strategic closeness to Lagos State, thereby attracting large number of investments to the State.

According to Ogun State Household survey report, 2008, 44.9% of sampled household were never married/single, 47.2% were married. While, 3.8%, 2.9% and 1.2% were widow/widower, separated and divorced respectively. The report also puts percentage of household members that had attended school at 88% while 12% have never attended school.

Ogun State Snapshot

- Total land area: 16,400 Km^2
- Local Government Areas: 20 LGAs: Abeokuta North, Abeokuta South, Ota, Ewekoro, Ifo, Ijebu East, Ijebu North, Ijebu North East, Ijebu Ode,

Ikenne, Imeko Afon, Ipokia, Obafemi Owode, Odogbolu, Odeda, Ogun Waterside, Remo North, Sagamu, Yewa North and Yewa South.

- Population: 5,573,704 (Male-2,842,589 and Female-2,731,115)
- Vegetation: Tropical Savannah.
- Major crops: Maize, Cocoa, Oil Palm, Rice, Cassava, Cotton.
- Solid minerals: Limestone, Bauxite, Bitumen, Timber, Gem Stones.

Main Investment Opportunities

Opportunities for investment exist in:

- Agribusiness
- Light Manufacturing
- Healthcare
- Energy
- Mining
- Tourism

Festivals in Ogun State

Ogun Festival is an annual festival observed by the Yoruba people of Ondo State, Nigeria in honour of Ogun, a warrior and powerful spirit of metal work believed by the Yoruba to be the first god to arrive on earth. Other notable festivals in Ogun State includes: Ojude Oba festival, Osousi Festival, Egungun Festival and many more.

No shrine or deity was encountered in the course of the ESIA baseline study. Similarly, there were no sacred forests and sites of archaeological interest.

Table 4.88: Population distribution of Ogun State

LGA	Population
Abeokuta North	198,793
Abeokuta South	250,295
Ado-Odo/Ota	527,242
Ewekoro	55,093
Ifo	539,170
Ijebu East	109,321
Ijebu North	280,520
Ijebu North East	68,800
Ijebu Ode	157,161
Ikenne	119,117
Imeko Afon	82,952

Ipokia	150,387
Obafemi-Owode	235,071
Odeda	109,522
Odogbolu	125,657
Ogun Waterside	74,222
Remo North	59,752
Sagamu	255,885
Yewa North (Egbado North)	183,844
Yewa South (Egbado South)	168,336

Source: National Population Census

Settlements Along Route

Abeokuta North, Abeokuta South, Ado-Odo/Ota, Ewekoro, Ifo, Ijebu East, Ijebu North, Ijebu North East, Ijebu Ode, Ikenne, Imeko Afon, Ipokia, Obafemi-Owode, Odeda, Odogbolu, Ogun Waterside, Remo North, Sagamu, Yewa North (Egbado North) and Yewa South (Egbado South)

4.11.10.1 Socioeconomic Profiles of Ogun State

This section of the report is a summary of the main findings of socio-economic variables which are peculiar to the study area (Ogun State). Data analysed were obtained from questionnaires administered and retrieved from 150-household population spread across the various communities in the study area.

Table 4.272 shows the percent distribution of the household populations sampled. The study population profile comprised of 22.67% in the age category of 15-29yrs; 52% in the age category of 30-44yrs; 22% in the age category of 45-59; and 3.33% in the age category of 60yrs and above. The distribution of the household population by gender is depicted in Table 4.89. From 150-household populations considered, the female has 40.66% while the male has 59.34% representation.

Table 4.89: Age Distribution by Sex of Ogun State Household Population (along the optic fibre routes)

Age Range	Male (Frequency)	Percentage	Female (Frequency)	Percentage	Total (Frequency)	Percentage

15-29	22	14.67	12	8.00	34	22.67
30-44	46	30.67	32	21.33	78	52.00
45-59	18	12.00	15	10.00	33	22.00
60+	3	2.00	2	1.33	5	3.33
Total	**89**	**59.34**	**61**	**40.66**	**150**	**100.00**

Source: Wordsworth Environ Field survey (2020)

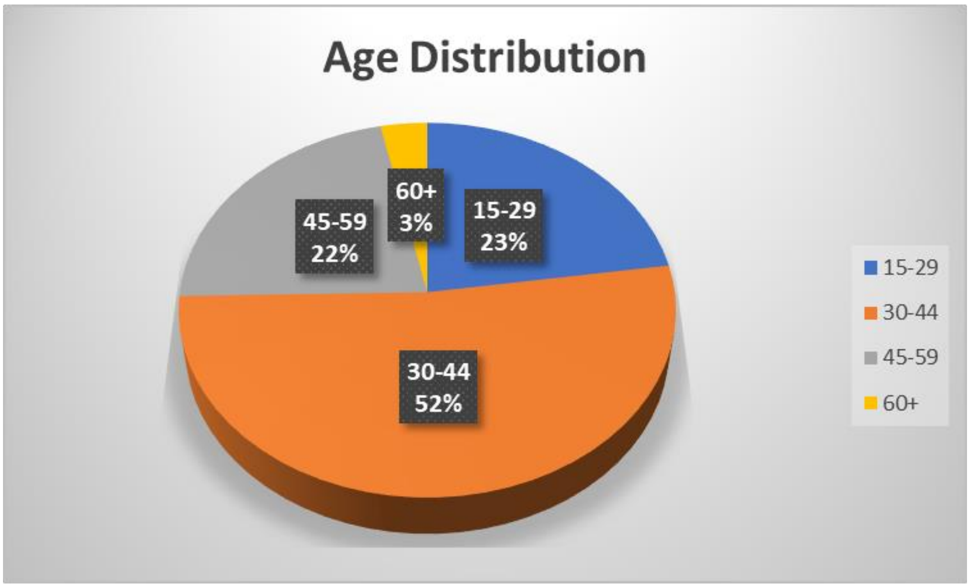


Figure 4.71: Percentage Distribution of Age Range of Ogun State Household Population

Marital Status of Household Population

The marital status of household population from 15 years old and above indicates that out of the 150-household population that constitute this age category, one hundred and two (102) of them (68%) are married or living together in the family while 35 of the household population representing 23% are never married (Figure 4.34). The marital status distribution by age and sex of household population is shown in Table 4.90 below.

Table 4.90: Marital Status by Age Group and Sex of Ogun State Household Population (along the optic fibre routes)

Age Group	Married		Single		Divorced		Widow(er)		Total	
	F	M	F	M	F	M	F	M	F	M
15 – 29	7	12	5	10	0	0	0	0	12	22
30 – 44	25	35	7	11	0	0	0	0	32	46

45-59	11	10	0	2	0	0	4	6	15	18
60+	1	1	0	0	0	0	1	2	2	3
Sub total	44	58	12	23	0	0	5	8	**61**	**89**
Total	**102**		**35**		**0**		**13**		**150**	

Source: Wordsworth Environ Field survey (2020)

F= Female; M= Male

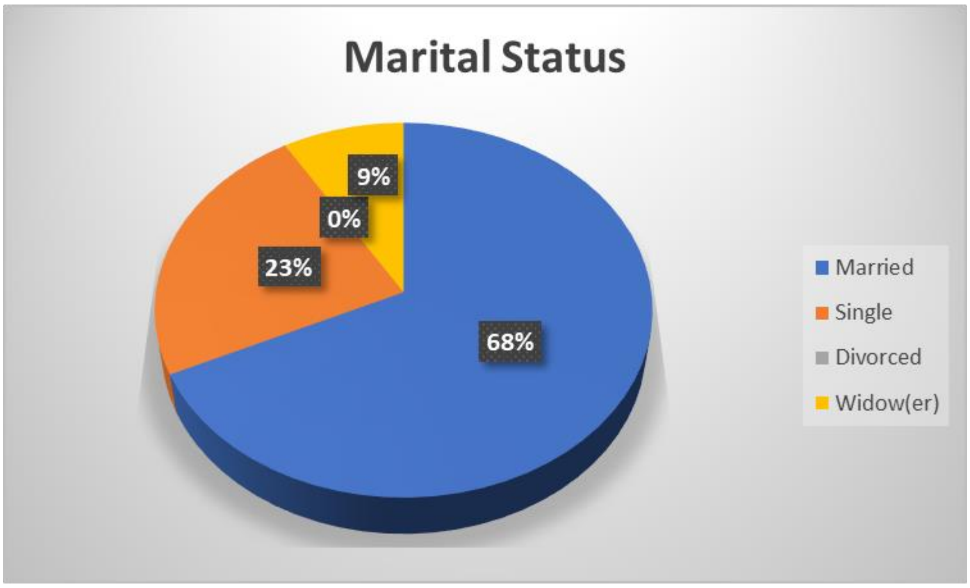


Figure 4.72: Percentage Distribution of Marital Status of Ogun State Household Population

Educational Institutions

There are several public and private owned primary and secondary schools in Ogun State. Also, there are several tertiary institutions in Ogun State which include: Federal University of Agriculture, Abeokuta, Crawford University, Federal Polytechnic, Ilaro, Mountain Top University, Ogun State College of Health Technology, Olabisi Onabanjo University, Redeemer's University Nigeria, Tai Solarin University of Education

Plate 4.28: Cross section of Schools (primary, secondary and tertiary) in Ogun State

The table below shows the highest educational qualification of household interviewed.

The table below shows the highest educational qualification of household interviewed.

Table 4.91: Highest Educational Qualification by Age Group of Ogun State Household Population (along the optic fibre routes)

Age Group	No education	Some primary	Completed primary	Some secondary	Completed secondary	More than secondary	Total
15 – 29	0	0	7	0	17	10	34
30 – 44	0	0	15	0	30	33	78
45-59	2	0	10	0	11	10	33
60+	0	0	2	0	3	0	5
Total	2	0	34	0	61	53	**150**

Source: Wordsworth Environ Field survey (2020)

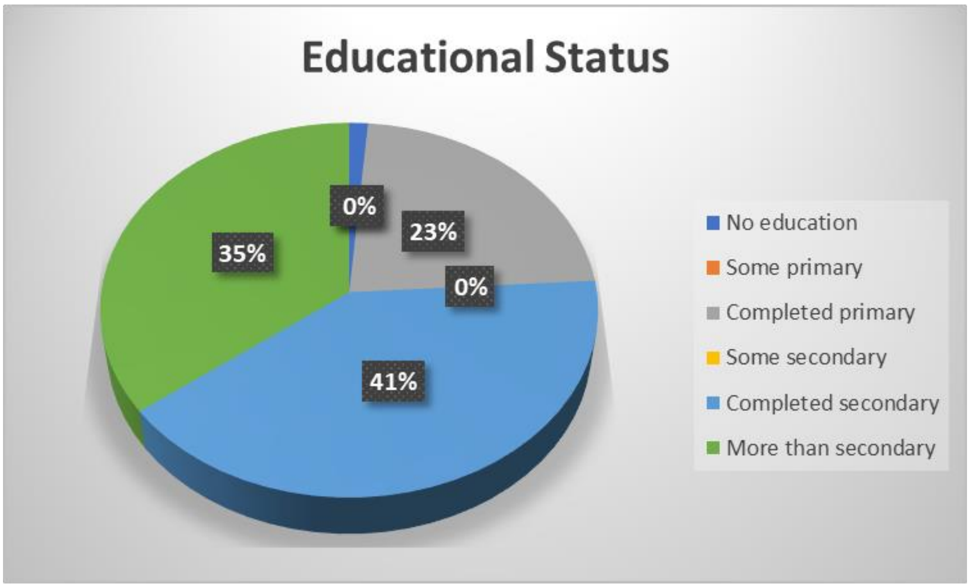


Figure 4.73: Percentage Distribution of Educational Status of Ogun State Household Population

Employment Status of Ogun State Household Population

For this group, the activities do not represent full employment and their labor is not fully utilized. They could be more profitably engaged in other activities. This group and those who in the last six months had had some temporary employment (lasting a one-hour work in a week. The Survey indicates that out of the 150-household population that constitute this age category (15 years and above), 83% of the household population are employed. The main form of occupation is manufacturing and construction as shown in Table 4.92.

Table 4.92: Employment Status by Age Group of Ogun State Household Population (along the optic fibre routes)

Age Group	Employed	Unemployed	Student/ Apprentice	Total
15 – 29	28	3	3	34
30 – 44	70	4	4	78
45-59	24	9	0	33
60+	3	2	0	5
Total	125	18	7	**150**

Source: Wordsworth Environ Field survey (2020)

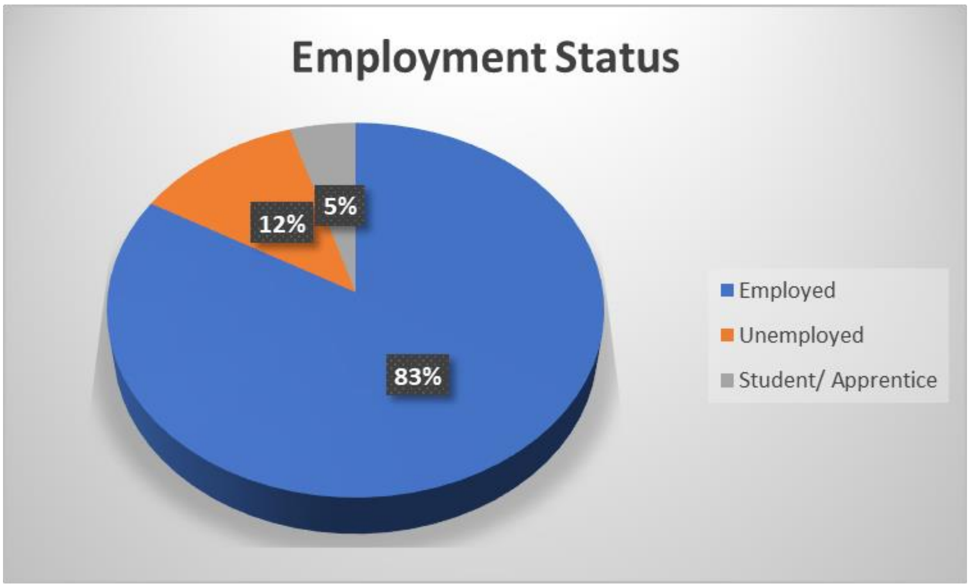


Figure 4.74: Percentage Distribution of Employment Status of Ogun State Household Population

Table 4.93: Activity in the Main Job of Ogun State Household Population (along the optic fibre routes)

Occupation (Main)	Frequency	Percentage
Agriculture, hunting or forestry and fishing	114	76.0
Mining	0	0.00
Manufacturing and Construction	5	3.33
Sales and Services	22	14.67
Others	9	6.00
No Answer	0	0.00
Total	**150**	**100**

Source: Wordsworth Environ Field survey (2020)

Income Level of Sampled Household Population

Three out of the 150 employed household population claimed that they do not actually keep records of their incomes. The breakdown of the income levels is presented in Table 4.94.

Table 4.94: Average Monthly Income Distribution of Ogun State Household Population (along the optic fibre routes)

Income Group	Frequency	Percentage	Type of Occupation
≤₦20,000	90	60.00	Agriculture, hunting or forestry, fishing, Sales and Services, others
₦20,001 – 40,000	46	30.67	Agriculture, hunting or forestry, fishing, Sales and Services Manufacturing, others
₦40,001 – 60,000	14	9.33	Agriculture, hunting or forestry Sales and Services Manufacturing, others
₦60,001 – 80,000	0	0.00	
₦80,001 – 100,000	0	0.00	
Above ₦100,000	0	0.00	
No Record	0	3.75	
Total	**150**	**100**	

Source: Wordsworth Environ Field survey (2020)

Infrastructural Facilities of Household

An analysis of infrastructural facilities in the study population is shown in Table 4.95.

Table 4.95: Infrastructural Facilities of Ogun State Household (along the optic fibre routes)

Facilities	**No. of Household**	**% of total Household**
Power Supply		
Electricity	125	83.33%
Alternative Power Supply		
Generator	113	75.33%
Primary Source of Water Supply (drinking)		
Bore Hole Hand Pump	20	13.34%
Bore Hole	35	23.33%
Well/Spring Protected	80	53.33%

Well/Spring Unprotected	0	0.00%
Rain Water /Streams/Pond/ River	0	0.00%
Tanker/Truck/Vendor	15	10.00%
Type of Refuse Disposal		
Burning	20	13.33%
Burying/Composting	0	0.00%
Open dumping in drains/borrow pit/dumpsite	85	56.67%
Government backed operators	45	30.00%
Nearby Bush	0	0.00%
No answer	0	0.00%
Type of Toilet Facility		
None	0	0.00%
Toilet on Water Flush to Sewage/septic	30	20.00%
Pit Latrine	120	80.00%

Source: Wordsworth Environ Field survey (2020)

Some of the households interviewed (83.33%) did have access to electricity from Ibadan Electricity Distribution Company (IBEDC). Even, those who have access to electricity are not satisfied due to regular interruption in power supply. Consequently, 75.33% out of these households have generator as an alternative source of power supply.

Six main types of primary water supply were utilized by the households. (see table above). Bore Hole and Bore Hole Hand Pump account for 13.34% and 23.33% respectively, well account for 53.33% as their primary source of drinking. The 80.00% households surveyed utilize Pit laterin facility while 56.67% of the household interviewed dispose off their waste through open dumping in drains/borrow pit/dumpsite.

Health and Sanitation

There is Federal Medical Centre in Abeokuta and many General Hospitals and primary health centres along the optic fibre routes in Ogun State. There are also several privately owned hospitals.

The most common ailment found in settlements along this route include: malaria, typhoid, rheumatism, high blood pressure, diabetes, among others. There have been few cases of HIV and AIDS. The types of toilet facilities found in settlements along this route include few water closets while most people still use the pit latrine and bushes. The wastes found in the area are mostly domestic wastes ranging from garbage, papers, nylon, food waste and rags. Waste disposal method is mostly by dumping long the road in open space (see plate).

Plate 4.29: Dumping of waste Indiscriminately at Ota town and Abeokuta the state capital of Ogun State

Issues Raised by Residents

Residents along this route were very excited about the plan to boost internet services and communication and that it was long over-due. For this reason, they raised neither objection nor complaint but wished that the project will be executed as proposed. They also expressed the hope that the contractor would employ their youths for the optic fibre project and that any property that would be affected should be dully and fully compensated.

4.12 Consultation

The consultations were carried out by means of communication, meetings and face to face interviews with stakeholders, local chiefs, students e.tc. Along the optic fibre routes, local residents, community leaders and the land owner were interviewed and were allowed to ask questions and express their concerns regarding the project. All these consultations followed recommended procedures that had been adopted in environmental impact assessment study for infrastructure developments.

Plate 4.30: Meeting with the FMEnv and State MEnv Officials in Osun State

Plate 4.31: Meeting with the FMEnv and State MEnv in Ondo State

Plate 4.32: Meeting with the FMEnv and State MEnv in Ekiti State

Plate 4.33: Meeting with the FMEnv and State MEnv in Kogi State

Plate 4.34: Meeting with the FMEnv and State MEnv Officials in Lagos State

Plate 4.35: Meeting with the FMEnv and State MEnv Officials, Local Government Service Commission in Ogun State

Plate 4.36: Meeting with the FMEnv and State MEnv Officials, Commissioner and PS, Min of Works & Infrastructure in Ogun State

Plate 4.37: Meeting with the FMEnv and State MEnv Officials, in Oyo State

Plate 4.38: Meeting with the FMEnv and State MEnv Officials, Director, Min of Public Works, Infrastructure & Transportation in Oyo State
Source:

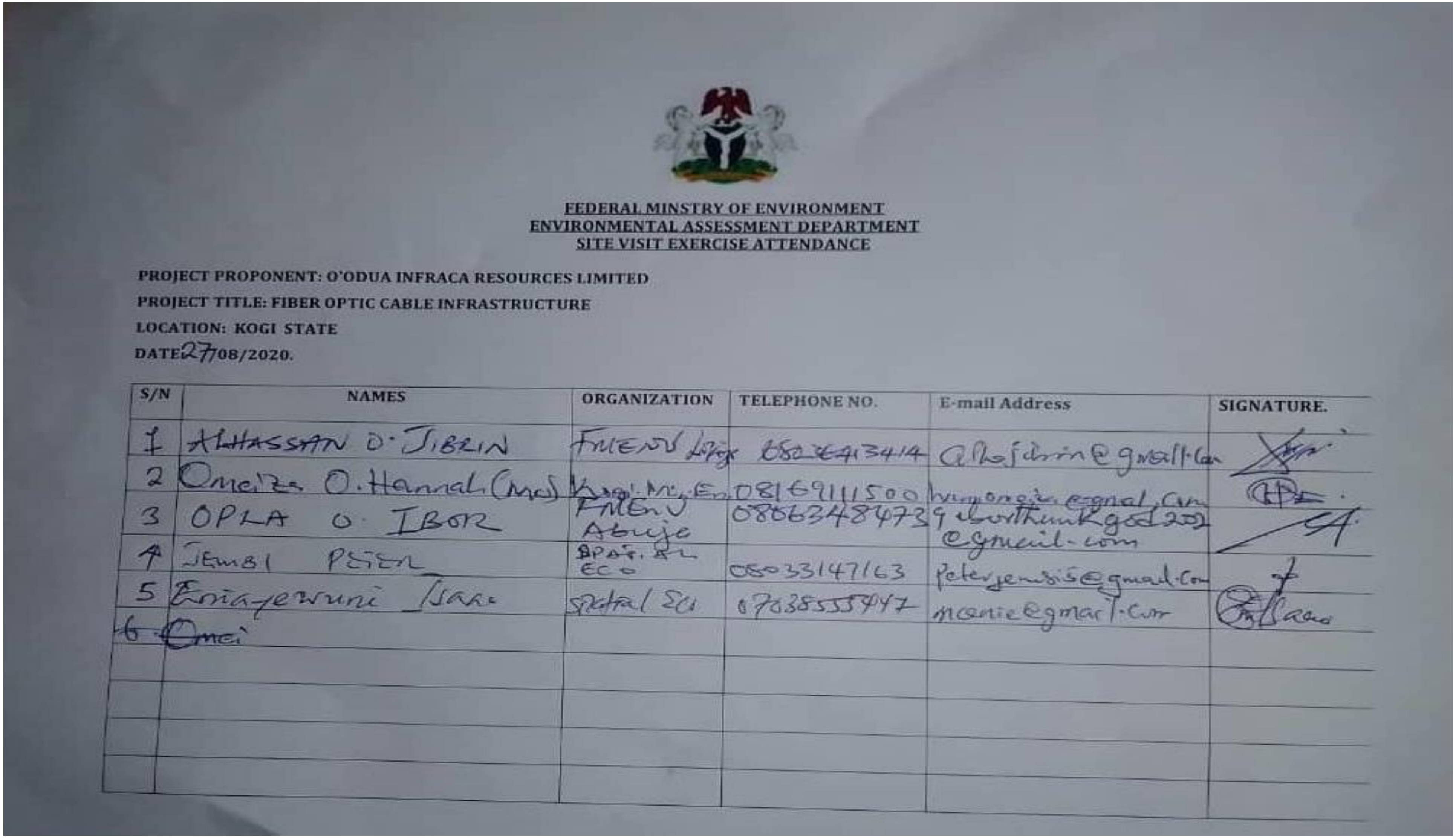
Plate 4.39: Meeting with the FMEnv and State MEnv Officials, PS, Min of Works, & Transport in Kwara State

Plate 4.40: Meeting with the FMEnv and State MEnv Officials, PS, Min of Enterprise Kwara State

Plate 4.41: Focal Discussion Group with people along the optic Fibre route at Ogbese in Ondo State


Plate 4.42: Consultation with General public and land owners at Ado Ekiti


Plate 4.43: Consultation with General public and land owners at Egbeda area of Ibadan



FEDERAL MINSTRY OF ENVIRONMENT
ENVIRONMENTAL ASSESSMENT DEPARTMENT
SITE VISIT EXERCISE ATTENDANCE

PROJECT PROPONENT: O'ODUA INFRACA RESOURCES LIMITED
PROJECT TITLE: FIBER OPTIC CABLE INFRASTRUCTURE
LOCATION: KOGI STATE
DATE 27/08/2020.

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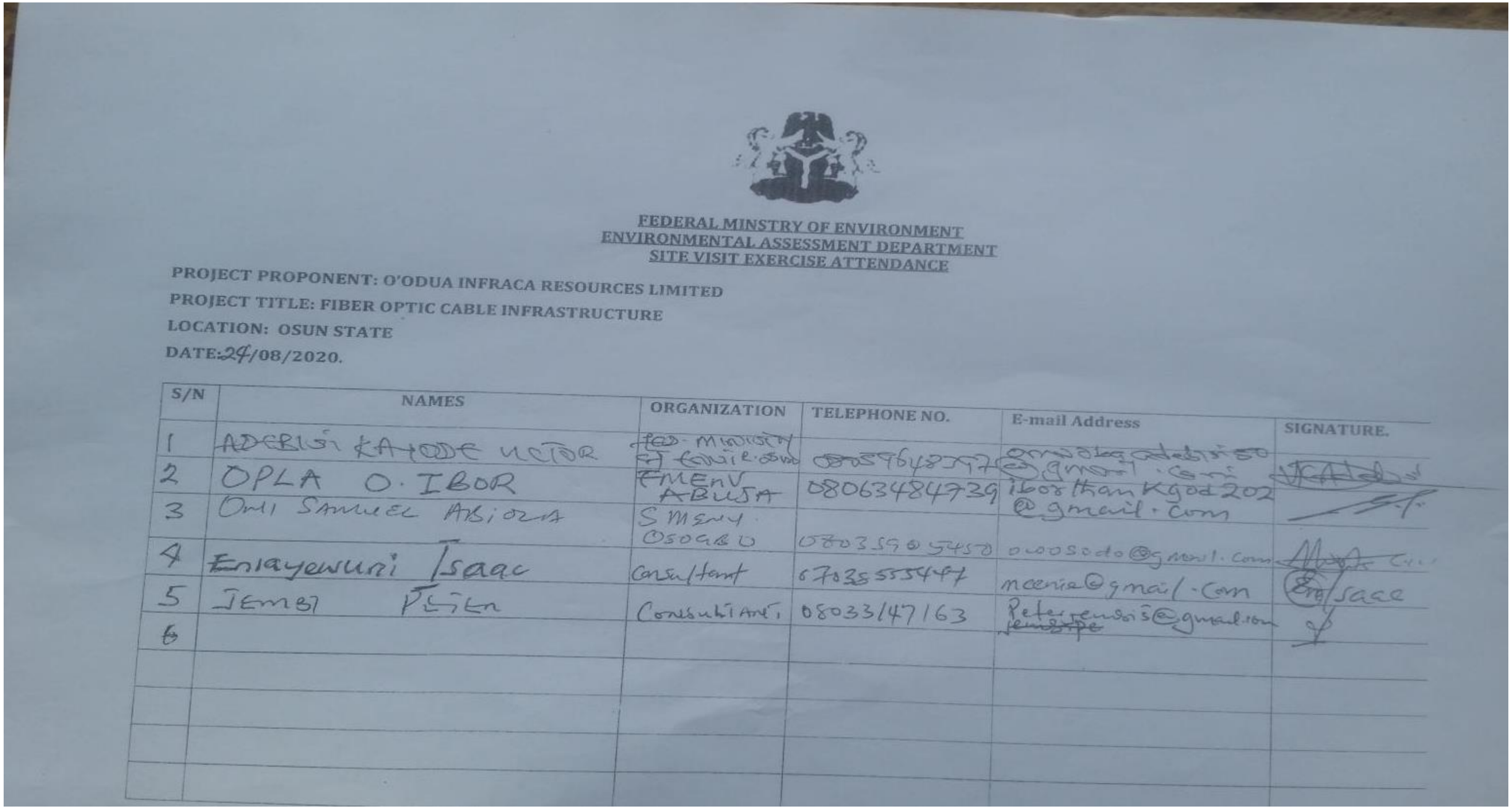
~~6 Omei~~					

Figure 4.75: Attendance Sheet (Kogi State)



FEDERAL MINSTRY OF ENVIRONMENT
ENVIRONMENTAL ASSESSMENT DEPARTMENT
SITE VISIT EXERCISE ATTENDANCE

PROJECT PROPONENT: O'ODUA INFRACA RESOURCES LIMITED
PROJECT TITLE: FIBER OPTIC CABLE INFRASTRUCTURE
LOCATION: OSUN STATE
DATE: 24/08/2020.

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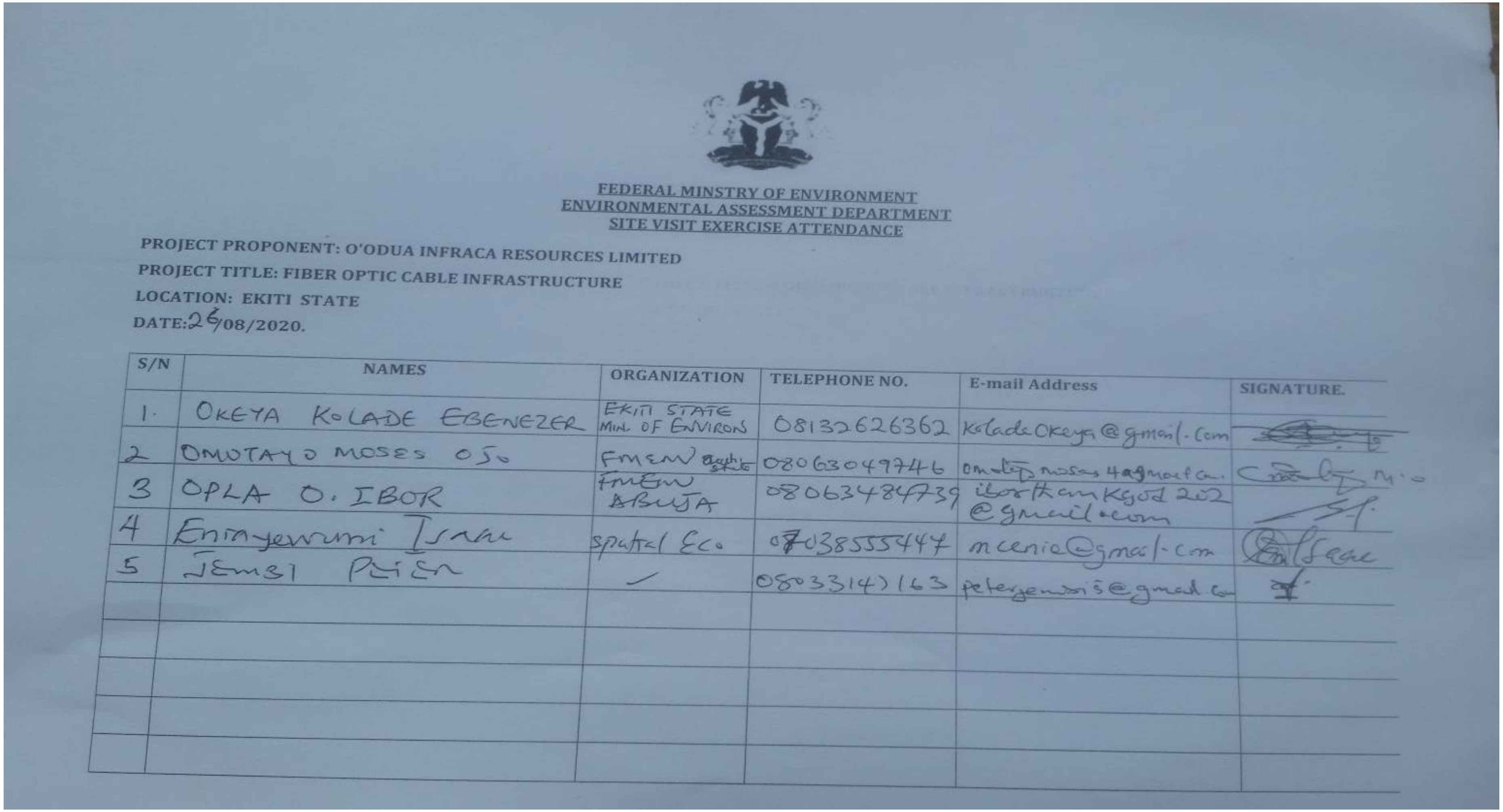
Figure 4.76: Attendance Sheet (Osun State)



FEDERAL MINSTRY OF ENVIRONMENT
ENVIRONMENTAL ASSESSMENT DEPARTMENT
SITE VISIT EXERCISE ATTENDANCE

PROJECT PROPONENT: O'ODUA INFRACA RESOURCES LIMITED
PROJECT TITLE: FIBER OPTIC CABLE INFRASTRUCTURE
LOCATION: EKITI STATE
DATE: 26/08/2020.

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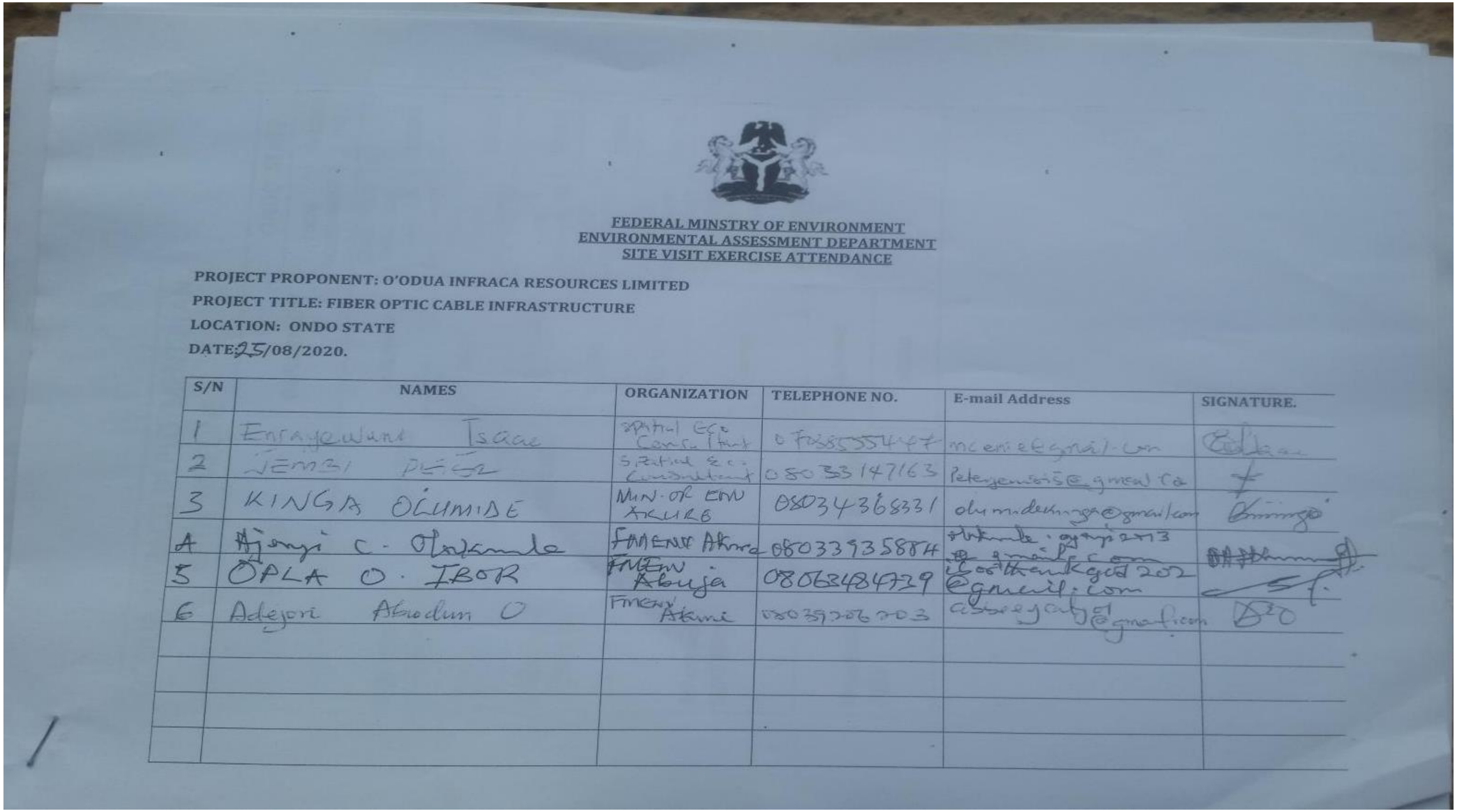
Figure 4.77: Attendance Sheet (Ekiti State)



FEDERAL MINSTRY OF ENVIRONMENT
ENVIRONMENTAL ASSESSMENT DEPARTMENT
SITE VISIT EXERCISE ATTENDANCE

PROJECT PROPONENT: O'ODUA INFRACA RESOURCES LIMITED
PROJECT TITLE: FIBER OPTIC CABLE INFRASTRUCTURE
LOCATION: ONDO STATE
DATE: 25/08/2020.

S/N	NAMES	ORGANIZATION	TELEPHONE NO.	E-mail Address	SIGNATURE.
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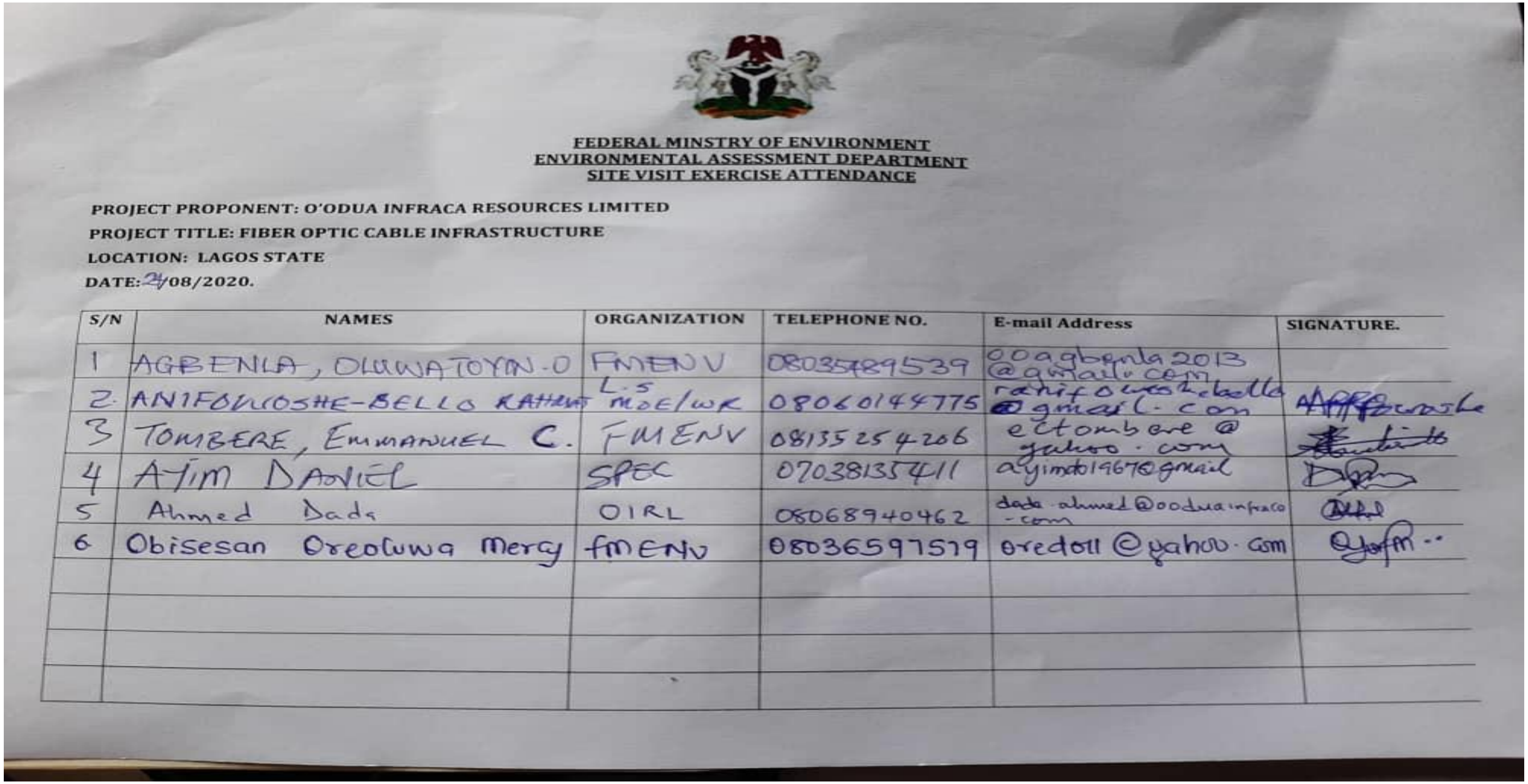
Figure 4.78: Attendance Sheet (Ondo State)



FEDERAL MINSTRY OF ENVIRONMENT
ENVIRONMENTAL ASSESSMENT DEPARTMENT
SITE VISIT EXERCISE ATTENDANCE

PROJECT PROPONENT: O'ODUA INFRACA RESOURCES LIMITED
PROJECT TITLE: FIBER OPTIC CABLE INFRASTRUCTURE
LOCATION: LAGOS STATE
DATE: 24/08/2020.

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Figure 4.79: Attendance Sheet (Lagos State)

FEDERAL MINISTRY OF ENVIRONMENT
ENVIRONMENTAL ASSESSMENT DEPARTMENT
SITE VISIT EXERCISE ATTENDANCE

PROJECT PROPONENT: O'ODUA INFRACA RESOURCES LIMITED

PROJECT TITLE: FIBER OPTIC CABLE INFRASTRUCTURE

LOCATION: OGUN STATE

DATE: 25/08/2020.

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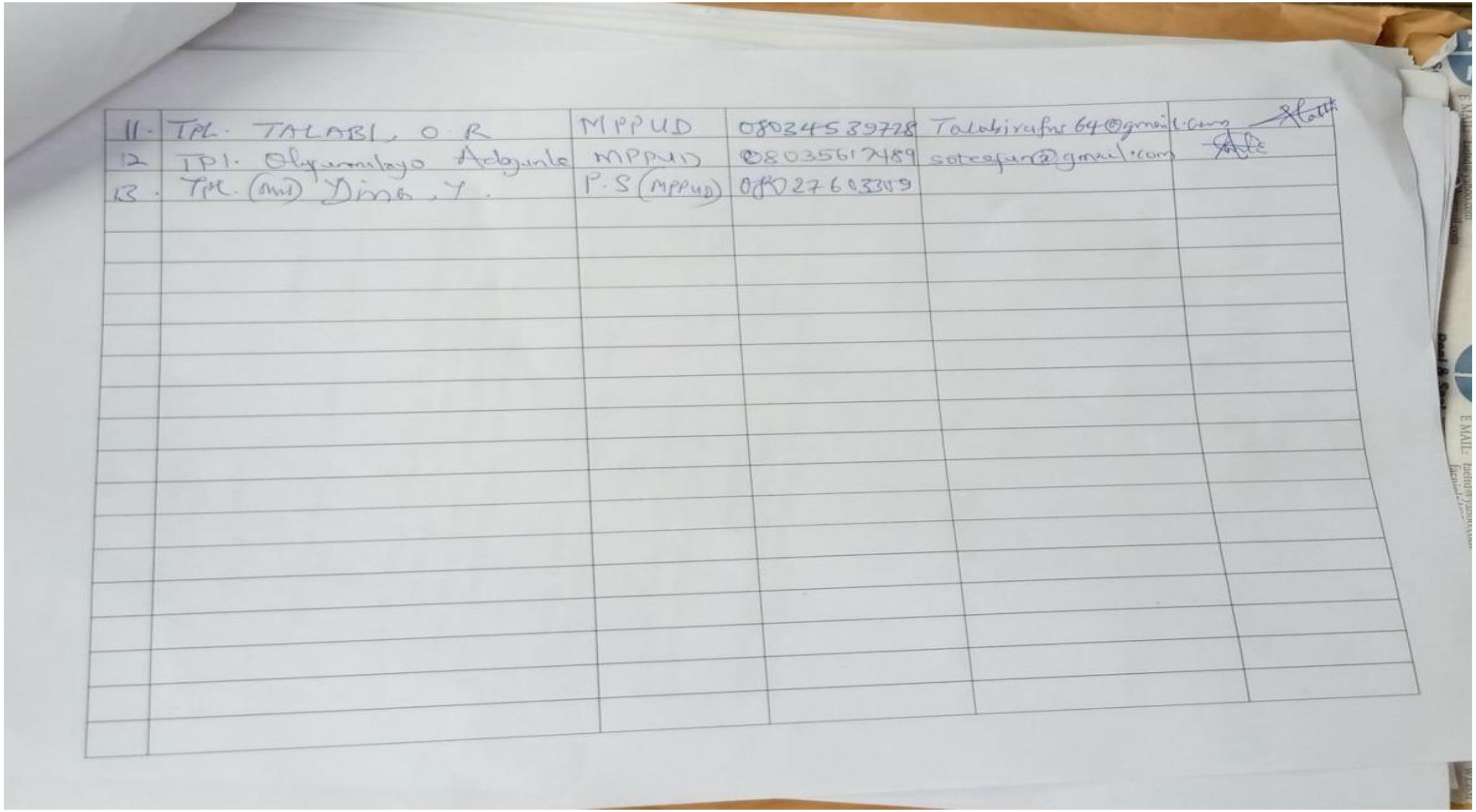

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Figure 4.80: Attendance Sheet (Ogun State)

FEDERAL MINSTRY OF ENVIRONMENT
ENVIRONMENTAL ASSESSMENT DEPARTMENT
SITE VISIT EXERCISE ATTENDANCE

PROJECT PROPONENT: O'ODUA INFRACA RESOURCES LIMITED

PROJECT TITLE: FIBER OPTIC CABLE INFRASTRUCTURE

LOCATION: OYO STATE

DATE: 26/08/2020.

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FEDERAL MINISTRY OF ENVIRONMENT
ENVIRONMENTAL ASSESSMENT DEPARTMENT
SITE VISIT EXERCISE ATTENDANCE

PROJECT PROPONENT: O'ODUA INFRACA RESOURCES LIMITED

PROJECT TITLE: FIBER OPTIC CABLE INFRASTRUCTURE

LOCATION: KWARA STATE

DATE: /08/2020.

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Figure 4.81: Attendance Sheet (Oyo State)

Figure 4.82: Attendance Sheet (Kwara State)

CHAPTER FIVE

ASSOCIATED AND POTENTIAL ENVIRONMENTAL IMPACTS

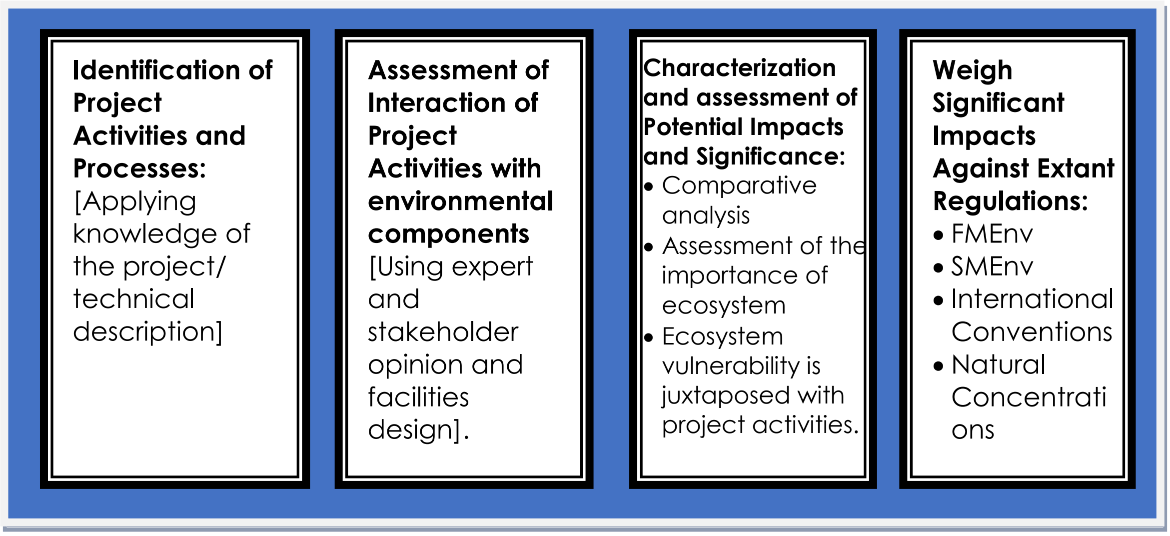
5.1 Introduction

The key objective of an ESIA is to predict changes (adverse or beneficial, whole or partial) in the ecological and socio-economic environment resulting from a proposed development project or activity as well as recommend mitigation measures to minimize, eliminate or offset those aspects that adversely impact on the environment.

The assessment approach generally involves matching the various activities of the project (as described in **Chapter 3** of this report) with the components of the existing environment. Consequently, the interaction may lead to changes in or impacts on the environment, hence mitigation measures are proffered to reduce, offset, or ameliorate such changes. The assessment of the associated and potential impacts of the proposed Open Access Metropolitan Fibre Network activities as well as the mitigation measures required for reducing the identified significant and residual impacts to as low as reasonably practicable is presented in subsequent sections.

5.2 Impact Assessment Methodology

The overall intent of the ESIA study is to identify and characterise all the associated and potential impacts or effects that will be caused by the proposed Open Access Metropolitan Fibre Network activities. Though there are several approaches for the prediction and evaluation of project environmental impacts, the ISO 14001 method was selected for this study. The ISO 14001 method is simple to apply, provides a high level of detail, and relies on limited data. The process and pathways followed in the identification and assessment of the associated and potential impacts of the proposed project are illustrated in **Figure 5.1**.



5.3 Summary of Environmental Impact Indicators

The environmental impact indicators are easily observable parameters that will indicate change/deviation, which can be used to monitor the various environmental components. Those considered in this study are summarized in **Table 5.1.**

Project Activities

The activities anticipated in the proposed Open Access Metropolitan Fibre Network project and its existing facilities' modifications cover all the anticipated phases including construction, operation/maintenance, and decommissioning. The anticipated activities of each of these phases include:

A. Pre-Construction phase activities

- Site Preparation,
- Engineering Design,
- Materials Delivery, Etc.
- Acquiring of Right of Way (Row)
- Mobilisation (Transport) to the Site (Equipment, Personnel and Construction Modules)
- Energy Requirements (Provision of Energy for Construction)
- Labour Requirements
- Site Preparation (Vegetation and Land Clearing)

Table 5.1: Environmental Components and Potential Impact Indicators

S/No	Environmental Components	Impact Indicators
1	Air Quality and Noise	SPM, NO_X, SO_2, CO, VOCs, NH_3, H_2S, and Noise
2	Soil/Agriculture	Soil type, Soil pH, TOC, Soil nutrients, Total Heterotrophic bacteria and fungi, Hydrocarbon

		Utilizing bacteria and fungi and Coliform, Hydrocarbon Utilizer; topography
3	Surface Water Quality	Dissolved and suspended solids, pH, BOD, COD, turbidity, toxicity, Pb, Cd, As, Ni, Fe, Hg, Mg.and Total Heterotrophic bacteria and fungi, Hydrocarbon Utilizing bacteria and fungi and Coliform, Hydrocarbon Utilizer
4	Groundwater quality	Dissolved and Suspended solids, Turbidity, pH, BOD, COD, Toxicity, Pb, Cd, As, Ni, Fe, Hg, Mg. and Total Heterotrophic bacteria and fungi, Hydrocarbon Utilizing bacteria and fungi and Coliform, Hydrocarbon Utilizer
5	Socio-economic/Health	Needs and concern of host communities/third party concerns; opportunities for employment; income level; health risks; waste streams, Handling, Treatment, and disposal; access to household water; access to roads; access to transport; opportunities for contracting and procurement; respect for labour rights; respect for human rights

B. Construction phase activities

- Trenching of Fibre Optic route
- Laying of Fibre cables
- installation of various equipment, power generation equipment, etc.)
- civil works
- Backfilling
- Commissioning of the proposed project
- Demobilization

C. The operational phase activities are

- Operation of the Open Access Metropolitan Fibre Network
- Maintenance or inspection of fibre cable along the RoW
- Maintenance of data center and Metro access system locations

D. The decommissioning activities include

- Removal of Open Access Metropolitan Fibre Network for relocation or sale

5.4 Impact Identification and Evaluation

To adhere strictly to general guidelines for an Environmental and Social Impact Assessment (ESIA) process, the following basic steps were adopted for the identification and evaluation of impacts in this study:

- Impact identification;
- Impact qualification;
- Impact rating; and
- Impact description

5.4.1 Impact Identification

Impact identification aims to account for the entire potential and associated biophysical, social, and health impacts making sure that both significant and insignificant impacts are accounted for. The anticipated impacts were determined based on the interaction between project activities and environmental sensitivities. The identified potential impacts during the different phases of the proposed project are listed in **Table 5.2.**

Table 5.2: Identified Project Impacts of the Proposed Open Access Metropolitan Fibre Network

Impacts	Phase		
Acceleration of erosion	√		
Acidification of soil and water	√		√
Alteration of local topography	√		
Alteration of the soil profile	√		√
Blockage of drainage pattern	√		√
Blockage of roads/motorways	√		√
Change in land use	√	√	√
Change in water quality	√	√	√
Contamination of groundwater	√	√	√
Contamination of surface water and soil	√	√	√
Damage to communication cables	√		
Exposure to heat and light	√		√
Impairment of air quality	√	√	√
Improved Telecommunication business		√	
Improved livelihood	√	√	√
Increased demand for social infrastructure	√	√	√
Increased surface water turbidity	√		√
Increase in incidence of STI's including HIV	√		√
Increase in income	√	√	√

Impacts	Phase		
Increase in price of locally sourced materials	√		
Increase in social vices	√	√	√
Increased opportunity for business and employment	√	√	√
The influx of migrant workers and camp-followers	√		√
Interference with road and water transportation	√	√	√
The kidnapping of workers and visitors on site	√	√	√
Land utilized for temporary base camps/restriction on land use	√		√
Legal issues	√	√	√
Loss of land	√	√	
Loss of employment/ income			√
Noise and vibration nuisance	√		√
Road accidents	√	√	√
Worksite accidents	√	√	√

5.4.2 Impact Qualification

The identified impacts of the project were qualified using four criteria including:

- Positive or negative
- Short-term or long-term
- Reversible or irreversible
- Direct or indirect

Negative impacts are those that adversely affect the biophysical, health, and social environments, while positive impacts are those, which enhance the quality of the environment. For this study, the short term means a period less than three months while any period greater than three months was considered long term. Reversible/irreversible meant whether the environment can either revert to previous conditions or remain permanent when the activity causing the impact is terminated.

5.4.3 Impact Rating

This stage involves the evaluation of the impact to determine whether or not it is significant. The quantification scale of 0, 1, 3, and 5 were used. The ratings are as adapted from the International Organization for Standardization (ISO) 14001–Environmental Management System Approach. The criteria and weighting scale used in evaluating significance are:

- Legal/regulatory requirements (L)
- Risk factor (R)
- Frequency of occurrence of impact (F)

- Importance of impact on an affected environmental component (I),
- Public perception/interest (P)

5.4.3.1 Legal /Regulatory Requirements (L)

This asks the question 'is there a legal/regulatory requirement or a permit required?' The scoring is as follows:

0= There is no legal/regulatory requirement
3= There is a legal/regulatory requirement
5= There is a legal/regulatory requirement and permit required

The legal/regulatory requirements were identified based on national laws/guidelines/standards (FMEnv, NCC, NESREA, State Ministries of Environment, etc) relating to the project activity.

5.4.3.2 Risk (R)

This uses a matrix based on the interaction of the probability of occurrence of the impact **(Table 5.3)** against consequences **(Table 5.4).** The matrix **(Figure 5.2)** is referred to as the Risk Assessment Matrix (RAM). Five probability categories interacted against four groups of consequences. The resultant outcomes were given scores with colour-coding. High-risk categories are red; intermediate risk, yellow and low risk, green as follows:

1=Low risk (green)
3=Intermediate risk (yellow)
5=High risk (red)

5.4.3.3 Frequency of Impact (F)

The frequency of impact refers to the number of occurrences of impact. The frequency of impact was determined using historical records of occurrence of impacts, and consultation with experts and local communities. The criteria for rating the frequency of impacts are outlined in **Table 5.5.**

5.4.3.4 Importance of Affected Environmental Component and Impact (I)

The importance of the affected environmental components was determined through consultation and consensus of opinions. This was also further facilitated by information on experiences on the impacts of already existing facilities in the proposed project area. The rating of the importance of impacts is summarized in **Table 5.6.**

Table 5.3: Probability of Occurrence

Probability Category	Definition
A	Possibility of Repeated Incidents

B	Possibility of Isolated Incidents
C	Possibility of Occurring Sometime
D	Not Likely to Occur
E	Practically Impossible

Table 5.4: Consequence Categories

Consequence Category	**Considerations**			
	Safety / Health	**Public Disruption**	**Environmental Aspects**	**Financial Implications**
I	Fatalities / Serious Impact on Public	Large Community	Major/Extended Duration/Full-Scale Response	High
II	Serious Injury to Personnel / Limited Impact on Public	Small Community	Serious / Significant Resource Commitment	Medium
III	Medical Treatment for Personnel / No Impact on Public	Minor	Moderate / Limited Response of Short Duration	Low
IV	Minor Impact on Personnel	Minimal to None	Minor / Little or No Response Needed	None

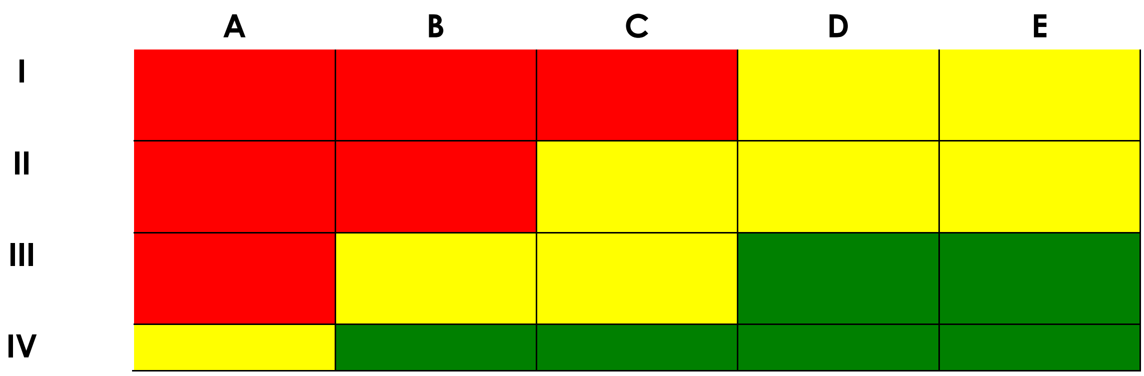


Figure 5.1: Risk Assessment Matrix

5.4.3.5 Public Perception (P)

The consensus of opinions among the project stakeholders was used to determine the public perception of the potential impacts and the criteria applied are as summarized in **Table 5.7**.

The combination of the five impact rating weights formed the basis for judging the level of significance of each impact. A matrix displaying the combination based on the ISO 14001 tool

The final ratings of the identified impacts are presented in **Tables 5.8 - 5.10.** In this study, medium and highly significant negative impacts were judged to require mitigation, and all positive impacts required enhancement.

Table 5.5: Frequency Rating and Criteria

Frequency	Rating	Criteria
Low	1	Rare, not likely to happen within project lifespan
Medium	3	Likely to happen ≥ 5 years
High	5	Very likely to happen throughout the project lifespan

Table 5.6: Importance Criteria

Importance	Rating	Criteria
Low	1	• Imperceptible outcome • Insignificant alteration in value, function, or service of impacted resource. • Within compliance, no controls required
Medium	3	• Negative outcome • Measurable reduction or disruption in value, function, or service of impacted resource • Potential for non-compliance
High	5	• Highly undesirable outcome (e.g., impairment of endangered species and protected habitat). • Detrimental, extended animal behavioural change (breeding, spawning, moulting). • Major reduction or disruption in value, function, or service of impacted valued ecosystem resource. • Impact during an environmentally sensitive period. • Continuous non-compliance with existing statutes

Table 5.7: Public Perception Criteria

Public Perception	Rating	Criteria
Low	1	• No risk to human health, acute and/or chronic • No possibility of life endangerment for residents, associated communities • A minor reduction in social, cultural, economic values

		• The unlikely adverse perception among the population
Medium	3	• The limited incremental risk to human health, acute and/or chronic. • Unlikely life endangerment for residents, abutting communities. • Some reduction in social, cultural, economic value • Possibility of adverse perception among the population. • Potential for non-compliance
High	5	• The elevated incremental risk to human health, acute and/or chronic. • Possibility of life endangerment for residents, abutting communities • Major reduction in social, cultural, economic value • Continuous non-compliance with statutes. • Any major public concern among the population in the study area.

Table 5.8: Impact Value and Rating Colour Code

Impact value	**Cut off values**	**Impact Rating**
L+R+F+I+P	<8	Low
L+R+F+I+P	≥8 but <15	Medium
L+R+F+I+P	≥15	High
F + I	>6	
P	= 5	
Positive		Positive

Table 5.9: Potential and Associated Impacts of the Proposed Project – Pre-Construction Phases ***Where L= Legal/Regulatory Requirement, R = Risk, F= Frequency, I = Importance, P = Public Interest/ Perception***

Project Phase	Project Activity	Description of Impact	Impact Qualification								Impact Quantification							Impact Rating
			Positive	Negative	Direct	Indirect	Short term	Long-term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	
Pre-Construction	Land Take for RoW	Loss of land		√	√		√	√	√		3	3	3	3	3	15	6	H
		Change in land use		√	√			√	√		3	1	5	1	1	11	6	M
		Legal issue		√	√			√	√		3	1	5	1	1	11	6	M
	Mobilisation (transport) to the site (equipment, personnel, and construction modules)	Road traffic accidents		√	√		√	√	√		3	3	3	3	3	15	6	H
		Noise nuisance		√	√		√		√		3	3	1	1	1	9	2	M
		Impairment of air quality		√	√		√		√		3	3	1	1	1	9	2	M
		Loss of biodiversity		√	√		√	√	√		3	3	3	3	3	15	6	H
	Energy consumption (provision of energy for pre-	Impairment of air quality		√	√		√		√		3	3	1	1	1	9	2	M
		Noise and vibration nuisance		√	√		√		√		3	3	1	1	1	9	2	M
		Increased opportunity for business and	√		√		√		√		-	-	-	-	-	-	-	P

	construction activities)	employment																
		Contamination of soil by waste oil		√	√		√		√		3	1	3	1	1	9	4	M
	Site Preparation – land clearing and removal of vegetation	Acceleration of erosion		√	√		√		√		3	1	3	1	1	9	4	M
		Alteration of local topography		√	√		√		√		3	1	3	1	1	9	4	M
		Blockage of drainage pattern		√	√		√		√		3	1	3	1	1	9	4	M
		Contamination of soil by run-offs		√	√	√	√		√		3	1	1	1	1	7	2	L
		Impairment of air quality		√	√	√	√		√		3	1	3	1	1	9	4	M
		Noise and vibration nuisance		√		√		√	√	√	3	5	3	5	5	21	8	H
		Worksite accidents		√		√		√	√	√	3	5	3	5	5	21	8	H
		Security/artificial light at night		√	√		√		√		0	1	3	1	1	6	4	L
		Habitat alteration		√	√			√		√	3	5	5	5	5	23	10	H

Table 5.10: Potential and Associated Impacts of the Proposed Project – Construction Phases- ***Where L= Legal/Regulatory, R = Risk, F= Frequency, I = Importance, P = Public Interest/ Perception***

Project Phase	Project Activity	Description of Impact	Impact Qualification								Impact Quantification							Impact Rating
			Positive	Negative	Direct	Indirect	Short term	Long-term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	
Construction	Transport activities during construction	Road traffic accidents		√	√		√		√		3	5	5	5	5	23	10	H
		Noise nuisance from steaming engines/ heavy vehicles.		√	√		√		√		3	3	3	1	3	13	4	M
		Impairment of air quality – emission from Heavy vehicles		√	√		√		√		3	1	1	1	3	9	2	M
	Trenching of Fibre Optic route and Laying of Fibre cables	Loss of vegetal cover with possible impact on biodiversity loss.		√	√	√	√	√	√		3	3	3	3	3	15	6	H
		Noise and vibration nuisance.		√	√		√		√		3	5	3	1	3	15	4	H
		Kidnapping of workers		√	√			√		√	3	5	5	5	5	23	10	H
		Waste generation from excavated materials.		√	√		√		√		3	5	3	1	3	15	4	H

		Impairment of air quality		√	√	√	√		√		3	5	3	3	1	15	6	H
		Contamination in the event of oil spills from equipment and machinery.		√	√			√	√		5	3	3	5	1	17	8	H
		Waste generation from excavated materials.		√	√		√		√		5	1	1	3	1	11	4	M
	Construction of Manholes and installation of various equipment, power generation equipment of data center and Metro access system	Waste Management - The potential effects will be of aesthetics as well as a nuisance of wastes such as metal cuttings, paper cartons, drums, paper, wood, etc.		√	√		√		√		3	5	3	1	3	15	4	H
		Impairment of air quality		√	√	√	√		√		3	5	3	3	1	15	6	H
		Noise and vibration nuisance		√		√		√	√	√	3	5	3	5	5	21	8	H
		Road/Worksite accidents		√		√		√	√	√	3	5	3	5	5	21	8	H
		Exposure to Covid-19 disease		√	√			√		√	3	5	5	5	5	23	10	H
		Presence of transport vehicles and site machinery could restrict traffic fluidity locally and lead to quarrelling with contractor		√	√		√		√		5	1	1	3	1	11	4	M
	Water utilization for	Changes in surface hydrology from water		√	√		√		√		0	1	1	1	1	4	2	L

	concrete-weight	utilization for construction.																
	Backfilling	Surface water may be polluted due to increased erosion, runoff from the construction site, and contamination in the event of oil spills from equipment and machinery.			√	√		√		√	3	5	3	5	1	17	8	H
		Alteration of hydrological patterns resulting in temporary or permanent flooding, soil erosion, and destruction of biodiversity.			√	√		√		√	3	5	3	5	1	17	8	H
		Habitat alteration		√	√		√		√		5	1	1	3	1	11	4	M
		Worksite accidents			√	√		√		√	3	5	3	5	1	17	8	H
		Increase in communicable disease (including STDs and HIV/AIDS).		√	√		√		√		5	1	1	3	1	11	4	M
	Site demobilization	Road traffic accidents		√	√			√		√	3	3	2	3	3	14	5	M

Table 5.11: Potential and Associated Impacts of the Proposed Project –Operation

Project Phase	Project Activity	Description of Impact	Impact Qualification								Impact Quantification							Impact Rating
			Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	
Operation/ Maintenance	Operation and maintenance or inspection of the Open Access Metropolitan Fibre Network along RoW, Maintenance of data center and Metro	Soil/ groundwater contamination due to Fuel/ oil spill		√	√			√		√	3	5	5	5	5	23	10	H
		Air emission during Maintenance/servicing of production equipment and ancillaries		√	√	√	√		√		3	3	3	3	3	15	6	H
		Noise and vibration nuisance from Generating set		√	√			√		√	3	5	5	5	5	23	10	H
		The kidnapping of personnel during regular maintenance of RoW		√	√			√		√	3	5	5	5	5	23	10	H
		Road traffic accidents as a result of transportation activities during data centre operation and maintenance of RoW		√	√			√		√	3	5	5	5	5	23	10	H

Project Phase	Project Activity	Description of Impact	Impact Qualification								Impact Quantification							Impact Rating
			Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	
	access system locations																	
		Stealing and Vandalization of fibre cables		√	√			√		√	3	5	5	5	5	23	10	H
		Generation of Waste during operation of the Data centre		√	√			√		√	3	5	5	5	5	23	10	H
		Exposure to Covid-19 disease		√	√			√		√	3	5	5	5	5	23	10	H
		The threat of Naturally Occurring Radioactive Material (NORM) to the environment.		√	√			√		√	5	5	5	5	5	25	10	H
		Thermal effects due to exposure to EMF experienced by residents located around the data centre		√	√	√	√		√		3	1	1	3	1	9	4	M
		Third-party Encroachment on the setback (RoW)		√	√	√	√		√		3	1	1	3	1	9	4	M
		Public Perception and fears		√	√	√	√		√		3	1	1	3	1	9	4	M
		Security threat and the		√	√			√		√	0	5	5	5	5	20	10	H

Project Phase	Project Activity	Description of Impact	Impact Qualification								Impact Quantification							Impact Rating
			Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	
		threat from major accidents related to the fires and explosions at the facility and potential accidental releases of diesel when refilling the storage tank																
		Worksite related accidents		√	√			√		√	0	5	5	5	5	20	10	H
		Contamination of soil by paints and coating as a result of spillage		√	√			√		√	3	5	5	5	5	23	10	H
		Hazardous waste generation from painting		√	√			√		√	3	5	5	5	5	23	10	H
		Improvement of network services within the affected sates	√		√		√		√		-	-	-	-	-	-	-	P
	Transport activities during operation	Road traffic accidents		√	√		√		√		0	1	5	1	1	8	6	M

Project Phase	Project Activity	Description of Impact	Impact Qualification								Impact Quantification							Impact Rating
			Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	
	Recruitment of personnel from the stakeholder communities	Employment generation: Personnel will be recruited from the community. This employment will cause an increase in the earnings of the affected persons.	√		√		√		√		-	-	-	-	-	-	-	P

Table 5.12: Potential and Associated Impacts of the Proposed Project – Decommissioning

Project Phase	Project Activity	Description of Impact	Impact Qualification								Impact Quantification							Impact Rating
			Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	
Decommissioning	Demolition and Evacuation	Interference with road transportation		√	√		√		√		3	3	3	1	3	13	4	M
		Noise and vibration nuisance		√	√		√		√		3	3	3	1	3	13	4	M
		Impairment of air quality		√	√	√	√		√		3	1	3	3	1	11	6	M
		Contamination of groundwater/ surface water		√	√	√	√		√		3	1	3	3	1	11	6	M
		Contamination of soil		√	√	√	√		√		3	1	3	3	1	11	6	M
		The threat of Naturally Occurring Radioactive Material (NORM) to the environment.		√	√			√		√	5	5	5	5	5	25	10	H
		Poor disposal of wastes generated during this phase		√	√	√	√		√		3	1	3	3	1	11	6	M
		Loss of job		√	√	√	√		√		3	1	3	3	1	11	6	M
		Kidnapping of workers		√	√			√		√	0	5	5	5	5	20	10	H
		Injury/fatalities in workforce /communities		√	√	√	√		√		3	1	3	3	1	11	6	H

Project Phase	Project Activity	Description of Impact	Impact Qualification								Impact Quantification							Impact Rating
			Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	
		Third-Party Agitation due to Employment Issues and Loss of Benefits as Host Communities.		√	√	√	√		√		3	1	3	3	1	11	6	M

5.4.4 Cumulative Impacts

Cumulative impacts are changes to the environment that are caused by certain activity in combination with other past, present, and future human activities.

The concept of cumulative effects is an important one. It holds that while impacts may be small individually, the overall impact of all environmental changes affecting the receptors taken together can be significant. When a resource is nearing its tolerance threshold, a small change can push it over. The objective of the cumulative impact assessment is to identify the environmental and/or socio-economic aspects that may not on their own constitute a significant impact but when combined with impacts from past, present, or reasonably foreseeable future activities associated with this and/or other projects result in larger and more significant impacts.

There could be cumulative impact such as Loss of biodiversity especially where more than one companies are having the same Optic Fibre routes, landtake, and human displacement. So, if there are functional existing ducting infrastructure, OIRL will go through it otherwise liaise with relevant authorities on how to construct a ducting channel before passage in other to reduce any cumulative impact. OIRL shall obtain all the permit require for Row before embarking on the proposed project. Also, land owners whose land shall be taken shall receive compensation for their land and displacement. In addition, the project shall be executed with the latest more environmentally safe available technology which shall reduce greenhouse house effect and climate change. Therefore, cumulative impacts which shall arise from this proposed Open Access Metropolitan Fibre Network shall be minimal.

5.5 Summary of Impacts as They Relate to the Various Phases

The potential positive and negative impacts rated either high or medium are further herein described as arguments underlying the assessment.

5.5.1 Pre-Construction and Construction Phases

The negative medium impacts in this phase are: change in land and water usage, while during Mobilisation (transport) to the site (equipment, personnel, and construction modules) there will be noise nuisance and interference with road transportation. Energy requirements (provision of energy for construction) will result in negative medium impacts from impairment of air quality and noise and vibration nuisance with labour requirements activity resulting in negative medium impacts from an increase in the incidence of STI's/ HIV, increased demand on social infrastructure and influx of migrant workers/followers.

The site preparation (vegetation and land clearing), trenching of the land area, and backfilling activities will lead to high impacts from the acceleration of erosion, exposure to heat, light, and radiation, welding flash impairment of air quality, and noise/vibration nuisance. The phase impacts with high negative significant ratings also include road accidents from mobilisation, injuries, and death from falling objects and worksite accidents from the site preparation.

The phase's positive impacts are increasing in income from mobilisation; increased opportunity for business and employment from energy requirements; increased opportunity for business and employment, increase in income and improved livelihood from labour requirements; an increase in income from demobilization.

5.5.1.1 Permitting

Permitting is the process of obtaining permission of communities/ individuals and relevant government agencies on issues related to the project. All the necessary permits especially for the Right of Way (RoW) shall be obtained from the proper channel.

5.5.1.2 Increase in disease conditions like respiratory tract diseases/Covid 19.

Improper adherence to sanitary guidelines could and not adhering to hand and respiratory hygiene measures could lead to contracting of Covid 19. The impact was direct, negative, short term/long term, local and reversible. The rating is major.

5.5.1.3 Acceptance of project and cooperation/participation from communities and government.

Prior to the commencement of the project, extensive stakeholder consultations shall be carried out with communities, State and Local Government agencies, NGOs/CBOs to enlist their support, cooperation, and participation in the project. The occurrence of this rated as medium and the impact positive.

5.5.1.4 Third-Party Agitations

Land take sometimes could lead to community agitation due either to compensation issues, or stakeholder identification, or incoherence in leadership hierarchy and/or from boundary recognition between communities. The impact was described as direct, negative, short-term, local, reversible, and rated moderate.

5.5.1.5 Construction of a temporary on-site facility

During the construction phase, there will be a need for a temporary on-site facility. The temporary on-site facility will be for mobilization, transfer, and logistics.

Equipment shall be transferred from this location. The effect is expected to be short term, negative and reversible therefore low.

5.5.1.6 Loss of land usage

The land that shall be used for the project shall not be available for any other possible project in the entire lifespan of the proposed project to maintain its integrity. The non-availability of this land and the change in its use due to the proposed project directly impacts on land availability in the host area and to last the entire life of the proposed Open Access Metropolitan Fibre Network anticipated to be about 50 years thus qualified the impacts to be rated long term. However, this land can be returned to the owner after the life-span of the project if desired thus the impacts are rated reversible. Application of the impacts quantification elements qualified it to be rated medium.

5.5.1.7 Blockage of road access to other users

Movement of materials, equipment, and personnel in preparation for the proposed project is anticipated to result in increased road traffic volume on the road leading in and out of the area thus may worsen the traffic situation around the area. However, these impacts are expected to last the period of mobilization to the site, storage of construction materials, site preparation for Open Access Metropolitan Fibre Network construction and installation activities. The impacts are short-term, negative, reversible, with the direct impact thus rated medium.

5.5.1.8 Conflicts/ Third party agitations over employment issues

Because all available local labour cannot possibly be engaged for the project, conflicts and agitations could arise over the distribution of employment slots to individuals and communities. This impact is direct, negative, short-term, reversible, and rated moderate.

5.5.1.9 Influx of job seekers into communities, thereby exerting pressure on infrastructure

The influx of job seekers into the communities for employment opportunities could exert additional pressure on limited community resources such as water supply, available food sources, and housing. This impact is rated direct, negative, short-term, local reversible, and moderate.

5.5.1.10 Destruction of Vegetation (Medicinal, Economic and Food)/Loss of Wildlife Habit

The natural vegetation of the land take(RoW) shall largely be removed to create space for the construction of the permanent structures. Nevertheless, since not all areas will be put to secondary use, any remaining vegetation, either for aesthetic beauty or as a green area on the land take will benefit from continuous tendering. These could serve a good purpose as indicators of environmental change.

5.5.1.11 Loss of species and their ecosystem services

This is the primary impact. Many native species will be cleared from the land take (RoW). Some will be lost to trampling. Unless prevented, some species would be lost to soil contamination. Also, since the land will be under continuous anthropogenic traffic and associated pressure, the sandbank will be lost for the most part. Ecosystem services being currently provided by the species, such as erosion control, modification of hydrological cycle, shelter to wildlife, and carbon sequestration will be negatively impacted upon.

Secondary impact includes an increase in ambient temperature and heat, weather modification, the prevalence of particulate matter suspended in the atmosphere. These might further put any plant species and wildlife near the plot at risk of impaired ecology and physiology, leading to stunted growth and reduced productivity.

The removal of the vegetation on the acquired land will lead to the loss of any medicinal, economic, or food crops in the area. The wildlife that used this vegetation for habitat would also be deprived of them. The impact will be direct, negative, long term, local, irreversible and is rated high.

5.5.1.12 Impairment of air quality/ Noise and vibration nuisance

Operations and activities of mobile and stationary plants to be involved in the transportation of construction materials, energy requirements, site preparation, onsite construction and installation, land trenching, backfilling, completion of the project, commissioning and demobilization project activities may generate noise and vibration while emissions from the plants and associated dust suspensions may cause impaired air quality. All these are direct, with negative impact to last the period of construction activities thus the short term. Though they are reversible, their level of impact caused them to be rated medium. Table 5.13 shows the air emission per day per fleet. Heavy-duty equipment and other related large machinery may produce noise levels as high as 91 decibels weighted to 'A' scale (dBA). Table 5.14 shows the typical construction equipment and their associated noise level.

Table 5.13: Air emission per day per fleet

Compound	Weight (metric tons)
Carbon dioxide	1.05
Carbon monoxide	0.458

Hydrocarbons	0.35
Nitrogen oxides	0.126
Particulates	0.17
Sulphur oxides	0.727

Source of emission factors http//:www.epa.gov/region09/air/marine vessel/pfds/tanimar/pdf

Table 5.14: Construction Equipment Noise level

Equipment Type	Noise Level at 50feet (dBA)
Backhoe	85
Tractor	80
Truck	91
Chipper	85
Chainsaw	76

5.5.1.13 Road traffic accidents

Increase in traffic volume anticipated on the major road leading to the facility during the mobilization, demobilization, construction, and operation of the project. There is the possibility of traffic accidents involving OIRL vehicles alone or engaged contractors and third-party vehicles during mobilization and demobilization and operation phases. Since some of these accidents may result in death which is negative, direct, and irreversible, they are rated high.

5.5.1.14 Injuries and death/worksite accidents

During site preparation, onsite construction, and installation of the proposed Open Access Metropolitan Fibre Network components as well as land trenching, there can be worksite accidents and injuries/death from falling objects on site. Also, accidents could occur as a result of tripping or falling from a height. Some of these accidents may result in the death of victims which is negative, direct, and irreversible, thus rated high.

5.5.1.15 Employment/contracting and an increase in income

Procurement of construction materials, transportation, labour requirements, and installation of the proposed Open Access Metropolitan Fibre Network modules and machinery activities shall create employment/contracting as well as an increase in income opportunities thus improving the economic power of the people in the proposed host environment. These impacts are positive ratings.

5.5.1.16 Improved Network in the affected states

The major aim of this proposed project is to boost internet system within the eight states under consideration. If the project is completed, it is expected that this aim will positively enhance the performance of the telecommunication industry in satisfying the expectations and demand of both the private and public sectors of the economy. These impacts are of positive rating.

5.5.1.17 Kidnapping of workers and visitors on site

The kidnapping of workers and visitors on site are among the major security concerns in Nigeria now. During movements and working as required in the construction phase, personnel and company contractor may be victims of kidnappers. Some of these attacks may result in the death of victims which is negative, direct, and irreversible, thus rated high.

5.5.1.18 Solid, Liquid, and Hazardous Waste Management

It is expected that construction activities could generate both hazardous and non-hazardous wastes. The potential effects will be of aesthetics as well as a nuisance. Non-hazardous waste will mainly come from excavated soils and debris woodpiles, fibre optic cables, discarded packaging materials such as paper cartons, and empty plastic water bottle, cans containers while hazardous wastes could come from grease trap pumping, used oil, waste lubricants, paints, maintenance-related wastes. Although the impact of this non-hazardous waste is expected to be minimal, poor disposal methods can lead to environmental problems due to their non-biodegradable nature. The impact will be short term, negative and irreversible, so considered medium. However, hazardous wastes are expected to be high if they are not treated and disposed of well which can lead to environmental problems due to their non-biodegradable nature. The impact can be long term, negative and irreversible, so considered high.

5.5.2 Operation/Maintenance Phase

This phase of the proposed project is anticipated to have high ratings negative impacts including noise, vibration nuisance as well as impairment of air quality. The positive impacts ratings in the phase include increased opportunity for business and employment and an increase in income and improved livelihood. However, the activities of the operation phase which could have negative impacts shall include vehicular movement during maintenance of optic fibre routes, air emissions and noise nuisance during data centre operation and maintenance, waste generation, stealing and vandalization optic fibre cables etc.

5.5.2.1 Impairment of air quality

Normal operations and activities of the proposed project during this phase may be sources of air pollution from the supporting equipment including generating set during operation, maintenance of these generating sets, and also refilling of the storage tank. These activities may result in air emission of suspended particulates matters (SPM), carbon monoxide (CO), oxides of nitrogen (NO_{X}), hydrocarbons (HC), and sulphur dioxide (SO_2). Though the quantities of these emissions will be determined by emission inventory with ground-level concentrations to be quantified using emission dispersion modeling, the volume of diesel to be handle made them rated high.

5.5.2.2 Noise and Vibration

Operations and maintenance of generating sets, could affect the environment. Though the levels of noise to be released from these supporting facilities shall be determined by Noise Map and a noise dispersion modeling tool, the impact was rated as direct, negative, short-term, local, reversible, and medium.

5.5.2.3 Waste generation

It is expected that during the operation of the Open Access Metropolitan Fibre Network, maintenance of the project could generate both hazardous and non-hazardous wastes. The potential effects will be of aesthetics as well as a nuisance. Non-hazardous waste will mainly come from discarded packaging materials such as paper cartons, and empty plastic water bottle, cans containers while hazardous wastes could come from grease trap pumping, lead-acid storage batteries, used oil, waste lubricants, paints, maintenance-related wastes, used air and liquid filtration media, and empty or partially full chemical containers. Although the impact of this non-hazardous waste is expected to be minimal, poor disposal methods can lead to environmental problems due to their non-biodegradable nature. The impact will be short term, negative and irreversible, so considered medium. However, hazardous wastes are expected to be high if they are not treated and disposed of well which can lead to environmental problems due to their non-biodegradable nature. The impact can be long term, negative and irreversible, so considered high.

5.5.2.4 Kidnapping of workers and visitors on site

Kidnapping is among major security concerns in Nigeria now. During maintenance of the Open Access Metropolitan Fibre Network personnel could be victims of kidnappers. Some of these attacks may result in the death of victims which is negative, direct, and irreversible, thus rated high.

5.5.2.5 Road traffic accidents

Increase in traffic volume anticipated on the major road leading to the facility during operation and maintenance of the Open Access Metropolitan Fibre

Network, there could be accidents from the movement of the vehicle in and out of the data centre and along the routes of the optic fibre in each state under consideration. Since some of these accidents may result in death which is negative, direct, and irreversible, they are rated high.

5.5.2.6 Employment/contracting and an increase in income

Operation of the proposed project shall create employment/contracting as well as an increase in income opportunities thus improving the economic power of the people in the proposed host environment. This impact is a positive rating.

5.5.3 Decommissioning Phase

At the end of this project which is anticipated to be 50 years by design, there will be decommissioning. In this phase, interference with road transportation and impairment of air quality are the two medium ratings anticipated while the kidnapping of workers and visitors on site is a high rating negative impact.

5.5.3.1 Impairment of air quality

Dismantling, removal, and site clean-up at the end of the proposed project may require the use of heavy machinery with activities that may open the soil surface. Decommissioning activities of the Open Access Metropolitan Fibre Network to be involved at this stage may generate emissions and associated dust suspensions may cause impaired air quality. These were identified as direct which will last the period of decommissioning activities. Though they were considered reversible, their levels caused them to be of medium ranking.

5.5.3.2 Kidnapping of workers and visitors on site

The kidnapping of workers and visitors on site are among the major security concerns in Nigeria now. During movements as required in decommissioning, personnel and company contractor may be victims of kidnappers. Some of these attacks may result in the death of victims which is negative, direct, and irreversible, thus rated high.

5.5.3.3 Solid, Liquid, and Hazardous Waste Management

Decommissioning activities will generate wastes such as excavated soils and debris woodpiles, fuels, lube oils, chemicals, and solid wastes from the demolition camp. Leaching from waste oil could result in groundwater contamination. The solid and hazardous waste generated during the decommissioning activities will be managed using the best management practices. The impact of hazardous waste management will be negative, short-term, localized, reversible, and medium. State

Ministries of Environment approved waste vendors shall be contacted for all waste-related issues.

5.5.3.4 Increased opportunity for employment and contracting resulting in increased income level.

The process of decommissioning will involve the repair of damaged roads, removal of structures, and restoration of the campsite. These activities could increase opportunities for employment and contract. The impact was rated as direct, positive, short-term, local, and reversible.

5.5.3.5 Injuries and death/worksite accidents

During decommissioning, removal of optic fibre components, as well as land excavation, could lead to worksite accidents and injuries/death. Also, an accident could occur as a result of tripping or falling. Some of these accidents may result in the death of victims which is negative, direct, and irreversible, thus rated high.

5.5.3.6 Nuisance (Noise, emission, Vibration, etc) from heavy machinery.

The process of decommissioning could also result in the generation of noise, vibration, etc. from heavy equipment. The impact was rated as direct, negative, short-term, local, reversible, and medium.

5.5.3.7 Third-Party Agitation due to Employment Issues and Loss of Benefits as Host Communities.

As decommissioning activities start and come to an end, there could be agitation by the third parties from loss of employment and contracting opportunities. The impact was direct, negative, short-term, local, and reversible, with the medium rating.

It is noteworthy to state that the beneficial impacts to be realized, could be emphasized as a justification of this viable Project. Major potential adverse impacts have been identified and evaluated. Except for the few significantly adverse impacts, most of the ratings for all project phases were low to medium. This is a good indication that the overall adverse impact of the Project on the various components of the environment would be minimal.

The significance of these impacts could as well be minimized to acceptable levels if adequate mitigation measures are put in place; allowing the project to be implemented in an environmentally sustainable manner. Sound and cost-effective mitigation measures for the identified negative impacts are therefore presented in the next chapter.

CHAPTER SIX

MITIGATION MEASURES

6.1 Background Information

This chapter provides mitigation measures that will be taken by the OIRL against identified impacts to ensure the environmental sustainability of its proposed Open Access Metropolitan Fibre Network in Lagos, Ogun, Oyo, Osun, Ondo, Ekiti, Kwara and Kogi States. The impact identification and evaluation process showed that components of the biophysical, health, and social environments will be impacted both positively and negatively. Several measures are hereby proposed to mitigate the impacts of the facility to an acceptable residual impact level.

The HSE design and operation objectives of the facilities are to implement all cost-effective measures to reduce the risks and impacts of routine or major hazards including accidents. Thus, the steps taken in the HSE process for the proposed project include the following:

- design based on codes, standards, and regulations
- improved operation based on quantitative risk assessment and
- best international practice

6.2 Criteria for Selection of Mitigation Measures

Selection of mitigation measures for the identified impact is based on the following considerations:

a) Engineering design of the Optic Fibre,
b) The practicability of the measures,
c) Regulatory requirements (FMEnv, State Ministries of Environment and NCC), and
d) Industry and international best practices.

6.3 Mitigation Measures

Mitigation measures are actions taken to minimized negative impacts, while also enhance positive ones. Mitigation measures are often implemented continuously throughout the project's life span. These measures aim to improve the environmental sustainability of the project. Mitigation measures are recommended for the project identified impacts on:

a) Environment
b) Occupational safety and health
c) Community health and safety.

The comprehensive mitigation measures encapsulating the project phases from pre-construction to construction, operation, and decommissioning are presented in ***Table 6.1*** below. Following the adoption of mitigation measures, residual impacts are also presented.

Table 6.1: Mitigation Measures of the Proposed Project Activities – Pre-Construction Phase

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
Land Take for RoW	Loss of land Change in land use Legal issue	H	This impact, although negative is reversible, the probability of the impact arising is also low because OIRL already has an gotten approval for Right of Way for all the routes where the optic fibres shall pass through. However, the OIRL shall ensure: ✓ continuous consultation and engagement with host communities and other stakeholders shall be maintained to forestall unrest in line with the company's grievance mechanism. ✓ that proper land acquisition procedure is followed and payment of all land dues to any concerned stakeholder	**L**
Mobilisation (transport) to the site (equipment, personnel, and construction modules)	Road traffic accidents	H	To prevent road accident, OIRL shall ensure: • compliance with journey management policy • Vehicles are pre-mobbed and pre-mobilization/compliance certificate issued. • The use of PPEs at sites; daily pep talk, carry out job hazard analysis. • Ensure that all traffic rules are obeyed by the drivers. • Speed breakers at sections traversing communities.	M

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			• Conformance with road traffic laws in line with the Federal Road Safety Commission (FRSC) safety requirements. • All safety incidents shall be reported and investigated. Corrective actions will also be implemented.	
	Noise nuisance	M	OIRL shall ensure: • Regular maintenance of vehicles. • Vehicles are turned off when not in use. • Vehicles are fitted with effective silencers.	L
	Impairment of air quality	M	OIRL shall ensure: • Engine to comply with international standards for exhaust gases; Maintenance of engines and exhaust gas check; Adoption of engine-off policy at the construction site • that nose masks and earmuffs are worn by site workers during excavation • that water shall be sprayed on construction sites to reduce dust levels, especially during the dry season. • there is regular maintenance of the generators; • generators are switched off when not in use • dust control and dust recovery machinery are used	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			• Construction materials and earth will be fully covered during transportation to the construction site by road; •	
	Loss of biodiversity	H	▪ Strictly regulating heavy equipment traffic ▪ Restricting the number of traffic lanes and limiting the movement of the machinery to the worksite and to the marked access way. ▪ Implement good housekeeping practice on-site. ▪ Storing and handling of the hazardous waste following approved WMP. ▪ Selecting vehicles suited for erodible soil. ▪ Limiting activities in erodable soil.	L
Energy consumption (provision of energy for pre-construction activities)	Impairment of air quality	M	OIRL shall ensure that: • there is regular maintenance of the generators; • generators are switched off when not in use	L
	Noise and vibration nuisance	M	OIRL shall ensure that: • electric power generators are fitted with effective silencers; • there shall be regular maintenance of the generators; • noise barriers are erected • generators are switched off when not in use; • soundproof electric power generators are engaged	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			• Provision of rubber padding/ noise isolators to DG sets and construction machines	
	Contamination of soil	M	OIRL shall ensure: • Soil disturbance shall be kept to the minimum required for operation and safety. • Oil spill containment shall be provided to prevent an oil spill from getting to the soil. • Implement good housekeeping practice on-site. • Storing and handling hazardous waste following approved WMP.	L
Site Preparation – land clearing, removal of vegetation,	Acceleration of erosion	M	OIRL shall: • Stabilize soil within the well location and campsite mechanically using compactors to reduce erosion potential • Mechanically stabilize the soil to reduce the potential for erosion • Provide for the placement of siltation ponds in areas subject to heavy erosion. • Select vehicles suited for erodible soil. • Limiting activities in erodable soil.	L
	Alteration of local	M	• OIRL shall ensure:	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
	topography		• re-grading of the sites, then replacing the layer of topsoil that was previously put. • restoring the operational site by restoring the original profile of the topography and the soil • strictly regulating heavy equipment traffic • restricting the number of traffic lanes and limiting the movement of the machinery to the worksite and to the marked access way.	
	Blockage of drainage pattern	M	OIRL shall ensure that: • Strict environmental policy shall be ensured • Regular cleaning of the drainage shall be ensured • The drainage network shall be covered	L
	Contamination of soil	M	OIRL shall: • Ensure that soil disturbance shall be kept to the minimum required for operation and safety. • Ensure that oil spill containment is provided to reduce oil spill from getting to the soil. • Implement good housekeeping practice on-site. • Store and handle hazardous waste following approved WMP. • Place filtration berms and sediment barriers.	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			• Use methods that minimises perturbation to the aquatic environment. Avoid spills prohibiting refuelling near a waterway.	
	Impairment of air quality	M	OIRL shall ensure that: • only pre-mobbed equipment is used; • all equipment is controlled; • equipment engines are turned off when not in use • OIRL shall ensure that all construction equipment shall be in proper operating condition and fitted with factory standard silencing features if appropriate • OIRL shall provide and enforce the use of PPE (e.g. nose masks and ear muffs) • OIRL shall construct soundproofing walls around stationary power generating sources • Use of the cleanest fuel economically available shall be adopted • Combustion technology and pollution control technology, which are all interrelated, shall be evaluated very carefully upstream of the project to optimize the project's environmental performance; • Use of loading and unloading equipment that	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			minimizes the height of fuel drop to the stockpile to reduce the generation of fugitive dust and installing of cyclone dust collectors; • Use of water spray systems to reduce the formation of fugitive dust from solid fuel storage in arid environments; • Use of enclosed conveyors with well designed, extraction and filtration equipment on conveyor transfer points to prevent the emission of dust;	
	Noise and vibration nuisance	H	OIRL shall ensure that: • equipment is fitted with effective silencers; • there shall be regular maintenance of equipment; • equipment is switched off when not in use; • vibration containment be made for equipment which is likely to cause vibration; and • PPEs shall be encouraged at all times.	L
	Worksite accidents	H	OIRL shall ensure that: • workers and visitors are properly kitted (use of appropriate PPEs) • use of warning signs • non-consumption of alcoholic beverages on work site	M

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			• Clinic / first aid kit shall always be available within the site	
	Habitat Alteration	H	OIRL shall: ▪ Use methods that minimises perturbation to the aquatic environment. ▪ Avoid spills prohibiting refuelling near waterways. ▪ Minimise destruction or modification of the vegetation cover by restoring vegetation at the end of the work.	L

Table 6.2: Mitigation Measures of the Proposed Project Activities– Construction Phase

Project Activity	**Description of Impacts**	**Rating before Mitigation**	**Mitigation/Control Measures**	**Rating after Mitigation**
Transport activities during construction	Road traffic accidents	H	To prevent road accident, OIRL shall ensure: • compliance with journey management policy. • Vehicles are pre-mobbed and pre-mobilization/compliance certificate issued. • the use of PPEs at sites; daily pep talk, carry out job hazard analysis • ensure that all traffic rules are obeyed by the drivers • Speed breakers at sections traversing communities • Conformance with road traffic laws in line with the Federal Road Safety Commission (FRSC) safety requirements. • All safety incidents will be reported and investigated. Corrective actions will also be implemented	M
	Noise nuisance	M	OIRL shall ensure: • regular maintenance of vehicles • Vehicles are turned off when not in use • Vehicles are fitted with effective silencers.	L
	Impairment of air quality – emission	M	OIRL shall ensure: • Engine to comply with international standards for	L

	from trucks		exhaust gases; • Maintenance of engines and exhaust gas check; Adoption of the engine of policy at the construction site. • that nose masks and earmuffs are worn by site workers during excavation • The use of the cleanest fuel economically available shall be adopted. • Combustion technology and pollution control technology, which are all interrelated, shall be evaluated very carefully upstream of the project to optimize the project's environmental performance; • Use of loading and unloading equipment that minimizes the height of fuel drop to the stockpile to reduce the generation of fugitive dust and installing of cyclone dust collectors; • Use of water spray systems to reduce the formation of fugitive dust from solid fuel storage in arid environments; • Use of enclosed conveyors with well designed, extraction and filtration equipment on conveyor transfer points to prevent the emission of dust	
Trenching of Fibre Optic	Loss of vegetal cover with possible impact on biodiversity loss	H	OIRL shall: ▪ Provide siltation pond in areas of heavy erosion ▪ Place filtration berms and sediment barriers.	M

route and Laying of Fibre cables			▪ Use methods that minimises perturbation to the aquatic environment. ▪ Avoid spills prohibiting refuelling near waterways. ▪ Minimise destruction or modification of the vegetation cover by restoring vegetation at the end of the work.	
	Impairment of air quality	H	OIRL shall ensure: • there is regular maintenance of the engines; • engines are switched off when not in use • engines to comply with international standards for exhaust gases; • Maintenance of engines and exhaust gas check; • that nose masks and earmuffs are worn by site workers during excavation. • Use of the cleanest fuel economically available shall be adopted • Combustion technology and pollution control technology, which are all interrelated, shall be evaluated very carefully upstream of the project to optimize the project's environmental performance;	L
	Noise and vibration nuisance	H	OIRL shall ensure that: • Machine engines are fitted with effective silencers; • regular maintenance of machine/ engines are performed; • engines are switched off when not in use; • soundproof electric power generators are engaged	L

			• the use of PPEs is encouraged • vibration containment shall be made for generators and machines	
	Contamination in the event of oil spills from equipment and machinery	H	• Oil spill containment shall be provided to reduce oil spill from getting to the soil and surface. • there shall be regular maintenance of the equipment and machinery.	M
	Kidnapping of workers	H	OIRL shall ensure that both contractor and OIRL personnel develop a high level of security consciousness both within and outside the work area • Daily security reports shall be reviewed by the OIRL Project Manager • A special security force shall be established and deployed for the project. This shall include deploying some of OIRL police to strengthen security in the area • OIRL shall ensure that a liaison to foster a partnership with the community to guarantee security for the project is established and sustained • To beef up security for the project, OIRL shall support government authorities by assisting with equipment e.g. patrol vehicles, to ensure improved security • OIRL shall ensure that safety workshops to identify, evaluate and recommend contingency plans for all security risks are regularly organized	M

			• OIRL shall ensure that there is a police station/post within and around the facility	
	Waste generation from excavated materials	H	OIRL shall ensure that: • all other wastes generated including environmentally deleterious materials generated by construction activities will be disposed of offsite in an appropriate, legal, and safe manner. • generation of all wastes are minimized as much as practically possible • Unsuitable excavated materials shall be systematically carried away from areas prone to erosion; • Reuse waste materials wherever possible and use designated disposal sites; • Used oil and lubricants shall be recovered and reused or removed from the site in full compliance with the national and local regulations; • Oil wastes, debris, and/or other waste materials must not be burned; • Optimize the reuse of soil and construction waste; • All the construction camps and facilities shall be dismantled and removed from the site unless otherwise desired by the local public; • the site shall be restored to a condition in no way inferior to the condition prior to the commencement of work.	L

			• safety measures while disposing of wastes are followed; • introduction of foreign soil and synthetic materials is avoided; • disposal of construction and related waste materials at designated and approved waste dump site; • waste management plan in road planning and contract specifications is incorporated; • there is a collaboration with relevant waste management agencies to enforce appropriate sanitation and other bye-laws.	
Construction of Manholes and installation of various equipment, power generation equipment of data center and Metro access system	Waste Management - The potential effects will be of aesthetics as well as a nuisance of wastes such as metal cuttings, paper carton, drums, paper, wood, optic fibre cables etc.	H	OIRL shall ensure that: • all other wastes generated including environmentally deleterious materials generated by construction activities will be disposed of offsite in an appropriate, legal, and safe manner. • generation of all wastes are minimized as much as practically possible • Unsuitable excavated materials shall be systematically carried away from areas prone to erosion; • Reuse waste materials wherever possible and use designated disposal sites; • Used oil and lubricants shall be recovered and reused or removed from the site in full compliance with the national and local regulations;	L

			• Oil wastes, debris, and/or other waste materials must not be burned; • Optimize the reuse of soil and construction waste; • All the construction camps and facilities shall be dismantled and removed from the site unless otherwise desired by the local public; • the site shall be restored to a condition in no way inferior to the condition prior to the commencement of work. • safety measures while disposing of wastes are followed; • introduction of foreign soil and synthetic materials is avoided; • disposal of construction and related waste materials at designated and approved waste dump site; • waste management plan in road planning and contract specifications is incorporated; • there is a collaboration with relevant waste management agencies to enforce appropriate sanitation and other bye-laws.	
	Impairment of air quality	H	OIRL shall ensure: • there is regular maintenance of the engines; • engines are switched off when not in use • engines to comply with international standards for exhaust gases; • Maintenance of engines and exhaust gas check;	L

			• that nose masks and earmuffs are worn by site workers during excavation • Use of the cleanest fuel economically available shall be adopted • Combustion technology and pollution control technology, which are all interrelated, shall be evaluated very carefully upstream of the project to optimize the project's environmental performance;	
	Noise and vibration nuisance	H	OIRL shall ensure: ✓ Regular maintenance of mobile and immobile equipment to ensure improved machine efficiency and complete combustion of fuel. ✓ Monitoring of the air quality during the construction phase at least 3 times. ✓ Ensure workers use hearing protectors.	L
	Road/Worksite accidents	H	OIRL shall ensure that: ✓ workers and visitors are properly kitted (use of appropriate PPEs) ✓ use of warning signs ✓ non-consumption of alcoholic beverages on work site ✓ Clinic / first aid kit shall always be available within the site ✓ compliance with journey management policy ✓ Vehicles are pre-mobbed and pre-	L

			mobilization/compliance certificate issued. ✓ the use of PPEs at sites; daily pep talk, carry out job hazard analysis ✓ ensure that all traffic rules are obeyed by the drivers ✓ Speed breakers at sections traversing communities ✓ All vehicles will be parked in the designated parking area only; ✓ Road crossings will be well marked and signaled. ✓ Informatory and warning signages will be retro-reflective type provided, clearly visible in the night. ✓ Marshals will be deployed to guide the vehicles and stop vehicles to avoid traffic jams at the arrival and departure of the OIRL Open Access Metropolitan Fibre Network.	
	Exposure to Covid-19 disease	H	➢ Social distancing, use of face mask, hand sanitizing protocols among others shall be enforced ➢ Sick workers shall not be allowed to work during construction	L
	Presence of transport vehicles and site machinery could restrict traffic fluidity locally and lead to quarrelling with	M	• Installing mobile signage in the works areas, especially at night and road signs and speed limit signs in dangerous areas; • Restoring access for local residents, which had been restricted by the works. • Ensuring compliance with local customs and traditions;	L

	contractor			
Backfilling	Surface water may be polluted due to increased erosion, runoff from a construction site, and contamination in the event of oil spills from equipment and machinery.	H	OIRL shall ensure that: • Soil disturbance shall be kept to the minimum required for operation and safety to reduce erosion • Oil spill containment shall be provided to reduce oil spill from getting to the soil and surface • there shall be regular maintenance of the equipment and machinery • Mechanically stabilising the soil to reduce the potential for erosion • Avoiding excavation/trenching and burial in the steeply sloped ground and avoiding the creation of great breaks • Providing for the placement of siltation ponds in areas subject to heavy erosion. • Selecting vehicles suited for erodible soil. • Limiting activities in erodable soil • After the work, levelling the disturbed soil and quickly seeding or replanting bushes to control soil erosion.	M
	Waste Management - The potential effects will be of aesthetics as well as a nuisance. Wastes shall mainly	H	OIRL shall ensure that: • toilets are created at the site. • the site remains clean, well maintained, and free of hazards, with the thoughtful location of litter bins. • Proper disposal of solid waste from construction activities	L

	come from discarded packaging materials such as metal cuttings and empty plastic containers. Poor disposal methods can lead to environmental problems due to their non-biodegradable nature. Most of the packaging wastes are expected to be reused		and labour camps. • storage of lubricants, fuels, and other hydrocarbons in self-contained enclosures. • sanitation arrangements at worksites/facilities to avoid the release of wastewater and sewage to the environment. • Minimum wastes are generated. • Reuse waste materials wherever possible and use designated disposal sites. • Used oil and lubricants shall be recovered and reused or removed from the site in full compliance with the national and local regulations. • Oil wastes, debris, and/or other waste materials shall not be burned. • safety measures are followed while disposing of wastes.	
	Alteration of hydrological patterns resulting in temporary or permanent flooding, soil erosion, and destruction of biodiversity	H	• Mechanically stabilising the soil to reduce the potential for erosion • Avoiding excavation and burial in the steeply sloped ground and avoiding the creation of great breaks • Providing for the placement of siltation ponds in areas subject to heavy erosion • Selecting vehicles suited for erodible soil • Limiting activities in erodable soil • At the completion of the work, levelling the disturbed soil and quickly seeding or replanting bushes to control	L

			soil erosion.	
	Habitat alteration	M	OIRL shall: • Implement good housekeeping practice on-site. • Store and handle hazardous waste following approved WMP • OIRL shall ensure the use of appropriate PPEs • OIRL shall ensure that backfilling is followed by mechanical compaction to retain the original level. • OIRL shall re-vegetate the soils with indigenous grasses, sedges, etc to check the incidence of flooding.	L
	Worksite accidents	H	OIRL shall ensure that: • workers and visitors are properly kitted (use of appropriate PPEs) • use of warning signs • non-consumption of alcoholic beverages on work site • Clinic / first aid kit shall always be available within the site	L
	Increase in communicable disease (including STDs and HIV/AIDS)	M	• Health awareness lectures shall be given to workers on the mode of transmission of STIs (including HIV/AIDS) • As much as possible provide psychological support to persons living with HIV. • OIRL shall ensure immunization of the workforce against as appropriate. • Regular spraying of work sites Provision of insecticide-	L

			treated nets to field workers to reduce the incidence of malaria. • Awareness campaign shall be carried out to enlighten the communities /field workers on the common communicable diseases and the health implications of drug and alcohol abuse, unprotected sex, prostitution, and the need to sustain cultural values. • OIRL shall assist the activities of the state action committee on STIs/HIV/AIDS as part of her stakeholders' engagement plan. • OIRL shall ensure site clinic is provided to take care of minor illnesses for all construction workers	
Site demobilization	Road traffic accidents	M	OIRL shall ensure: • enforcement of the use of PPEs • daily pep talk is carried out • job hazard analysis is carried out • compliance with journey management policy	L

Table 6.3: Mitigation Measures of the Proposed Project Activities – Operation/Maintenance

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
Operation and maintenance or inspection of the Open Access Metropolitan Fibre Network along RoW, Maintenance of data center and Metro access system locations	Noise and vibration nuisance from Generating set	H	Mitigation measures to reduce the noise footprint of the project include: ✓ there is regular maintenance of generators. ✓ engines are switched off when not in use. ✓ Noise monitoring systems that monitor the noise level of the Data centre. ✓ The use of Renewable Energy such as wind and solar systems.	M
	Air emission during Maintenance/servicing of production equipment and ancillaries	H	OIRL shall ensure: • there is regular maintenance of generators; • engines are switched off when not in use • engines to comply with international standards for exhaust gases; • Maintenance of engines and exhaust gas check; • Use of the cleanest fuel economically available shall be adopted. • The use of a hybrid system shall also be considered	L
	The kidnapping of personnel during regular maintenance of RoW	H	• OIRL shall ensure that personnel develop a high level of security consciousness both within and outside the Data centre. • Daily security reports shall be reviewed by the	M

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			authority • Special security forces shall be established and deployed during sporting activities. This shall include deploying some of OIRL police, Nigeria Civil Defence Corps (NCDC) to strengthen security in the area. • To beef up security for the project, OIRL shall assist with equipment e.g. patrol vehicles, to ensure improved security. • OIRL shall ensure that there is a police station/post within and around the facility.	
	Generation of Waste during operation of the Data centre	H	• Good housekeeping shall be instituted and maintained. • hazardous wastes shall be collected, stored, and disposed of appropriately in line with FMEnv standard at an approved disposal site. • Properly labeled waste bins shall be located at appropriate areas within the Data centre premises. • Waste shall be disposed of through approved waste managers regularly • Good general house keeping	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
	Exposure to Covid-19 disease	H	➢ Social distancing, use of face mask, hand sanitizing protocols among others shall be enforced • Sick workers shall not be allowed to work during construction	L
	Road traffic accidents as a result of transportation activities during data centre operation and maintenance of RoW	H	To prevent road accident, OIRL shall ensure: • compliance with journey management policy • Vehicles are pre-mobbed and pre-mobilization/compliance certificate issued. • the use of PPEs at sites; daily pep talk, carry out job hazard analysis • ensure that all traffic rules are obeyed by the drivers • Speed breakers at sections traversing communities • All vehicles will be parked in the designated parking area only; • Road crossings will be well marked and signaled. • Informatory and warning signages will be retro-reflective type provided, clearly visible in the night. • Marshals will be deployed to guide the vehicles and stop vehicles to avoid traffic jams at the arrival and departure of the OIRL Open Access	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			Metropolitan Fibre Network.	
	Soil/ groundwater contamination due to fuel/ oil spill	H	Provision of secondary containment for storage tanks	L
	Security threat and the threat from major accidents related to the fires and explosions at the facility and potential accidental releases of diesel when refilling the storage tank	H	• Limiting the areas that may be potentially affected by accidental releases by: o Defining fire zones and equipping them with a drainage system to collect and convey accidental releases of flammable liquids to a safe containment area including secondary containment of storage tanks. o Installing fire/blast partition walls in areas where appropriate separation distances cannot be achieved • By providing firefighting equipment around the Data centre	L
	Worksite related accidents	H	OIRL shall ensure that: ✓ workers and visitors are properly kitted (use of appropriate PPEs) ✓ use of warning signs ✓ non-consumption of alcoholic beverages on work	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			site ✓ Clinic / first aid kit shall always be available within the site	
	The threat of Naturally Occurring Radioactive Material (NORM) to the environment (soil, water, and air)	H	OIRL shall ensure: • Regular maintenance or servicing of production equipment as at when due; • Regular NORM monitoring programs to detect materials and equipment with NORM; • carrying out personal dosimetry for external radiation exposures to confirm that exposures fall into the range expected from external radiation surveillance monitoring; • measuring airborne radioactive dust during maintenance activities to check that the assumptions upon which respirator selections were made are accurate – or if respirators are needed at all; • a surface contamination survey in a workshop to confirm that NORM contamination controls are working; • sampling and analysis of waste streams to confirm	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			that they remain within regulatory limits; • materials used in NORM control procedures, such as gloves, plastic sheeting, disposable coveralls, etc. if an area, materials, or equipment is affected by NORM • At equipment cleaning facilities, scale/sludge shall be removed by reaming; high-pressure water blasting; or a process called "rattling," where a high-speed rotating device is inserted into the pipe to break up and loosen the scale. Then the waste generated shall be handled by FMEnv approved Waste Manager to be disposed of at an approved disposal site.	
	Thermal effects due to exposure to EMF around the data centre	M	OIRL shall, and require that contractors implement the following measures to address occupational EMF exposure: ✓ Prepare and implement an EMF safety program including the following components: o Identification of potential exposure levels in the workplace.	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			○ Surveys of exposure levels in new projects and the use of personal monitors during working activities. ○ Training of workers in the identification of occupational EMF levels and hazards. ○ Establishment and identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, limiting access to properly trained workers. ○ Implementation of action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP). ✓ Set personal exposure monitoring equipment to warn of exposure levels that are below occupational exposure reference levels (e.g. 50 percent). ✓ Limit exposure time through work rotation. ✓ Increase the distance between the EMF source and	

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			the worker, when feasible, or the use of shielding materials. ✓ Deactivation of transmission equipment during maintenance activities, limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, use of shielding materials; or installation of ladders or other climbing devices inside the mast or towers, and behind the transmission beams.	
	Third-party Encroachment on the setback (RoW)	M	OIRL shall always involve lawyers in agreeing with landowners to deter them from encroachment on their RoW and report to NESREA/FMEnv in case of any encroachment	L
	Stealing and Vandalization of fibre cables	H	OIRL shall ensure that: • Daily security reports shall be reviewed by the OIRL project manager. • A special security force shall be established and deployed to the optic fibre routes. This shall include deploying some policemen to strengthen security in the area. • A liaison to foster a partnership with the community to	M

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			guarantee security for the project is established and sustained. • Safety workshops to identify, evaluate, and recommend contingency plans for all security risks are regularly organized. • Regular monitoring of optic fibre routes	
	Public Perception and fears	M	OIRL shall always sensitize the public to allay their fears. Organize a workshop for the public to have new information on telecommunication equipment	L
Repainting of rusted and corroded structural fittings at the Data Centre	Contamination of soil by paints and coating as a result of spillage	H	• Using of engineering controls (containment, automatic alarms, and shut-off systems) commensurate with the nature of hazard; • Implementing management controls (procedures, inspections, communications, and training) to address residual risks that have not been prevented or controlled through engineering measures. • Safe ventilation for storage of volatile materials shall be provided; • Access to areas containing paint substances shall be restricted and controlled;	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			• Paints shall be stored on the impervious ground undercover; the area shall be constructed as a spill tray to avoid the spread of accidental spills.	
	Hazardous waste generation from painting	H	• Good housekeeping shall be instituted and maintained • hazardous wastes shall be collected, stored, and disposed of appropriately in line with FMEnv standard at an approved disposal site. • PPEs must be used by workers who are handling paint	L
Transport activities during operation	Road traffic accidents	M	OIRL shall ensure: • compliance with the journey management policy. • Vehicles are pre-mobbed and pre mobilization/compliance certificate issued. • Regular maintenance of the vehicles. • Follow driving rules and regulations. • seat belt for drivers and other workers in the vehicle during a visit to the site for maintenance must always be on. First aid training of workforce and provision of first	L

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
			aid boxes in operational vehicles.	

Table 6.4: Mitigation Measures of the Proposed Project Activities – Decommissioning

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation
Demolition and Evacuation	Interference with road transportation	M	• OIRL shall monitor the nos of trucks per day to know if there is a need to create other access roads. • OIRL shall develop a transport management plan specifying routes, speeds, times of travel, and key roads/waterways in terms of local services. • Consideration shall be given to avoid reliance on public transport and contractors shall be required to use private vehicles.	L
	Noise and vibration nuisance	M	OIRL shall ensure that: • electric power generators are fitted with effective silencers; • there shall be regular maintenance of vehicles and generators; • generators and vehicles are switched off when not in	L

			use; • soundproof electric power generators are engaged • PPEs are used	
	Impairment of air quality	H	OIRL shall ensure: • Engine to comply with international standards for exhaust gases; Maintenance of engines and exhaust gas check; Adoption of engine-off policy at the construction site. • that nose masks and earmuffs are worn by site workers during excavation. • that water shall be sprayed on construction sites to reduce dust levels, especially during the dry season.	L
	Contamination of surface and Groundwater & soil by the oil spill	M	OIRL shall ensure: • Soil disturbance shall be kept to the minimum required for operation and safety. • Oil spill containment shall be provided to reduce oil spill from getting to the soil and surface/ groundwater. • Follow FMEnv guidelines on waste management • Cleanup in compliance with relevant national and • International guidelines, involving the removal of the waste, etc. • Restore the to a condition in no way inferior to the	L

			condition prior to the commencement of work.	
	Poor disposal of wastes generated during this phase	H	• OIRL shall treat and dispose of all wastes following regulatory requirements and best practice using approved contractors. • OIRL shall ensure that none of these wastes are disposed of into any water body or on land. • follow safety measures while disposing of wastes. • OIRL shall keep all waste consignment, treatment, and disposal records for regulatory verification • Proper disposal of solid waste from labour camps; • storage of lubricants, fuels, and other hydrocarbons in self-contained enclosures; • sanitation arrangements at worksites/facilities to avoid the release of wastewater to the environment • All other wastes generated including environmentally deleterious materials generated by construction activities will be disposed of offsite in an appropriate, legal, and safe manner. • There is a minimum generation of waste. • Unsuitable excavated materials shall be systematically carried away from areas prone to erosion; • Reuse waste materials wherever possible	M

			• Wastes shall be segregated, stored, and disposed of by an accredited state waste collector.	
	The threat of Naturally Occurring Radioactive Material (NORM) to the environment	H	OIRL shall ensure: • Regular maintenance or servicing of production equipment as at when due; • Regular NORM monitoring programs to detect materials and equipment with NORM; • carrying out personal dosimetry for external radiation exposures to confirm that exposures fall into the range expected from external radiation surveillance monitoring; • measuring airborne radioactive dust during maintenance activities to check that the assumptions upon which respirator selections were made are accurate – or if respirators are needed at all; • a surface contamination survey in a workshop to confirm that NORM contamination controls are working; • sampling and analysis of waste streams to confirm that they remain within regulatory limits; • materials used in NORM control procedures, such as gloves, plastic sheeting, disposable coveralls, etc. if an area, materials, or equipment is affected	M

			by NORM. • Equipment with NORM shall be recycled or incinerated at an approved recycled or incinerated center as the case may be.	
	Loss of job	H	OIRL shall • Counsel worker who losses job. • Give enough notice • Assist staff that are likely to lose jobs in skill acquisition • Assist in setting small scale business	L
	Injury/fatalities in workforce /communities	H	OIRL shall • Ensure Safety awareness training for the workforce. • Emergency response procedures shall be put in place and enforced • to ensure the use of PPE. • Provide first aid and clinic on site.	L
	The kidnapping of workers and visitors on site	H	• OIRL shall ensure that both contractor and OIRL personnel develop a high level of security consciousness both within and outside the work area. • Daily security reports shall be reviewed by the OIRL Project Manager. • A special security force shall be established and deployed for the project. This shall include deploying some of OIRL police to strengthen	M

			security in the area. • OIRL shall ensure that a liaison to foster a partnership with the community to guarantee security for the project is established and sustained. • To beef up security for the project, OIRL shall support government authorities by assisting with equipment e.g. patrol vehicles, to ensure improved security. • OIRL shall ensure that safety workshops to identify, evaluate and recommend contingency plans for all security risks are regularly organized • OIRL shall ensure that there is a police station/post within and around the facility	
	Third-Party Agitation due to Employment Issues and Loss of Benefits as Host Communities.	M	• Assist staff that are likely to lose jobs in skill acquisition • Assist in setting small scale business	L

6.4 Summary of Residual Impacts after Mitigation

Residual Effects can be considered as those that remain significant following the application of mitigation measures, although they are likely to have been reduced in magnitude as a result of the mitigation measure implemented.

Overall, on balance, with the provision of the proposed mitigation measures as outlined in Tables 6.1 to 6.3, the positive impacts of the scheme will considerably outweigh the negative impacts. The public as a whole will benefit from the completion of the project. Once the mitigation measures outlined are implemented, the residual impact of construction and operation on the different elements identified will not be significant.

An overall mitigation measure is to undertake a Job Hazard Analysis, to enable each worker to assess the risks associated with the job and work safely using procedural guidelines in handling equipment and the facilities.

6.4.1 Community Unrest

Baseline

Widespread youth restiveness is common in the project area. However, issues about employment, supplies, contracts, and MOUs if not well managed would likely elicit community unrest and kidnapping.

Mitigation

As a mitigation measure, the OIRL shall establish and maintain channels of communication with the communities during all phases of the project. Furthermore, the OIRL shall require contractors to hire local labour where feasible. OIRL shall also ensure that its contractors adopt transparent approaches in matters of employment.

OIRL shall also honour all MOU items agreed with the local communities. Also, there will be the presence of a police station/post within and around the facility. From the foregoing, the impact rating should drop from high to medium, since it is impossible to eliminate all sources of community disagreements in a project such as this.

6.4.2 Influx of People

The influx of labour and camp followers is anticipated to increase the pressure on services and infrastructure. Currently, these facilities are inadequate and further pressure on them if not well managed could lead to further deterioration.

Mitigation

Contractors shall provide adequate accommodation with standard facilities to their migrant workforce to reduce anticipated pressure on community facilities. Medical facilities (clinic) and emergency rescue and medrescue/medevac procedures shall be provided at the worksites.

The impact is considered to be of *medium* significance, but following mitigation, it should drop to *low*. It will not be eliminated because some of the workers may want to remain to seek employment in the gas plant.

6.4.3 Increase in Cost of Living / Inflation

The cost of living is likely to be high as a result of a rise in income and economic activities. The attendant inflation will cut across all phases of the project to varying degrees.

Mitigation

OIRL shall support skills development and sustainable economic enhancement of the local communities through training, complemented by the formation of cooperatives and the introduction of micro-credit schemes.

Inflation is of *medium* significance and after mitigation, it will drop to *low*. This is because, at the end of the project activities, it is expected that the local economy will stabilise. Also, those that acquired skills may likely migrate to other areas in search of better opportunities. Furthermore, inflation is a national phenomenon and responds to other factors that originate outside the project area.

6.4.4 Increase in Social Vices

With an influx of migrant workers of diverse characters, there is the potential for an increase in social vices such as stealing, drug abuse, alcoholism, and sexual promiscuity.

Mitigation

OIRL shall carry out sustained campaigns to raise awareness and achieve behavioural modification amongst the workforce. OIRL shall also enforce the alcohol and drug policy of the company at all her worksites. Access control shall also be maintained at the work and campsites. The rating after mitigation will drop from *medium* to *low* and not eliminated since behaviour change is a difficult process.

6.5 Enhancing Positive Impacts

6.5.1 Job Creation

This project is expected to create jobs during different phases. There will be opportunities for both skilled and unskilled employment. It is also expected that most of the local workers will acquire relevant skills during the various project phases.

To enhance job creation opportunities throughout the life of the project, OIRL shall ensure the participation of contractors from host communities. Also, the OIRL shall promote the acquisition/ improvement of skills that will better equip the members of the host communities and enhance their chances for better employment elsewhere.

6.5.2 Business / Economic Opportunities

Movement of the workforce during the different project phases will increase local economic and business activities, especially for food vendors, retailers, transporters, etc. This will promote entrepreneurship and income generation capabilities of the local populace. To sustain stable economic growth, the OIRL shall support the local economy through its various economic empowerment programmes.

6.6 Greenhouse Gas / Climate Change Analysis

Fibre Optic Broadband: A Greener Internet Solution

Fibre is not only the best Internet technology with regard to speed and reliability, it is also by far the best for the environment. Fibre has a minimal ecological impact, reduces waste, consumes very little energy and helps decrease greenhouse gas emissions.

Fibre reduces the demand for Copper

DSL and cable Internet, the two past alternatives, use copper wire to transmit data. Copper mining is harmful to the environment and dangerous, producing hazardous chemicals and toxic by-products. Fibreglass, on the other hand, is made from quartz, occurring naturally as sand and rocks. The production and disposal of copper wire has a negative environmental impact more than 10'000 times larger than the production and disposal of fibre optic cable.

Less Energy Consumption

Fibre uses up to twelve times less energy than copper by transmitting data using light. Furthermore, the energy consumed by copper and cable networks creates heat, which must be kept cool on the backend to prevent overheating. Cooling is accomplished with air conditioners, which consume a ton of electricity. By consuming less energy, fibre networks stay cooler and reduce the need for energy-sucking air conditioners.

Greenhouse Gas Reduction

The main benefit of using less electricity by using a fibre network is reducing carbon dioxide emissions, a key contributor to the Greenhouse Effect, which is warming the earth at an alarming rate. Widespread adoption of fibre internet in Switzerland could result in an incremental reduction of more than 3 million tons of greenhouse gas per year.

Another way to reduce greenhouse gas emission is through telecommuting. This however requires both download and upload speeds at a sufficient rate. Copper upload and download speeds are often inadequate. Only fibre offers symmetrical speeds so you can upload and download your work just as quickly as if you were in the office, making telecommuting easier than ever and leading to less busy roads.

Thanks to fibre glass there will be an enormous reduction in CO_2 emissions helping the environment, helping people and helping animals in a very positive manner.

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Background Information

OIRL has established a comprehensive Environmental and Social Management Plan (ESMP) to achieve its corporate health, safety, and environment (HSE) policy objectives and to fulfill its regulatory compliance requirements to FMEnv, NCC and State Ministries of Environment. This ESMP is developed to help fulfill the requirements for environmental protection as stipulated in Environmental Impact Assessment (EIA) Act Cap E12, LFN 2004. The ESMP provides the procedures and processes that will be used to check, monitor, and continually improve the effectiveness of the recommended mitigation and enhancement measures.

7.2 Purpose & Scope

The purpose of this ESMP is to establish the operational requirements and plan to ensure it delivers its stated business objective in an environmentally responsible manner. The ESMP includes a series of associated sub-plans relating to:

- Waste Management.
- Transport and Journey Management
- Environment Monitoring including;
    - Air Quality
    - Ground Water and Soil Monitoring
    - Greenhouse gases
    - Noise
- Emergency Response.
- Environmental Auditing.
- Risk Assessment & Disaster Management Plan

7.3 Features of the ESMP

To accomplish its objectives, the ESMP considered each environmental, social, and health impact of the project as well as the parameters for their monitoring. The ESMP translates the recommended mitigation and monitoring measures into specific actions that will be carried out by OIRL in collaboration with FMEnv and NCC. ESMP is an integral part of business management. To this end, the OIRL shall put in place measures to enforce compliance throughout the project life. It outlines the actions necessary to attain this goal and describes the means, time frames, and designation of responsibility required for compliance and conformance. The ESMP:

- identifies and discusses the management and implementation of commitments to stakeholders, as identified in the report;
- discusses how to implement the mitigating/amelioration measures, as identified in the report;
- designed and implements an appropriate post-ESIA monitoring;
- identified the action parties and provide a time frame for implementation of issues identified;
- is accompanied by a fiscal plan for implementation of mitigating measures and monitoring; and
- puts in place a systematic procedure of obtaining all necessary regulatory approvals/permits for all the aspects of the project.

7.4 Roles and Responsibility

OIRL assigns roles and responsibilities about the effective implementation of ESMP requirements as appropriate. This is supported by job descriptions, resource planning, budgeting, and appropriate delegation of authority. OIRL's leadership and governance cycle are described in ***Figure 7.1*** below.

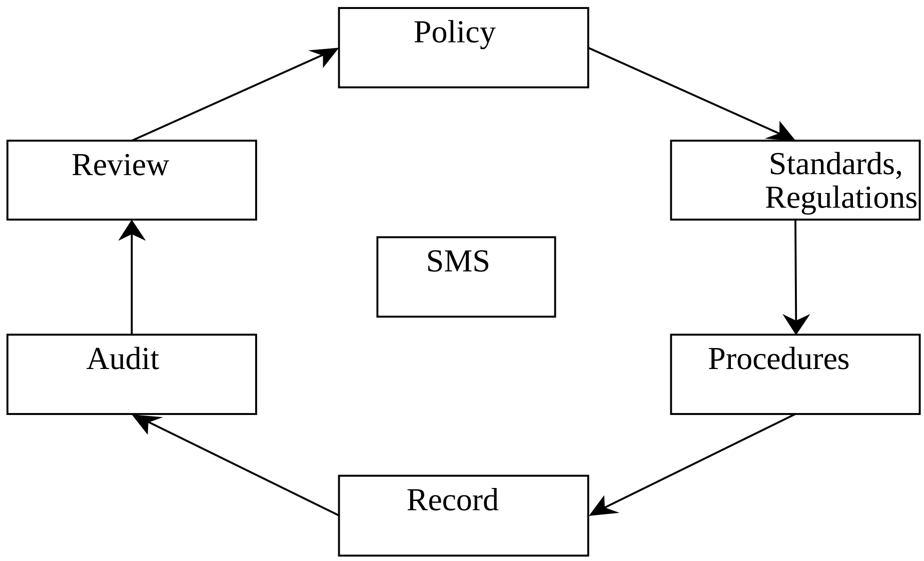


Figure 7.1: OIRL leadership and governance circle

7.4.1 Management Commitment

The Management's commitment and responsibility are detailed in the company's Health, Safety, and Environmental (HSE) policy. The company operates in strict compliance with all the provisions of its HSE policy which specifies the need for adherence to national standards and guidelines by the company and its contractors. The HSE policy of OIRL states that projects are planned and executed in a manner that achieves the following:

- preserves the health, safety, and security of its employees, contractors, and all members of the public who may be affected by its operations;
- minimizes the impact of its operations on the environment; and
- be sensitive to the needs and concerns of OIRL host communities

7.4.2 HSE Organisation Structure

OIRL has an HSE organisation structure ***(Figure 7.2)*** that describes the various departments, responsibilities, and responsible parties that will help achieve its overall environmental objective. The HSE department is primarily responsible for environmental, safety, security, and occupational health management. The ESMP is administered by the HSE department.

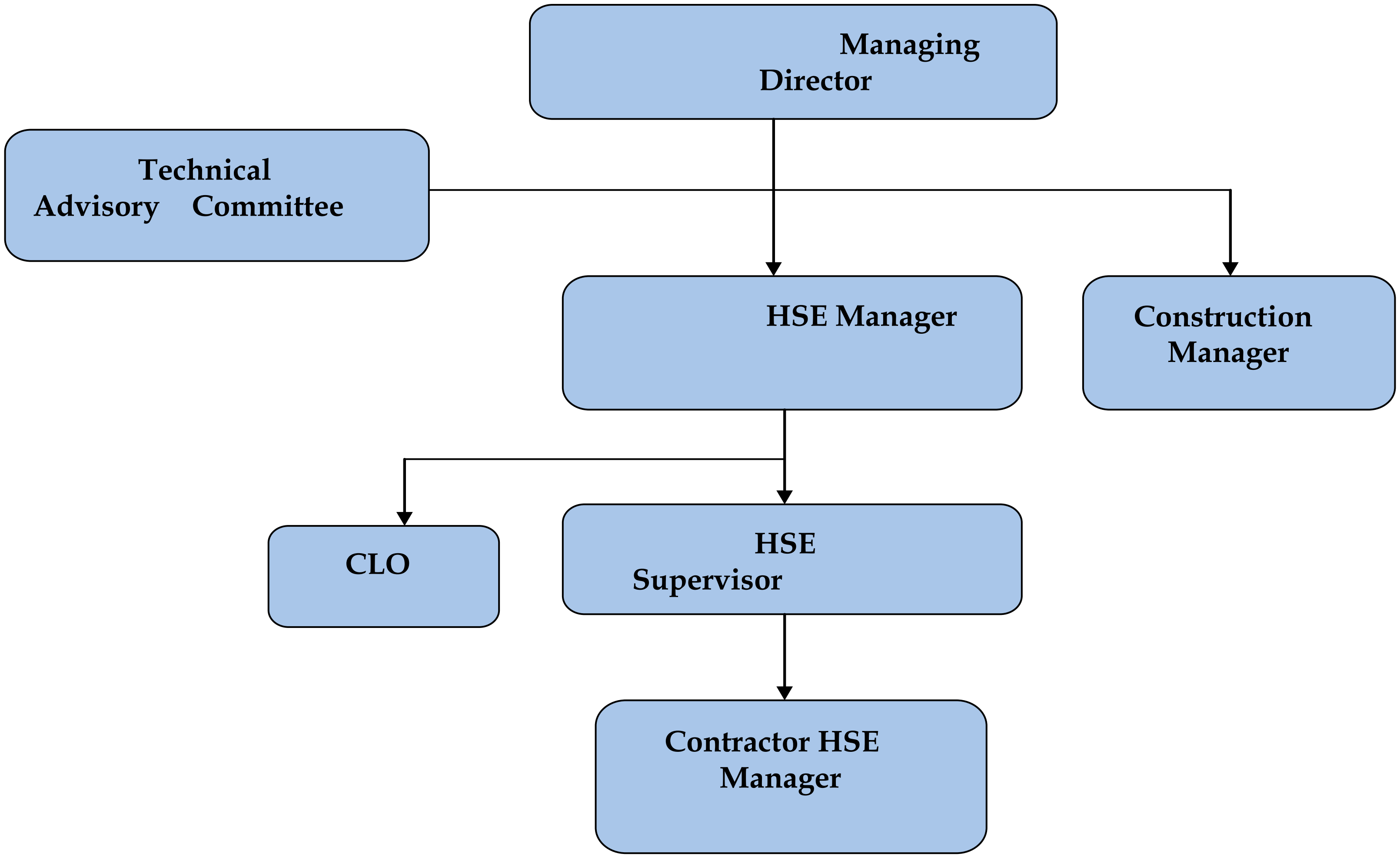


Figure 7.2: HSE Responsibility and Communication Organogram (Pre-Operations Phase)

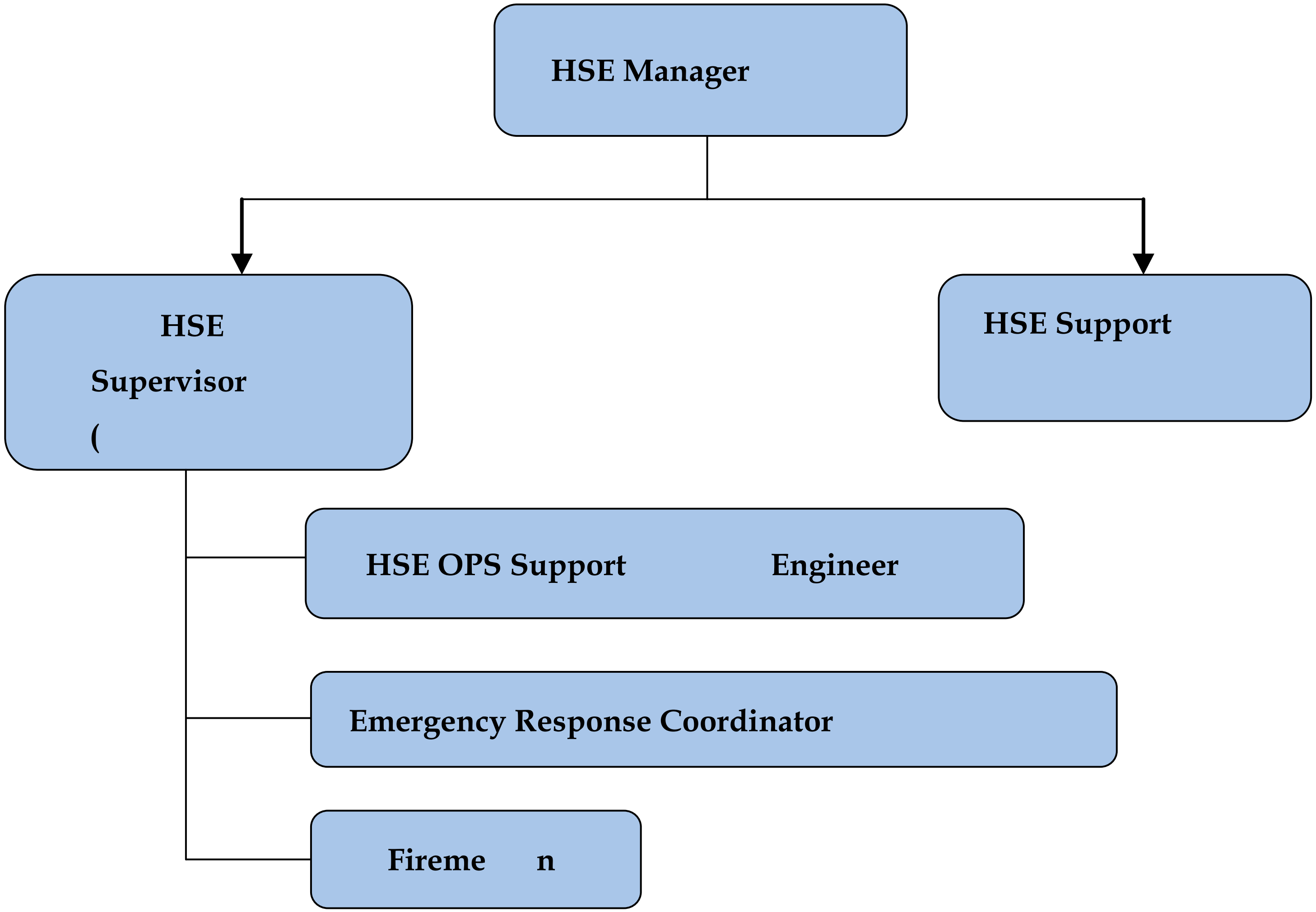


Figure 7.3: HSE Responsibility and Communication Organogram (Operations Phase)

7.4.3 Contractor Management

OIRL has engaged contractors to carry out the various project activities. The contractors are responsible for performing all work in compliance with relevant national and international HSE legislation and regulations, and in conformance with OIRL's HSE MS requirements; and with OIRL's technical and quality specifications. As a contractual requirement, the Contractor will provide sufficient resources to manage HSE aspects of the work to be performed. This includes providing resources to ensure sub-contractor compliance and a process for emergency stop-work orders in response to monitoring triggers.

7.5 Implementation

7.5.1 Employee Training

OIRL shall establish, as and where appropriate, environmental training and awareness programs, environmental campaigns, and initiatives for its staff and contractors to support the implementation of this ESMP. In the event of any significant change, and/or updates identified by any management stream or system; the OIRL Management of Change (MOC) process shall capture such impacts on training effectiveness and efficiency, and shall provide trainers with a description of such changes that affect training information or programmes, so that employee training may be kept up to date.

7.5.2 Environmental Awareness Programs

OIRL shall establish and regularly provide Environmental awareness programs and campaigns that address trends, priorities, and issues relevant to the operation/ development phase. OIRL shall also contribute to the environmental wellbeing through such campaigns (e.g. clean the earth day, save a drop of water, noise and stress, energy consumption, reuse reduce and recycle, etc.). OIRL shall introduce studies and sufficient research material and reports on common environmental issues that include;

- Global warming
- Air, land, water pollution
- Wildlife
- New technologies, practices, and innovation at work
- Obsolete methodologies
- Security.

7.5.3 Documentation

OIRL will control HSE documentation, including plans (e.g., the ESMP); associated procedures; and checklists, forms, and reports, through a formal company procedure. The document control procedure also describes the processes that OIRL and the Contractor will employ for official communication of both hardcopy and electronic (through the intranet) document deliverables. Also, it describes the requirement for electronic filing and posting and assignment of a document tracking and control number (including revision codes).

The OIRL Document Control Officer is responsible for maintaining a master listing of applicable documents, including HSE documents, and making sure that this list is communicated to the appropriate parties. The OIRL HSE Manager is responsible for providing notice to the affected parties of changes or revisions to documents, for issuing revised copies, and for checking that the information is communicated within that party's organization appropriately. The Contractor shall be required to develop a system for maintaining and controlling its HSE documentation and describe these systems in their respective HSE Plans/ Site-Specific HSE Plans.

7.5.4 Operational Control Procedures

Each potentially significant impact identified by the ESIA shall have an operational control associated with it that specifies appropriate procedures, work instructions, best management practices, roles, responsibilities, authorities, monitoring, measurement, and record-keeping for avoiding or reducing impacts. Operational controls are monitored for compliance and effectiveness regularly through a monitoring and auditing procedure described in the ESMP.

7.6 Community Engagement Policy

Introduction

Community is made up of the people who live, work, visit, or invest in the in all the communities across the eight states where the proposed project shall be situated. Community Engagement is the process through which the community is informed about and/or invited to contribute, through consultation or involvement, to proposals or policy changes relating to all the communities across the eight states, events, strategic plans, issues, and projects.

Purpose

The OIRL Engagement Plan will ensure that:

- OIRL has the opportunity to consider the input of a wide range of communities' members before making decisions;
- Communities' members are allowed to contribute to the planning and development process.

The plan will:

- Establish a standard process for community engagement;
- Ensure that the process is implemented by OIRL staff and some key members of the community;
- Ensure that inclusive and efficient consultation is undertaken at all times;
- Ensure that the community is kept informed of decisions emanating from community engagement.

The Plan contains three key strategies:

1. Inform
2. Consult
3. Involve

Each strategy has a specific goal, a commitment to the community, and a set of methodologies.

Scope

This Community Engagement Plan relates to many activities undertaken by the OIRL which will have an effect on the communities except for notifications concerning statutory notifications. Where legislative requirements exist, which address specific information/consultation processes, the legislative requirements take precedence.

Benefits

There are several benefits of having a Community Engagement Plan, including:

- Commits OIRL to be open and accountable.
- Assists OIRL to plan services that better meet community needs.
- Enables the OIRL to prioritize services and make better use of resources.
- Allows a broader range of views to be expressed and more information to be assembled before making decisions.
- Sees the OIRL and the community working together to achieve balanced decisions.

- Offers opportunities for the community to contribute to and influence outcomes which directly affect their lives.
- Ensures an open and familiar process that becomes easier for community members to participate in.

Community Engagement Strategy 1: Inform

Information dissemination is the primary form of community engagement. To be able to actively engage in their communities and OIRL's decision-making processes, the community requires information in a variety of ways to reach all sections of the community.

Goal

To provide the communities with appropriate information regarding OIRL services, events, strategic plans, issues, and projects.

Commitment to the Communities

We will keep you informed, ensuring that information is easy to access, relevant to the issue, and easy to understand using clear, jargon-free language.

Methodology: How

By making up-to-date information available on the OIRL's processes, meeting agendas/minutes, services, projects and on how residents may feedback any issues, concerns, and suggestions for service improvements and ensuring that all information is in a form that is accessible to all groups in the Community i.e., people with disabilities, people with computer literacy difficulties, young people, the aged and, people from diverse cultural backgrounds.

Methods can include;

- **Advertising - Newspapers** - both local and state. Other publications can be considered dependent on the target group.
- **Advertising - Radio** - both local and regional.
- **Public Meetings / Forums** - at various locations / localities, as appropriate.

When

Ongoing, as OIRL events, strategic plans, issues, and projects are scheduled.

Who

Entire communities, noting that communities' members need to be aware of the methods that are in use.

Communities Engagement Strategy 2: Consult

The consultation takes place when feedback is required to:

- *The development of new policies, strategies, and plans;*
- *The review and evaluation of existing policies, strategies, and plans;*
- *The planning and development of new services and infrastructure;*
- *The review and evaluation of existing services and infrastructure;*
- *Issues which impact on or are of concern to the community, including:*
    - *Broad community issues i.e. Communities Safety;*
    - *Specific communities' issues i.e. Seniors and Youth; and*
    - *Area issues i.e. traffic management and land-use changes*

Goal

To capture communities' input on strategic plans, directions, issues, priorities, and projects.

Commitment to the Communities

We will listen to you, consider your ideas and keep you informed about what input was received, an analysis of this input, and the final decision/s reached.

Methodology: How

Consultation mechanisms will be chosen that take account of the primary stakeholders and are accessible to the communities. Communities' consultation techniques will vary depending on who is being consulted and the nature and complexity of the issue. Available resources will also determine the type of techniques that can be utilised i.e. the timeframe, funds, and staff available.

A range of consultation techniques will be utilised to ensure greater participation levels. These will include;

- **Consultative Workshops:** open to the community with the aim of briefing interested residents on specific projects and getting their feedback.
- **Focus Groups:** open by invitation to specific groups with relevant experience of the issue at hand.
- **Surveys/Questionnaires:** a series of relevant questions regarding a subject, with the collated replies available for consideration and distribution. These may be conducted via mail, email/web, or in person, for example, venues could include but are not limited to homes/schools/businesses / community meetings to ensure the

inclusion of community members who may not normally be able to participate in community engagement.

When

OIRL will ensure that the communities are consulted on issues which impact on or are of concern to the communities promptly to allow adequate community comment to occur and be analysed to inform decision making processes.

Who

All communities' members who are identified as being directly impacted will be consulted, with the whole community being informed. Stakeholders shall vary according to the issue, but could include residents, ratepayers, businesses, volunteers, those who visit or work in the municipality, other service providers/agencies, community groups, other levels of government, peak bodies, etc. It could also include particular groups within the community, i.e., older people, families, children, youth, different ethnic groups, business people, people with a disability, etc.

7.7 Checking and Corrective Action

The objective of the inspection and monitoring activities described in this section is to verify compliance with the ESMP. The inspection and monitoring approach will also be reflected in the Contractor's HSE procedures. Contractors will be responsible for implementing the OIRL's environmental and social commitments in the field daily. Auditing of the monitoring and inspection activities by the Contractor and by OIRL provides the mechanism by which OIRL ensures that it remains compliant with regulatory commitments as well as its HSE standards and policies.

The *inspection* activities described in this ESMP refer to qualitative monitoring, e.g., visual inspections. The *monitoring* activities described in this ESMP refer to empirical monitoring (e.g., measurements).

7.7.1 Inspection

Inspections shall be conducted by Staff, Contractor's HSE department daily. The results of the inspection and monitoring activities shall be made available to OIRL every week or more frequently if requested by the OIRL Head HSE.

7.7.2 Monitoring

Monitoring shall be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Concerning the significant impacts identified in the ESIA, OIRL has developed a program to monitor the effectiveness of the mitigation measures. The program describes what effect is to be measured and the frequency.

In conjunction with monitoring of the effectiveness of specific mitigation measures, the OIRL has developed a program to monitor for compliance with relevant regulatory standards. This program also ensures that staff is meeting contractual obligations concerning work practices and design specifications. Monitoring is carried out by OIRL HSE department and/or by Supervisors and Contractors according to their contractual obligations. The parameters to be measured during the project activities along with the frequency of monitoring are provided in **Tables 7.1 – 7.5** below.

Table 7.1: Environmental and Social Management Plan (ESMP) of the proposed Open Access Metropolitan Fibre Network – Pre-Construction Phase

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
Land Take for RoW Mobilisation (transport) to the site (equipment, personnel, and construction modules)	Loss of land Change in land use Legal issue	H	This impact, although negative is reversible, the probability of the impact arising is also low because OIRL already has an gotten approval for Right of Way for all the routes where the optic fibres shall pass through. However, the OIRL shall ensure: ✓ continuous consultation and engagement with host communities and other stakeholders shall be maintained to forestall unrest in line with the company's grievance mechanism. ✓ that proper land acquisition procedure is followed and payment of all land dues to any concerned stakeholder	**L**	Stakeholder engagement document	OIRL	During Pre-Construction
	Road traffic accidents	H	To prevent road accident, OIRL shall ensure: • compliance with journey management policy • Vehicles are pre-mobbed and pre-mobilization/compliance	M	Site inspection/ stakeholder engagement report Inventory of	OIRL	During Pre-Construction

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			certificate issued. • The use of PPEs at sites; daily pep talk, carry out job hazard analysis. • Ensure that all traffic rules are obeyed by the drivers. • Speed breakers at sections traversing communities. • Conformance with road traffic laws in line with the Federal Road Safety Commission (FRSC) safety requirements. • All safety incidents shall be reported and investigated. Corrective actions will also be implemented.		approved journey management forms		
	Noise nuisance	M	OIRL shall ensure: • Regular maintenance of vehicles. • Vehicles are turned off when not in use. • Vehicles are fitted with effective silencers.	L	Site inspection report Compliance monitoring report	OIRL	During Pre-Construction
	Impairment of air quality	M	OIRL shall ensure: • Engine to comply with international standards for exhaust gases;	L	Site inspection report Compliance	OIRL	During Pre-Construction

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			Maintenance of engines and exhaust gas check; Adoption of engine-off policy at the construction site • that nose masks and earmuffs are worn by site workers during excavation • that water shall be sprayed on construction sites to reduce dust levels, especially during the dry season. • there is regular maintenance of the generators; • generators are switched off when not in use • dust control and dust recovery machinery are used • Construction materials and earth will be fully covered during transportation to the construction site by road; •		monitoring report		
	Loss of biodiversit	H	▪ Strictly regulating heavy equipment traffic	L	Site inspection report	OIRL	During Pre-Construction

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
	y		▪ Restricting the number of traffic lanes and limiting the movement of the machinery to the worksite and to the marked access way. ▪ Implement good housekeeping practice on-site. ▪ Storing and handling of the hazardous waste following approved WMP. ▪ Selecting vehicles suited for erodible soil. • Limiting activities in erodable soil.		Compliance monitoring report		
Energy consumption (provision of energy for pre-construction activities)	Impairment of air quality	M	OIRL shall ensure that: • there is regular maintenance of the generators; • generators are switched off when not in use	L	Site inspection report Compliance monitoring report	OIRL	During Pre-Construction
	Noise and vibration nuisance	M	OIRL shall ensure that: • electric power generators are fitted with effective silencers; • there shall be regular maintenance of the generators;	L	Site inspection report Compliance monitoring report	OIRL	During Pre-Construction

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			• noise barriers are erected • generators are switched off when not in use; • soundproof electric power generators are engaged • Provision of rubber padding/ noise isolators to DG sets and construction machines				
	Contamination of soil	M	OIRL shall ensure: • Soil disturbance shall be kept to the minimum required for operation and safety. • Oil spill containment shall be provided to prevent an oil spill from getting to the soil. • Implement good housekeeping practice on-site. • Storing and handling hazardous waste following approved WMP.	L	Site inspection report Compliance monitoring report	OIRL	During Pre-Construction
Site Preparation – land clearing, removal of	Acceleration of erosion	M	OIRL shall: • Stabilize soil within the well location and campsite mechanically using compactors to reduce	L	Site inspection report Compliance monitoring	OIRL	During Pre-Construction

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
vegetation ,			erosion potential • Mechanically stabilize the soil to reduce the potential for erosion • Provide for the placement of siltation ponds in areas subject to heavy erosion. • Select vehicles suited for erodible soil. • Limiting activities in erodable soil.		report		
	Alteration of local topography	M	• OIRL shall ensure: • re-grading of the sites, then replacing the layer of topsoil that was previously put. • restoring the operational site by restoring the original profile of the topography and the soil • strictly regulating heavy equipment traffic • restricting the number of traffic lanes and limiting the movement of the machinery to the worksite and to the marked access way.	L	Site inspection report	OIRL	During Pre-Construction
	Blockage of	M	OIRL shall ensure that: • Strict environmental policy	L	Site inspection report	OIRL	During Pre-Construction

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
	drainage pattern		shall be ensured • Regular cleaning of the drainage shall be ensured • The drainage network shall be covered				
	Contamination of soil	M	OIRL shall: • Ensure that soil disturbance shall be kept to the minimum required for operation and safety. • Ensure that oil spill containment is provided to reduce oil spill from getting to the soil. • Implement good housekeeping practice on-site. • Store and handle hazardous waste following approved WMP. • Place filtration berms and sediment barriers. • Use methods that minimises perturbation to the aquatic environment. • Avoid spills prohibiting refuelling near a waterway.	L	Compliance monitoring report	OIRL	During Pre-Construction
	Impairme	M	OIRL shall ensure that:	L		OIRL	During Pre-

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
	nt of air quality		• only pre-mobbed equipment is used; • all equipment is controlled; • equipment engines are turned off when not in use • OIRL shall ensure that all construction equipment shall be in proper operating condition and fitted with factory standard silencing features if appropriate • OIRL shall provide and enforce the use of PPE (e.g. nose masks and ear muffs) • OIRL shall construct soundproofing walls around stationary power generating sources • Use of the cleanest fuel economically available shall be adopted • Combustion technology and pollution control technology, which are all interrelated, shall be evaluated very carefully upstream of the project to optimize the project's		Compliance monitoring report		Construction

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			environmental performance; • Use of loading and unloading equipment that minimizes the height of fuel drop to the stockpile to reduce the generation of fugitive dust and installing of cyclone dust collectors; • Use of water spray systems to reduce the formation of fugitive dust from solid fuel storage in arid environments; • Use of enclosed conveyors with well designed, extraction and filtration equipment on conveyor transfer points to prevent the emission of dust;				
	Noise and vibration nuisance	H	OIRL shall ensure that: • equipment is fitted with effective silencers; • there shall be regular maintenance of equipment; • equipment is switched off when not in use; • vibration containment be	L	Site inspection report Compliance monitoring report	OIRL	During Pre-Construction

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			made for equipment which is likely to cause vibration; and • PPEs shall be encouraged at all times.				
	Worksite accidents	H	OIRL shall ensure that: • workers and visitors are properly kitted (use of appropriate PPEs) • use of warning signs • non-consumption of alcoholic beverages on work site • Clinic / first aid kit shall always be available within the site	M			
	Habitat Alteration	H	OIRL shall: ▪ Use methods that minimises perturbation to the aquatic environment. ▪ Avoid spills prohibiting refuelling near waterways. • Minimise destruction or modification of the vegetation cover by restoring vegetation at the end of the work.	L	Site inspection report	OIRL	During Pre-Construction

Table 7.2: Environmental and Social Management Plan (ESMP) of the proposed Open Access Metropolitan Fibre Network – Construction Phase

Project Activity	**Description of Impacts**	**Rating before Mitigation**	**Mitigation/Control Measures**	**Rating after Mitigation**	**Parameters for Monitoring**	**Action Party**	**Monitoring Frequency**
Transport activities during construction	Road traffic accidents	H	To prevent road accident, OIRL shall ensure: • compliance with journey management policy. • Vehicles are pre-mobbed and pre-mobilization/compliance certificate issued. • the use of PPEs at sites; daily pep talk, carry out job hazard analysis • ensure that all traffic rules are obeyed by the drivers • Speed breakers at sections traversing communities • Conformance with road traffic laws in line with the Federal Road Safety Commission (FRSC) safety requirements. • All safety incidents will be reported and investigated. Corrective actions will also be implemented	M	Site inspection/ stakeholder engagement report Inventory of approved journey management forms	OIRL/ State Ministries of Environment/FMEnv	During Construction
	Noise nuisance	M	OIRL shall ensure: • regular maintenance of vehicles	L	Site inspection report	OIRL/State Ministries of	During Constructi

			• Vehicles are turned off when not in use • Vehicles are fitted with effective silencers.		Compliance monitoring report	Environment/FME nv	on
	Impairment of air quality – emission from trucks	M	OIRL shall ensure: • Engine to comply with international standards for exhaust gases; • Maintenance of engines and exhaust gas check; Adoption of the engine of policy at the construction site. • that nose masks and earmuffs are worn by site workers during excavation • The use of the cleanest fuel economically available shall be adopted. • Combustion technology and pollution control technology, which are all interrelated, shall be evaluated very carefully upstream of the project to optimize the project's environmental performance; • Use of loading and unloading equipment that minimizes the height of fuel drop to the stockpile to reduce the generation of fugitive dust and installing of cyclone dust	L	Site inspection report Compliance monitoring report	OIRL/State Ministries of Environment/FME nv/	During Constructi on

			collectors; • Use of water spray systems to reduce the formation of fugitive dust from solid fuel storage in arid environments; • Use of enclosed conveyors with well designed, extraction and filtration equipment on conveyor transfer points to prevent the emission of dust				
Trenching of Fibre Optic route and Laying of Fibre cables	Loss of vegetal cover with possible impact on biodiversity loss	H	OIRL shall: ▪ Provide siltation pond in areas of heavy erosion ▪ Place filtration berms and sediment barriers. ▪ Use methods that minimises perturbation to the aquatic environment. ▪ Avoid spills prohibiting refuelling near waterways. ▪ Minimise destruction or modification of the vegetation cover by restoring vegetation at the end of the work.	M	Site inspection report Compliance monitoring report	OIRL	During Pre-Construction and Construction
	Impairment of air quality	H	OIRL shall ensure: • there is regular maintenance of the engines; • engines are switched off when not in use • engines to comply with international standards for exhaust gases; • Maintenance of engines and exhaust	L	Site inspection report Compliance monitoring report	OIRL/State Ministries of Environment/FMEnv	During Construction

			gas check; • that nose masks and earmuffs are worn by site workers during excavation. • Use of the cleanest fuel economically available shall be adopted • Combustion technology and pollution control technology, which are all interrelated, shall be evaluated very carefully upstream of the project to optimize the project's environmental performance;				
	Noise and vibration nuisance	H	OIRL shall ensure that: • Machine engines are fitted with effective silencers; • regular maintenance of machine/ engines are performed; • engines are switched off when not in use; • soundproof electric power generators are engaged • the use of PPEs is encouraged • vibration containment shall be made for generators and machines	L	Compliance monitoring report	OIRL/State Ministries of Environment/FMEnv	During Construction
	Contamination in the event of oil spills from equipment and machinery	H	• Oil spill containment shall be provided to reduce oil spill from getting to the soil and surface. • there shall be regular maintenance of the equipment and machinery.	M	Site inspection report Compliance monitoring report	OIRL/State Ministries of Environment/FMEnv	During Construction

	Kidnapping of workers	H	OIRL shall ensure that both contractor and OIRL personnel develop a high level of security consciousness both within and outside the work area • Daily security reports shall be reviewed by the OIRL Project Manager • A special security force shall be established and deployed for the project. This shall include deploying some of OIRL police to strengthen security in the area • OIRL shall ensure that a liaison to foster a partnership with the community to guarantee security for the project is established and sustained • To beef up security for the project, OIRL shall support government authorities by assisting with equipment e.g. patrol vehicles, to ensure improved security • OIRL shall ensure that safety workshops to identify, evaluate and recommend contingency plans for all security risks are regularly organized • OIRL shall ensure that there is a police station/post within and	M	Security report	OIRL/State Ministries of Environment/Nigeria Police Force Police/NSDC	

			around the facility				
	Waste generation from excavated materials	H	OIRL shall ensure that: • all other wastes generated including environmentally deleterious materials generated by construction activities will be disposed of offsite in an appropriate, legal, and safe manner. • generation of all wastes are minimized as much as practically possible • Unsuitable excavated materials shall be systematically carried away from areas prone to erosion; • Reuse waste materials wherever possible and use designated disposal sites; • Used oil and lubricants shall be recovered and reused or removed from the site in full compliance with the national and local regulations; • Oil wastes, debris, and/or other waste materials must not be burned; • Optimize the reuse of soil and construction waste; • All the construction camps and facilities shall be dismantled and removed from the site unless otherwise desired by the local public; • the site shall be restored to a condition in no way inferior to the	L	Site inspection report Waste Management report Waste tracking records	OIRL/State Ministries of Environment/FMEnv	During Construction

			condition prior to the commencement of work. • safety measures while disposing of wastes are followed; • introduction of foreign soil and synthetic materials is avoided; • disposal of construction and related waste materials at designated and approved waste dump site; • waste management plan in road planning and contract specifications is incorporated; • there is a collaboration with relevant waste management agencies to enforce appropriate sanitation and other bye-laws.				
Construction of Manholes and installation of various equipment, power generation equipment	Waste Management - The potential effects will be of aesthetics as well as a nuisance of wastes such as metal cuttings, paper carton, drums, paper, wood, optic fibre	H	OIRL shall ensure that: • all other wastes generated including environmentally deleterious materials generated by construction activities will be disposed of offsite in an appropriate, legal, and safe manner. • generation of all wastes are minimized as much as practically possible • Unsuitable excavated materials shall be systematically carried away from areas prone to erosion; • Reuse waste materials wherever possible and use designated disposal sites;	L	Waste Management report Waste tracking records Compliance monitoring report	OIRL/State Ministries of Environment/FMEnv	During Construction

	cables etc.		• Used oil and lubricants shall be recovered and reused or removed from the site in full compliance with the national and local regulations; • Oil wastes, debris, and/or other waste materials must not be burned; • Optimize the reuse of soil and construction waste; • All the construction camps and facilities shall be dismantled and removed from the site unless otherwise desired by the local public; • the site shall be restored to a condition in no way inferior to the condition prior to the commencement of work. • safety measures while disposing of wastes are followed; • introduction of foreign soil and synthetic materials is avoided; • disposal of construction and related waste materials at designated and approved waste dump site; • waste management plan in road planning and contract specifications is incorporated; • there is a collaboration with relevant waste management agencies to enforce appropriate sanitation and other bye-laws.				
	Impairment	H	OIRL shall ensure:	L	report	OIRL/State	During

	of air quality		• there is regular maintenance of the engines; • engines are switched off when not in use • engines to comply with international standards for exhaust gases; • Maintenance of engines and exhaust gas check; • that nose masks and earmuffs are worn by site workers during excavation • Use of the cleanest fuel economically available shall be adopted ✓ Combustion technology and pollution control technology, which are all interrelated, shall be evaluated very carefully upstream of the project to optimize the project's environmental performance;		Compliance monitoring report	Ministries of Environment/FMEnv	Construction
	Noise and vibration nuisance	H	OIRL shall ensure: ✓ Regular maintenance of mobile and immobile equipment to ensure improved machine efficiency and complete combustion of fuel. ✓ Monitoring of the air quality during the construction phase at least 3 times. ✓ Ensure workers use hearing protectors.	L	Site inspection report Compliance monitoring report	OIRL/State Ministries of Environment/FMEnv	During Construction

	Road/Worksite accidents	H	OIRL shall ensure that: ✓ workers and visitors are properly kitted (use of appropriate PPEs) ✓ use of warning signs ✓ non-consumption of alcoholic beverages on work site ✓ Clinic / first aid kit shall always be available within the site ✓ compliance with journey management policy ✓ Vehicles are pre-mobbed and pre-mobilization/compliance certificate issued. ✓ the use of PPEs at sites; daily pep talk, carry out job hazard analysis ✓ ensure that all traffic rules are obeyed by the drivers ✓ Speed breakers at sections traversing communities ✓ All vehicles will be parked in the designated parking area only; ✓ Road crossings will be well marked and signaled. ✓ Informatory and warning signages will be retro-reflective type provided, clearly visible in the night. ✓ Marshals will be deployed to guide the vehicles and stop vehicles to avoid traffic jams at the arrival and departure of the	L	Daily/weekly report	OIRL/State Ministries of Environment/FMEnv	During Construction

			OIRL Open Access Metropolitan Fibre Network.				
	Exposure to Covid-19 disease	H	➢ Social distancing, use of face mask, hand sanitizing protocols among others shall be enforced Sick workers shall not be allowed to work during construction	L	Daily/weekly report	OIRL/State Ministries of Health	During Construction
	Presence of transport vehicles and site machinery could restrict traffic fluidity locally and lead to quarrelling with contractor	M	• Installing mobile signage in the works areas, especially at night and road signs and speed limit signs in dangerous areas; • Restoring access for local residents, which had been restricted by the works. Ensuring compliance with local customs and traditions;	L	Daily/weekly report	OIRL/State Ministries of Environment/FMEnv	During Construction
Backfilling	Surface water may be polluted due to increased erosion, runoff from a construction site, and contamination in the event of oil spills from equipment	H	OIRL shall ensure that: • Soil disturbance shall be kept to the minimum required for operation and safety to reduce erosion • Oil spill containment shall be provided to reduce oil spill from getting to the soil and surface • there shall be regular maintenance of the equipment and machinery • Mechanically stabilising the soil to reduce the potential for erosion	M	Site inspection report	OIRL	During Construction

	and machinery.		• Avoiding excavation/trenching and burial in the steeply sloped ground and avoiding the creation of great breaks • Providing for the placement of siltation ponds in areas subject to heavy erosion. • Selecting vehicles suited for erodible soil. • Limiting activities in erodable soil • After the work, levelling the disturbed soil and quickly seeding or replanting bushes to control soil erosion.				
	Waste Management - The potential effects will be of aesthetics as well as a nuisance. Wastes shall mainly come from discarded packaging materials such as metal cuttings and empty plastic containers.	H	OIRL shall ensure that: • toilets are created at the site. • the site remains clean, well maintained, and free of hazards, with the thoughtful location of litter bins. • Proper disposal of solid waste from construction activities and labour camps. • storage of lubricants, fuels, and other hydrocarbons in self-contained enclosures. • sanitation arrangements at worksites/facilities to avoid the release of wastewater and sewage to the environment. • Minimum wastes are generated. • Reuse waste materials wherever	L	Waste Management report Waste tracking records Site inspection report	OIRL	During Construction

	Poor disposal methods can lead to environmental problems due to their non-biodegradable nature. Most of the packaging wastes are expected to be reused		possible and use designated disposal sites. • Used oil and lubricants shall be recovered and reused or removed from the site in full compliance with the national and local regulations. • Oil wastes, debris, and/or other waste materials shall not be burned. • safety measures are followed while disposing of wastes.				
	Alteration of hydrological patterns resulting in temporary or permanent flooding, soil erosion, and destruction of biodiversity	H	• Mechanically stabilising the soil to reduce the potential for erosion • Avoiding excavation and burial in the steeply sloped ground and avoiding the creation of great breaks • Providing for the placement of siltation ponds in areas subject to heavy erosion • Selecting vehicles suited for erodible soil • Limiting activities in erodable soil • At the completion of the work, levelling the disturbed soil and quickly seeding or replanting bushes to control soil erosion.	L	Site inspection report Compliance monitoring report	OIRL/State Ministries of Environment/FMEnv	During Construction
	Habitat	M	OIRL shall:	L	Site inspection	OIRL/State	During

	alteration		• Implement good housekeeping practice on-site. • Store and handle hazardous waste following approved WMP • OIRL shall ensure the use of appropriate PPEs • OIRL shall ensure that backfilling is followed by mechanical compaction to retain the original level. • OIRL shall re-vegetate the soils with indigenous grasses, sedges, etc to check the incidence of flooding.		report Compliance monitoring report	Ministries of Environment/FMEnv	Construction
	Worksite accidents	H	OIRL shall ensure that: • workers and visitors are properly kitted (use of appropriate PPEs) • use of warning signs • non-consumption of alcoholic beverages on work site • Clinic / first aid kit shall always be available within the site	L	Site inspection report Compliance monitoring report	OIRL/State Ministries of Environment/FMEnv	During Construction
	Increase in communicable disease (including STDs and HIV/AIDS)	M	• Health awareness lectures shall be given to workers on the mode of transmission of STIs (including HIV/AIDS) • As much as possible provide psychological support to persons living with HIV. • OIRL shall ensure immunization of the workforce against as appropriate.	L	Site inspection report	OIRL/State Ministries of Environment/FMEnv	During Construction

			• Regular spraying of work sites Provision of insecticide-treated nets to field workers to reduce the incidence of malaria. • Awareness campaign shall be carried out to enlighten the communities /field workers on the common communicable diseases and the health implications of drug and alcohol abuse, unprotected sex, prostitution, and the need to sustain cultural values. • OIRL shall assist the activities of the state action committee on STIs/HIV/AIDS as part of her stakeholders' engagement plan. • OIRL shall ensure site clinic is provided to take care of minor illnesses for all construction workers				
Site demobilization	Road traffic accidents	M	OIRL shall ensure: • enforcement of the use of PPEs • daily pep talk is carried out • job hazard analysis is carried out • compliance with journey management policy	L	Site inspection report Compliance monitoring report	OIRL/State Ministries of Environment/FMEnv	During Construction

Table 7.3: Environmental and Social Management Plan (ESMP) of the proposed Open Access Metropolitan Fibre Network – Operation/Maintenance

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
Operation and maintenance or inspection of the Open Access Metropolitan Fibre Network along RoW, Maintenance of data center and	Noise and vibration nuisance from Generating set	H	Mitigation measures to reduce the noise footprint of the project include: ✓ there is regular maintenance of generators. ✓ engines are switched off when not in use. ✓ Noise monitoring systems that monitor the noise level of the Data centre. ✓ The use of Renewable Energy such as wind and solar systems.	M	Site inspection report Compliance monitoring report	FMEnv/State Ministries of Environment	During Operation

Project Activity	**Description of Impacts**	**Rating before Mitigation**	**Mitigation/Control Measures**	**Rating after Mitigation**	**Parameters for Monitoring**	**Action Party**	**Monitoring Frequency**
Metro access system locations	Air emission during Maintenance/servicing of production equipment and ancillaries	H	OIRL shall ensure: • there shall be regular maintenance of generators; • engines are switched off when not in use • engines to comply with international standards for exhaust gases; • Maintenance of engines and exhaust gas check; • Use of the cleanest fuel economically available shall be adopted. • The use of a hybrid system shall be adopted to help the use of generating sets	L	Site inspection report Compliance monitoring report	FMEnv/State Ministries of Environment	During Operation
	The kidnapping of personnel during regular maintenance of RoW	H	• OIRL shall ensure that personnel develop a high level of security consciousness both within and outside the Data centre. • Daily security reports shall be reviewed by the authority • Special security forces shall be established and deployed during sporting activities. This shall include deploying some of OIRL police, Nigeria Security and Civil Defence Corps (NSCDC) to strengthen security in the area. • To beef up security for the project,	M	Site inspection/ Security reports	State Ministries of Environment/Nigerian Police Force/NSCDC	During Operation

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			OIRL shall assist with equipment e.g. patrol vehicles, to ensure improved security. • OIRL shall ensure that there is a police station/post within and around the facility.				
	Generation of Waste during operation of the Data centre	H	• Good housekeeping shall be instituted and maintained. • hazardous wastes shall be collected, stored, and disposed of appropriately in line with FMEnv standard at an approved disposal site. • Properly labeled waste bins shall be located at appropriate areas within the Data centre premises. • Waste shall be disposed of through approved waste managers regularly	L	Waste Management report Waste tracking records	FMEnv/State Ministries of Environment	During Operation
	Exposure to Covid-19 disease	H	➢ Social distancing, use of face mask, hand sanitizing protocols among others shall be enforced • Sick workers shall not be allowed to work during operation and maintenance phase	L	Site inspection report	FMEnv/State Ministries of Environment	During Operation
	Road traffic accidents as a result of transportation	H	To prevent road accident, OIRL shall ensure: • compliance with journey management policy • Vehicles are pre-mobbed and pre-	L	Site inspection report	FMEnv/State Ministries of Environment	During Operation

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
	activities during data centre operation and maintenance of RoW		mobilization/compliance certificate issued. • the use of PPEs at sites; daily pep talk, carry out job hazard analysis • ensure that all traffic rules are obeyed by the drivers • Speed breakers at sections traversing communities • All vehicles will be parked in the designated parking area only; • Road crossings will be well marked and signaled. • Informatory and warning signages will be retro-reflective type provided, clearly visible in the night. • Marshals will be deployed to guide the vehicles and stop vehicles to avoid traffic jams at the arrival and departure of the OIRL Open Access Metropolitan Fibre Network.		Compliance monitoring report		
	Soil/ groundwater contamination due to fuel/ oil spill	H	• Provision of secondary containment for storage tanks	L	Site inspection report Compliance monitoring report	FMEnv/State Ministries of Environment	During Operation

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
	Security threat and the threat from major accidents related to the fires and explosions at the facility and potential accidental releases of diesel when refilling the storage tank	H	• Limiting the areas that may be potentially affected by accidental releases by: o Defining fire zones and equipping them with a drainage system to collect and convey accidental releases of flammable liquids to a safe containment area including secondary containment of storage tanks. o Installing fire/blast partition walls in areas where appropriate separation distances cannot be achieved • By providing firefighting equipment around the Data centre	L	Compliance monitoring report	FMEnv/State Ministries of Environment	During Operation
	Worksite related accidents	H	OIRL shall ensure that: ✓ workers and visitors are properly kitted (use of appropriate PPEs) ✓ use of warning signs ✓ non-consumption of alcoholic beverages on work site Clinic / first aid kit shall always be available within the site	L	Site inspection report Compliance monitoring report	FMEnv/State Ministries of Environment	During Operation
	The threat of Naturally	H	OIRL shall ensure: • Regular maintenance or servicing of	L	Site inspectio	FMEnv/State Ministries of	During Operation

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
	Occurring Radioactive Material (NORM) to the environment (soil, water, and air)		production equipment as at when due; • Regular NORM monitoring programs to detect materials and equipment with NORM; • carrying out personal dosimetry for external radiation exposures to confirm that exposures fall into the range expected from external radiation surveillance monitoring; • measuring airborne radioactive dust during maintenance activities to check that the assumptions upon which respirator selections were made are accurate – or if respirators are needed at all; • a surface contamination survey in a workshop to confirm that NORM contamination controls are working; • sampling and analysis of waste streams to confirm that they remain within regulatory limits; • materials used in NORM control procedures, such as gloves, plastic sheeting, disposable coveralls, etc. if an area, materials, or equipment is affected by NORM • At equipment cleaning facilities,		n report Compliance monitoring report	Environment	

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			scale/sludge shall be removed by reaming; high-pressure water blasting; or a process called "rattling," where a high-speed rotating device is inserted into the pipe to break up and loosen the scale. Then the waste generated shall be handled by FMEnv approved Waste Manager to be disposed of at an approved disposal site.				
	Thermal effects due to exposure to EMF around the data centre	M	OIRL shall, and require that contractors implement the following measures to address occupational EMF exposure: ✓ Prepare and implement an EMF safety program including the following components: o Identification of potential exposure levels in the workplace. o Surveys of exposure levels in new projects and the use of personal monitors during working activities. o Training of workers in the identification of occupational EMF levels and hazards. o Establishment and identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable	L	Compliance monitoring report	FMEnv/State Ministries of Environment	During Operation

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			for public exposure, limiting access to properly trained workers. o Implementation of action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP). ✓ Set personal exposure monitoring equipment to warn of exposure levels that are below occupational exposure reference levels (e.g. 50 percent). ✓ Limit exposure time through work rotation. ✓ Increase the distance between the EMF source and the worker, when feasible, or the use of shielding materials. ✓ Deactivation of transmission equipment during maintenance activities, limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, use of shielding materials; or installation of ladders or other				

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			climbing devices inside the mast or towers, and behind the transmission beams.				
	Third-party Encroachment on the setback (RoW)	M	✓ OIRL shall always involve lawyers in agreeing with landowners to deter them from encroachment on their RoW and report to NESREA/FMEnv in case of any encroachment	L	Site inspection report Compliance monitoring report	FMEnv/State Ministries of Environment	During Operation
	Stealing and Vandalization of fibre cables	H	OIRL shall ensure that: • Daily security reports shall be reviewed by the OIRL project manager. • A special security force shall be established and deployed to the optic fibre routes. This shall include deploying some policemen to strengthen security in the area. • A liaison to foster a partnership with the community to guarantee security for the project is established and sustained. • Safety workshops to identify, evaluate, and recommend contingency plans for all security risks are regularly organized. • Regular monitoring of optic fibre routes	M	Site inspection report Compliance monitoring report	FMEnv/State Ministries of Environment/Police/NSCDC	During Operation
	Public	M	OIRL shall always sensitize the public to allay	L	Site	FMEnv/State	During

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
	Perception and fears		their fears. o Organize a workshop for the public to have new information on telecommunication equipment		inspection report Compliance monitoring report	Ministries of Environment/NCC	Operation
	Thermal effects due to exposure to EMF around the data centre	M	OIRL shall, and require that contractors implement the following measures to address occupational EMF exposure: ✓ Prepare and implement an EMF safety program including the following components: o Identification of potential exposure levels in the workplace. o Surveys of exposure levels in new projects and the use of personal monitors during working activities. o Training of workers in the identification of occupational EMF levels and hazards. o Establishment and identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, limiting	L	Site inspection report Compliance monitoring report	FMEnv/State Ministries of Environment/NCC	During Operation

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			access to properly trained workers. o Implementation of action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP). ✓ Set personal exposure monitoring equipment to warn of exposure levels that are below occupational exposure reference levels (e.g. 50 percent). ✓ Limit exposure time through work rotation. ✓ Increase the distance between the EMF source and the worker, when feasible, or the use of shielding materials. ✓ Deactivation of transmission equipment during maintenance activities, limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, use of shielding materials; or installation of ladders or other climbing devices inside the mast or towers, and behind				

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			the transmission beams.				
Repainting of rusted and corroded structural fittings at the Data Centre	Contamination of soil by paints and coating as a result of spillage	H	• Using of engineering controls (containment, automatic alarms, and shut-off systems) commensurate with the nature of hazard; • Implementing management controls (procedures, inspections, communications, and training) to address residual risks that have not been prevented or controlled through engineering measures. • Safe ventilation for storage of volatile materials shall be provided; • Access to areas containing paint substances shall be restricted and controlled; • Paints shall be stored on the impervious ground undercover; the area shall be constructed as a spill tray to avoid the spread of accidental spills.	L	Site inspection report Compliance monitoring report	FMEnv/State Ministries of Environment	During Operation
	Hazardous waste generation from painting	H	• Good housekeeping shall be instituted and maintained • hazardous wastes shall be collected, stored, and disposed of appropriately in line with FMEnv standard at an approved disposal site.	L	Site inspection report Compliance monitorin	FMEnv/State Ministries of Environment	During Operation

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
			• PPEs must be used by workers who are handling paint		g report		

7.8 Performance Indicator Monitoring

7.8.1 Environmental Monitoring Program

Environmental monitoring programs for the proposed project shall be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during both normal operations and upset conditions. Environmental monitoring activities shall be based on direct or indirect indicators of emissions, wastewater, and resource use applicable to the project, and for point sources of emissions which will include both concentration and mass flow rate of pollutants.

Monitoring frequency shall be sufficient to provide representative data for the parameter being monitored. Monitoring shall be conducted by trained individuals following suitable and appropriate monitoring and record-keeping procedures and using regularly calibrated and suitably maintained equipment. Monitoring data shall be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. The proposed operation phase monitoring programme is provided in ***Table 7.4*** below.

***Table 7.4*: Environmental Monitoring Programme for OIRL Open Access Metropolitan Fibre Network**

Component	Type	Monitoring Parameter	Source point / Sampling point	Monitoring Frequency	Responsibility
Environment					
Emissions	Fugitive emission	CH4; VOCs, CO, CO_2, SO_2 and SO_3, NOx, and H_2S.	Valves and machinery seals, storage tanks, generating sets	Weekly and 3-year Audit	Consultant/ HSE
Nuisance	Ambient	Noise level, odour, vibration, radiation	Within site and 1km radius	Weekly and 3-year Audit	Consultant/ HSE
Surface water	Rivers, streams, ponds, etc. (2km radius)	pH, Hydrocarbons (BTEX, TPH, PAH, THC), Temperature, Conductivity, Chloride, Turbidity, TDS, BOD_5, COD, THC, DO, Total hardness, Heavy metals, *E. coli* and *Enterococci*	Upstream, midstream, and downstream	Quarterly (Compliance monitoring) and 3-year Audit	Consultant/ HSE
Groundwater	Shallow wells and boreholes (2km radius)	Temperature, hydrocarbons (BTEX, TPH, PAH, THC), pH, Electrical Conductivity, Total Solids, Dissolved Oxygen, Total Hydrocarbon Content, BOD_5, COD Sulphate, Nitrate, Phosphate, phenol, heavy metals, Total coliform, and Faecal Coliform bacteria	Boreholes and wells	Quarterly (Compliance monitoring)	Consultant, HSE
Rainwater and stormwater	Rainwater and stormwater	Precipitation rate, pH, TDS, acidity, alkalinity, colour, hardness, etc.	Stormwater (Point of discharge from the facility)	Quarterly (Compliance monitoring), 3-year Audit	Consultant, HSE

Component	Type	Monitoring Parameter	Source point / Sampling point	Monitoring Frequency	Responsibility
Sanitary sewage	-	Residual chlorine, pH, TSS, DO, BOD5, Total Coliform, and Faecal coliform	Sanitary sewage treatment plant (SSTP)	Post-treatment	Consultant/ HSE
Air quality	Ambient air	Particulate matter, C_XH_Y, SOx, CO, VOC, NOx, Noise, H_2S, NH_3.	Established sampling points and 500m radius of the Data centre and RoW	Weekly and 3-year Audit	Consultant/ HSE
Traffic	Vehicular traffic	Vehicular volume count, origin and destination survey	Established observation points around the optic fibre routes and the Data centre	3-year audit	Consultant, HSE/ Logistics
Safety and health					
	Occupational safety and health	Lost time injury (LTI), Lost time injury frequency (LTIF), Medical cases, Fatality, etc.	Within site	Daily	HSE
	Community health	The oil spill, fire, explosion, benzene concentration, vehicular accident, accidental chemical release, or other major hazards	Stakeholder communities	Daily	HSE

7.9 Emergency Response Plan

Preparation of an Emergency Response Plan (ERP) and access to specialist equipment is essential for the safety of personnel, assets, the public, and to minimise the severity of an incident. The ERP will address wherever possible environmental considerations and include:

- Define the command-and-control system for response and rapid dissemination of critical information to affected parties.
- Evaluate response preparedness including support facilities for firefighting, and operational procedures for the handling of equipment and chemicals.
- Clean up and disposal procedures.
- Coordination with mutual aid groups such as Police, and state fire service.
- Staff awareness and training.

7.10 Environmental Auditing

OIRL Operations Unit shall schedule environmental audits to assess its performance with regards to the requirements of this ESMP. The internal auditing objectives of OIRL are to:

- Review existing operations/activities environmental and occupational health aspects to determine where improvements could be made.
- Review compliance with FMENV/NCC and FMEnv regulations.
- Identify hazards and take preventive and corrective actions.
- Assess the effectiveness of OIRL policy, responsibilities spread, current initiatives success rates such as the provision of regular supervision and environmental awareness campaigns and programs, tolerance management enforcement, and hazard control.
- Appraise the environmental performance of the company.
- Heighten awareness of personnel on the importance of sound environmental management.
- Ensure that Open Access Metropolitan Fibre Network does not detrimentally impact the environment.
- Review community affairs

Environmental auditing programs include:

- Compliance auditing, including auditing of any terms and conditions associated with the Open Access Metropolitan Fibre Network approvals and permits.
- Auditing of the Environmental Management Plan.

- Auditing of the Environment Monitoring.
- Auditing of any drills or actual responses associated with the ERP

OIRL Safety Unit shall develop a schedule for the audit of Open Access Metropolitan Fibre Network operations. The timing of audits shall be adjusted based on environmental risks identified.

7.11 Reporting

OIRL shall keep regulatory authorities informed of the project performance concerning HSE matters by way of written status reports and face-to-face meetings. It shall prepare annual reports on environmental and social performance and submit the same to relevant regulators. In addition to regular reporting, official notification shall be made to the government for any of the following:

- Significant modifications to this ESMP or the ESIA;
- Significant design, routing, or implementation changes;
- Results of environmental monitoring;
- Community incidents; and
- Safety incidents or accidents.

OIRL shall make accessible to government authorities, or provide upon request appropriate documentation of HSE related activities, including internal inspection records, training records, and reports. Subcontractors are also required to provide HSE performance reporting to the OIRL regularly through weekly and monthly reports.

7.12 Regulatory Oversight

Communications between the OIRL management and government regulatory agencies shall be instituted through a variety of mechanisms, including written reports and memos, as well as informal and formal meetings. Meetings will include regularly scheduled sessions as well as additional meetings called on and as the need arises. At the field level, formal meetings with government regulatory agency representatives shall be held as needed to discuss scheduling/planning issues, current areas of concern, and emerging HSE and socioeconomic issues.

At the management level, formal meetings are expected to be held, but on a less frequent basis. Informal meetings and communications will also hold as necessary. Concerning formal meetings, the HSE Manager will meet with government regulatory agency representatives to review HSE and socioeconomic performance based on the analysis of internal HS-EMS and field reports. These meetings can be expected to include discussion of upcoming work plans and coordination issues and resolution of problems that could not be adequately addressed at the field level. At the field level, government regulatory agency field representatives will inform appropriate OIRL representatives if compliance concerns arise. At the management level, regularly scheduled meetings will hold between HSE Managers and the appropriate government regulatory agency representative to review HSE performance, areas of concern, and emerging issues.

7.13 Fiscal Plan for the ESMP

To effectively implement the environmental and social management measures suggested as part of the ESMP, an estimated budget has been made by OIRL for the project components. Please see the budget section in **Tables 7.10** below.

Table 7.5: Budget for the ESMP

Component	Type	Monitoring Parameter
Emissions	Fugitive emission	Carbon dioxide (CO_2), nitrogen oxides (NOx), sulphur oxides (SOx), carbon monoxide (CO), and particulate matter (PM), Hydrogen sulphide (H_2S)
Budget	***₦4,500,000.00***	
	Sanitary sewage	Residual chlorine, pH, TSS, DO, BOD_5, Total Coliform, and Faecal coliform
Budget	***₦1,000,000.00***	
Air quality and Nuisance	Nuisances	Noise level, odour, vibration, radiation
	Ambient air quality	Particulate matter, C_XH_Y, Sox, CO, VOC, NOx, Noise, H_2S, NH_3, etc.
Budget	***₦1,500,000.00***	
Surface water	Rivers, streams, seasonal ponds, etc	pH, Hydrocarbons (BTEX, TPH, PAH, THC), Temperature, Conductivity, Chloride, Turbidity, TDS, BOD_5, COD, THC, DO, Total hardness, Heavy metals, *E. coli* and *Enterococci*
Groundwater	Boreholes	Temperature, hydrocarbons (BTEX, TPH, PAH, THC), pH, Electrical Conductivity, Total Solids, Dissolved Oxygen, Total Hydrocarbon Content, BOD_5, COD Sulphate, Nitrate, Phosphate, phenol, heavy metals, Total coliform, and Faecal Coliform bacteria
Rainwater and stormwater	Rainwater and stormwater	Precipitation rate, pH, TDS, acidity, alkalinity, colour, hardness, etc.
Budget	***₦3,500,000.00***	
Traffic	Vehicular traffic	Vehicular volume count, origin and destination survey
Budget	***₦2,500,000.00***	
Safety and health		

Component	Type	Monitoring Parameter
	Occupational safety and health	Lost time injury (LTI), Lost time injury frequency (LTIF), Medical cases, Fatality, etc.
	Community health	Fire, explosion, vehicular accident, accidental chemical release, or other major hazards
Budget	***₦7,000,000.00***	

CHAPTER EIGHT

DECOMMISSIONING AND RESTORATION PLAN

8.1 Background Information

The life span of any proposed project is hinged on several considerations. It is important to put in place plans to recover and/or restore the project site to its original state after the project is closed or decommissioned. This requires a good understanding of all the environmental components of the project on the ecosystem during its lifespan (50 years). At the decommissioning stage, the facility is taken out of its current operational use with the isolation of its units. When a project has undergone this process, it is then abandoned or modified for reuse. This Chapter presents the Open Access Metropolitan Fibre Network decommissioning and abandonment plan.

8.2 Outline of Planning and Implementation Programme

1) OIRL shall commence activities related to decommissioning, at least, one (1) year before abandonment,
2) Determine the scope of decommissioning,
3) Engagement and due consultation of stakeholders (including FMEnv, State Ministries of Environment,, communities, NCC, etc.) shall be instituted,
4) Put in place a Decommissioning Plan Report for review and approval by FMEnv. The plan shall include:
   - identification of all components of the project that will be disengaged, removed, or exhumed;
   - method(s) for removal or re-use of any project unit/ material if applicable;
   - effort being put in place to mitigate any environmental impacts associated with the decommissioning process; and
   - appropriate site remediation/rehabilitation programme
5) Ensure the safety of operation, taking into consideration all appropriate international conventions, regulatory requirements, and corporate policies.
6) Remove all structures (surface and sub-surface structures) with due regard for the protection of the environment.

8.3 Decommissioning and Restoration Principle

At decommissioning, all units buried or fixed on land shall be removed entirely. All wastes items arising from the decommissioning process shall be managed in line with the Stadium Waste Management Plan (WMP). Decommissioning shall be carried out in line with the standard decommissioning procedure. OIRL shall:

- avoid any significant adverse effect on the environment; and
- Provide a platform for reuse of decommissioned items locally in line with its WMP

8.4 Site Remediation and Restoration

Following decommissioning and abandonment, OIRL will carry out site remediation and restoration work as part of the project's environmental management programmes. This will entail:

1) A survey of the decommissioned site for contamination as part of a conceptual site model and a strategy plan.
2) Evaluation of the site hydrology and geology.
3) Preparation of a site assessment report to be approved by FMEnv.
4) Interim action or remediation is designed to confirm the applicability and feasibility of one or more potential remedial options.

Finally, the site shall be monitored for compliance and performance to confirm the effectiveness of the remedial measures. At the end of the site abandonment, the following useful documentation shall be reviewed:

1) The initial Decommissioning and Restoration Plan.
2) The abandonment operations conducted in the field, along with changes to plan necessitated by field conditions.
3) Soil test reports.
4) Final Open Access Metropolitan Fibre Network ESIA Report.

8.5 Post Decommissioning Impact Assessment

Before abandonment, a post decommissioning Impact Assessment Report shall be prepared to detail the state of the environment after remediation. The report shall be submitted to FMEnv, after which a joint site visit shall be done by a team of OIRL, FMEnv, Community, Consultant, and other stakeholders. The table below shows the comprehensive Environmental and Social Management Plan (ESMP) of the Open Access Metropolitan Fibre Network during the Decommissioning Phase.

Table 8.1: Environmental and Social Management Plan (ESMP) of the proposed Open Access Metropolitan Fibre Network – Decommissioning

Project Activity	Description of Impacts	Rating before Mitigation	Mitigation/Control Measures	Rating after Mitigation	Parameters for Monitoring	Action Party	Monitoring Frequency
Demolition and Evacuation	Interference with road transportation	M	• OIRL shall monitor the no of trucks per day to know if there is a need to create other accessible roads. • OIRL shall develop a transport management plan specifying routes, speeds, times of travel, and key roads/waterway in terms of local services. • Consideration shall be given to avoid reliance on public transport and contractors shall be required to use private vehicles.	L	Inventory of approved journey management forms	OIRL/State Ministries of Environment/FMEnv	During Decommissioning
	Noise and vibration nuisance	M	OIRL shall ensure that: • electric power generators are fitted with effective silencers; • there shall be regular maintenance of vehicles and generators.	L	Compliance monitoring report	OIRL /State Ministries of Environment/FMEnv	During Decommissioning

			• generators and vehicles are switched off when not in us. • soundproof electric power generators are engaged • PPEs are used				
	Impairment of air quality	H	OIRL shall ensure: • Engine to comply with international standards for exhaust gases; Maintenance of engines and exhaust gas check; Adoption of engine-off policy at the construction site. • that nose masks and earmuffs are worn by site workers during excavation. • that water shall be sprayed on construction sites to reduce dust levels, especially during the dry season.	L	Compliance monitoring report	OIRL / State Ministries of Environment/FMEnv	During Decommissioning
	Contamination of surface and Groundwat	M	OIRL shall ensure: • Soil disturbance shall be kept to minimum required for operation and safety • Oil spill containment shall	L	Compliance monitoring report	OIRL / State Ministries of Environment/FMEnv	During Decommissioning

	er & soil by the oil spill		be provided to reduce oil spill • from getting to the soil and surface/ groundwater • Follow FMEnv guidelines on waste management • Cleanup in compliance with relevant national and • international guidelines, involving the removal of the waste, etc • Restore the to a condition in no way inferior to the condition • before the commencement of work.				
	Poor disposal of wastes generated during this phase	H	• OIRL shall treat and dispose of all wastes following regulatory requirements and best practice using approved contractors. • OIRL shall ensure that none of these wastes are disposed of into any water body or on land. • follow safety measures while disposing of wastes. • OIRL shall keep all waste	M	Site inspection report Waste Management Policy/ tracking sheet	OIRL / State Ministries of Environment/FMEnv	During Decommissioning

			consignment, treatment, and disposal records for regulatory verification. • Proper disposal of solid waste from labour camps. • storage of lubricants, fuels, and other hydrocarbons in self-contained enclosures. • sanitation arrangements at worksites/facilities to avoid the release of wastewater to the environment. • All other wastes generated including environmentally deleterious materials generated by construction activities will be disposed of offsite in an appropriate, legal, and safe manner. • There is a minimum generation of waste. • Unsuitable excavated materials shall be systematically carried away from areas prone to erosion; • Reuse waste materials wherever possible				

			• Wastes shall be segregated, stored, and disposed of by an accredited state waste collector				
	The threat of Naturally Occurring Radioactive Material (NORM) to the environment	H	OIRL shall ensure: • Regular maintenance or servicing of production equipment as at when due; • Regular NORM monitoring programs to detect materials and equipment with NORM; • carrying out personal dosimetry for external radiation exposures to confirm that exposures fall into the range expected from external radiation surveillance monitoring; • measuring airborne radioactive dust during maintenance activities to check that the assumptions upon which respirator selections were made are accurate – or if respirators are needed at all;	M	Site inspection report Waste Management Policy/ tracking sheet	OIRL / State Ministries of Environment/FMEnv	During Decommissioning

			• a surface contamination survey in a workshop to confirm that NORM contamination controls are working; • sampling and analysis of waste streams to confirm that they remain within regulatory limits; • materials used in NORM control procedures, such as gloves, plastic sheeting, disposable coveralls, etc. if an area, materials, or equipment is affected by NORM. • Equipment with NORM shall be recycled or incinerated at an approved recycled or incinerated center as the case may be				
	Loss of job	H	OIRL shall • Counsel worker who loses their job. • Give enough notice • Assist staff that are likely to lose their job in skill acquisition.	L	Contract documents/ list of community members	OIRL / State Ministries of Environment/FMEnv	During Decommissioning

			• Assist in setting small scale business.		employed		
	The kidnapping of workers and visitors on site	H	• OIRL shall ensure that both contractor and OIRL personnel develop a high level of security consciousness both within and outside the work area. • Daily security reports shall be reviewed by the OIRL Project Manager. • A special security force shall be established and deployed for the project. This shall include deploying some of OIRL police to strengthen security in the area. • OIRL shall ensure that a liaison to foster a partnership with the community to guarantee security for the project is established and sustained. • OIRL shall ensure that safety workshops to identify, evaluate and recommend contingency plans for all	M	Progress/sit e inspection report	OIRL / State Ministries of Environment/F MEnv / Nigeria Police Force/NCDC	During Decommissi oning

			security risks are regularly organized • OIRL shall ensure that there is a police station/post within and around the facility				
	Third-Party Agitation due to employment Issues and Loss of Benefits as Host Communities.	M	• Assist staff that are likely to lose the job in skill acquisition. • Assist in setting small scale business	L	Contract documents/ list of community members employed	OIRL / State Ministries of Environment/FMEnv	During Decommissioning

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CHAPTER NINE

CONCLUSION AND RECOMMENDATIONS

9.1 Background Information

The project ESIA study shows that with the application of the recommendations built into the environmental and social management plan and other provisions incorporated therewith, the construction and operation of the Open Access Metropolitan Fibre Network will be carried out with minimal impacts on the environment.

9.2 Conclusion

Open Access Metropolitan Fibre Network Environmental and Social Impact Assessment (ESIA) draft report was prepared *following the Environmental Impact Assessment (EIA) Act CAP E12, LFN 2004*. The study area baseline environmental description was based on one season of field sampling consolidated by a review of previous studies on the same environment.

The goal of the ESIA process was to get to a position where the Project does not have any major residual impacts on the environment, certainly not ones that would endure into the long term or extend over a large area. Therefore, following the application of mitigation measures, the residual impacts became short-term, mostly localized, and reversible. Similarly, recommendations were also proffered for the beneficial impacts of the projects to enhance/sustain them.

To establish the project's operational requirements aimed at ensuring it delivers its stated business objective in an environmentally responsible manner, an Environmental and Social Management Plan (ESMP) was developed. The ESMP translated the mitigation/enhancement measures to action points. Similarly, performance indicators monitoring and audit programmes were recommended. This is to ensure that all impact indicators for the various environmental components are within statutory limits throughout the project life.

9.3 Recommendations

9.3.1 Management Action Plan

OIRL will adhere to the following management recommendations to ensure sustainability and continual environmental performance of the project. Therefore, the OIRL shall:

- Always support green initiative in all phases of the proposed Open Access Metropolitan Fibre Network to reduce the effect of greenhouse gas emission
- Implement the Environmental and Social Management Plan (ESMP) designed for the project through its phases of development covering construction, operation, and decommissioning. The ESMP shall also be reviewed as the need may arise;
- Develop and implement a standard Environmental Management System (EMS) such as ISO 14001:2015 EMS and ISO 14064-1:2006 on *Greenhouse gases* for the project.
- Develop and implement a standard Safety Management System (SMS) in line with FMEnvs,
- Implement the project's Waste Management Plan (WMP)
- Implement the project's performance indicator monitoring programme as recommended. Monitoring (inspection and measurements) shall be carried out at least three (3) times during the construction phase, and during operation, quarterly.
- Carry out a 3-year post-ESIA environmental auditing. The audit shall be carried out by a competent third-party person to ensure objectivity.
- Develop and implement a public complaint and grievance redress system to effectively handle the stakeholders' concerns.
- Provide adequate resources for the management of the project's environmental aspects (including noise, air emissions, birds strike, etc.)
- Obtain relevant regulatory permits and approvals before the commencement of the project, and as when due.

9.3.2 Operations Action Plan

The following specific environmental management and pollution control action will be implemented:

- Implement scheduled inspection and maintenance of mobile and immobile equipment
- Implement noise and emissions mitigation measures as recommended

- Prevent and control of accidental releases of liquids and spill response plans,
- Maintain a good housekeeping practice.

The ESIA shows that there is no potentially significant negative residual impact following the application of mitigation measures. To this end, O'odua Infraco Resources Limited hereby solicits for the approval of the ESIA Report by FMEnv, while appropriate mitigation measures and post ESIA monitoring will be carried out following implementation.

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