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ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

OF

THE PROPOSED CONSTRUCTION AND ESTABLISHMENT OF 18'' X 60KM NATURAL GAS PIPELINE FROM OGERE TO IBADAN TOLL GATE

BY

NIPCO GAS LIMITED

SUBMITTED TO

FEDERAL MINISTRY OF ENVIRONMENT, ABUJA

Prepared by

DISKOL
ENVIRONMENTAL CONSULTING

(Accredited by FME, NESREA, OGSME, OYSME, NURC and NOSDRA)

DECEMBER, 2022

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ACKNOWLEDGEMENT

Nipco Gas Limited and their Environmental Consultants wish to acknowledge and thank the management and technical staffs of Federal Ministry of Environment, Oyo State Ministry of Environment, Ogun State Minsitry of Environment, National Environmental Standards and Regulations Enforcement Agency, host community, Local Government Areas, NGOs, CBOs and other concerned stakeholders and persons, for their understanding and support during the studies. Many thanks also go to those who assisted in providing essential technical and project planning information necessary to produce the Environmental Impact Assessment (EIA) for the project.

The appreciate assistance received from all sources of data and information for this project which have contributed immensely towards the success of the field studies and the preparation of this Environmental Impact Assessment (EIA).

Diskol Environmental Consulting Limited however wishes to emphasis in line with its policy, that all the information contained in this report would be accorded the strictest confidentiality.

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LIST OF ABBREVIATIONS AND ACRONYMS

GENERAL

API	Area of Potential Influence
ASL	Above Sea level
BAP	Biodiversity Action Plan
BAT	Best Available Technology
BDL	Below Detection Limit
BOD	Biochemical Oxygen Demand
CAGR	Compound Annual Growth Rate
CAPA	Corrective and Preventive Actions
CBOs	Community Based Organizations
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COD	Chemical Oxygen Demand
COPD	Chronic Obstructive Pulmonary Disease
CSR	Corporate Social Responsibility
DD	Data Deficient
DO	Dissolved Oxygen
DS	Dissolved Solids
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EN	Endangered
EA	Environmental Assessment

FA	Factories Act 1990
FDI	Foreign Direct Investments
FNC	First National Communication
GDP	Gross Domestic Product
GIIP	Good International Industry Practice
Hc	Hydrocarbon
HSE	Health, Safety and Environment
IT	Information Technology
IUCN	International Union for Conservation of Nature and Natural Resources
ITCZ	Inter- tropical Convergence Zone
ITD	Inter-Tropical Discontinuity
ITN	Insecticide Treated Nets
LC	Least Concern
NDC	Nationally Determined Contributions
NE	Not Evaluated.
NFE	Non-Formal Education
NGOs	Non-Governmental Organization
NOSCP	National Oil Spill Contingency Plan
NUPRC	Nigerian Upstream Petroleum Regulatory Commission
PA	Paris Agreement
PACs	Project Affected Communities
PPE	Personal Protective Equipment
PS	Performance Standards
QA	Quality Assurance

QC	Quality Control
SS	Suspended solids
STDs	Sexually Transmitted Diseases
TDS	Total Dissolved Solids
THC	Total Hydrocarbon
ToR	Terms of Reference
TSP	Total Suspended Particulate
TSS	Total Suspended Solid
USD	United State of America Dollar
VES	Vertical Electrical Sounding
VOCs	Volatile Organic Compoun

UNITS of MEASUREMENT

%	Percentage
µm	micrometer
µs	micro Siemen
cfu/ml	Colony forming unit per milliliter
cl	centilitre
cm	Centimetre
dB(A)	Decibel
g/cm	Gramme per Centimetre
kg	Kilogramme
Km	Kilometer
MT	Metric Tonnes
m	Metre

m/s	Metre per second
m^3	Metre Cube
meq	Milliequivalent
mg	Milligramme
mg/kg	Milligramme per kilogramme
mg/l	Milligramme per litre
ml	Millilitre
mm	Millimetre
NTU	Nephelometric Turbidity Unit
pH	Hydrogen ion concentration
ppb	parts per billion
ppm	parts per million
^oC	Degrees Celsius
TU	Turbidity

CHEMICAL ELEMENTS AND COMPOUNDS

Al	Aluminum
C	Carbon
$CaCO_3$	Calcium Carbonate
Cl	Chloride
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Cr	Chromium
Cu	Copper
Fe	Iron

H	Hydrogen
H_2S	Hydrogen Sulphide
Hg	Mercury
K	Potassium
Mg	Magnesium
Mn	Manganese
N	Nitrogen
Na	Sodium
Na_3PO_4	Sodium phosphate
NaOH	Sodium hydroxide
NH_3	Ammonia
NH_4	Ammonium ion
Ni	Nickel
NO_2^-	Nitrite ion
NO_3^-	Nitrate ion
NO	Nitrogen Oxides
Pb	Lead
PO_4^{3-}	Phosphate
SiO_3^{2-}	Silicate
SO_2	Sulphur dioxide
SO_4^{2-}	Sulphate ion
Zn	Zinc

STRUCTURES AND EQUIPMENT

AAS	Atomic Absorption Spectrophotometer
GPS	Global Positioning System

ORGANIZATIONS

APHA	America Public Health Association
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BIS	Bank for International Settlements
CDA	Community Development Association
CEM	Commission on Ecosystem
FNGP	Food and Agricultural Organization of the United Nations
FEPA	Federal Environmental Protection Agency
FMEnv	Federal Ministry of Environment
IFC	International Finance Corporation
ILO	International Labour Organisation
ISO	International Organisation for Standardization
IUCN	International Union for Conservation of Nature and Natural Resources
NAFDAC	National Agency for Food and Drugs Administration and Control
NBS	Nigeria Bureau of Statistics
NDLEA	National Drug Law Enforcement Agency
NFPA	National Fire Protection Association

NESREA	National Environmental Standards and Regulations Enforcement Agency
NGL	Nipco Gas Limited
NiMet	Nigeria Meteorological Agencies
NOSDRA	National Oil Spill Detection and Response Agency
NPC	National Population Commission
NSCDC	Nigerian Security and Civil Defence Corps
NUPRC	Nigerian Upstream Petroleum Regulatory Commission
SON	Standard Organisation of Nigeria
TCN	Transmission Company of Nigeria
UNDP	United Nations Development Programme
UNEP	United Nation Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United State Environmental Protection Agency
WB	World Bank
WHO	World Health Organisation

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EXECUTIVE SUMMARY

ES 1.1 Introduction

NIPCO PLC is committed to meeting the needs of all stakeholders in the downstream sector of the Oil & Gas industry by providing quality services in petroleum product storage and handling in an environment that is friendly, safe and dignifying and become an integrated Oil & Gas company by venturing into the upstream sector. It intends to marry profitable business with environmental sustainability and eco development. As an experienced player in oil and Gas storage and marketing industry, the company is contributing creditably to the economic growth and provision of quality jobs for the unemployed youths, adding sustainable positive values for economic growth. The industrial entity registered as Limited Liability Company is being managed by an experienced and eco-conscious team intends to laying of 18inch diameter, 60 Kilometers in length of 3 Layer Polyethylene Carbon Steel Pipeline to convey Natural Gas from Yaali Foods, Ogere, Ogun State to Ibadan Tollgate, Oyo State. This proposed pipeline is a continuation/extension of the company's existing pipeline infrastructure from its Compressed Natural Gas (CNG) Station at Ibafo, Ogun State that currently terminates at Yaali Foods, Ogere, Ogun State (which is the start point for this particular project).

The facility is spatially located at N0809117.984, E00596469.357 (Ibadan Toll Gate) and N0763997.658, E00569157.014 (Ogere end). The proposed gas pipeline is located along busy Lagos-Ibadan Expressway representing industrial cum commercial zone and surrounded by anthropologically influenced environment with galloping industrial and commercial development. When completed the proposed gas pipeline technology facility which can compete favorable with worldwide standards shall impact positively on socio-economic development of the state, its environs and entire country. Nipco Gas Limited backed by an experienced and dedicated management team grew from a modest beginning into a foremost, appreciated and consumer's friendly industrial giant with hard earned consumers' confidence, reputation for excellence and sustainable operational practices are surely going to place the company as Nigeria's most trusted name in supply of compressed natural gas without compromising the tenets of sustainable development..

However, Sustainable Development and Environmental Management are being pursued by Nipco Gas Limited as goals of equal importance. Consequently, compliance with environmental regulations and proactive corporate policy on health, safety and environmental issues are key factors that characterize contemporary economic and industrial development decision-making. The need to carry out this development in accordance with the principles of sustainable development and in conformity with existing regulatory requirements of the Federal Republic of Nigeria, Ogun and Oyo State government has necessitated this Environmental Impact Assessment (EIA) study.

The 60km x 18" length gas pipeline intends to transport natural gas from compressed natural gas station, along the Lagos – Ibadan Expressway in Sagamu LGA, Ogun State to feed the Gas Pipeline Project in Ibadan and major industries along the row in order to utilize natural gas to power gas turbine plants constructed by industries and any government around the project area. This will improve power supply in the project area, provide cheaper, cleaner and more efficient fuel for the end users in particular and the country in general, promote the use of natural gas as a substitute for liquid fuel, as well as enhancing environmental status as natural gas is friendly, boost economic activities within the area and country at large, encourage gas utilization culture in Nigeria as fuel-of-first-choice and offer job opportunities in various categories to a number of Nigerian professionals, skilled and semi-skilled craftsmen. Diskol Environmental Consulting Limited a FMEnv accredited Environmental Consultant prepared this report on behalf of Nipco Gas Ltd. The Environmental Impact Assessment (EIA) report presents the findings of the technical studies conducted to evaluate the proposed project's environmental and social impacts. The EIA report describes the affected environment, identifies anticipated and potential environmental and social impacts, and provides recommendations for impact mitigation. The report also includes a detailed synopsis of the proposed Environmental Management Plan (EMP) that will govern the construction and operation of the gas pipeline throughout its life cycle. The EIA and the EMP will apply to all aquatic and terrestrial environments within the project's Area of Influence (AOI).

ES 1.2 Proponent

Nipco Gas Limited is an indigenously owned Nigerian company licensed to carry out independent Power generation. It has its headquarters at 15 Dockyard Road, Apapa, Lagos State Nigeria. Nipco Gas is principally engaged in the business of acquiring, developing, owning, and operating Compressed Natural Gas distribution system. In March 2007, NIPCO Plc made its presentation of its CNG project to the Inter-ministerial team of the Federal Government. In the same month FG accorded it's approval to commence the proposed project at Benin City. NIPCO Gas was formed as

Joint Venture Company between NIPCO and Nigerian Gas Company Limited (NGC) to implement the CNG project.

Currently NGC which is subsidiary of NNPC owns 55% of equity while NIPCO owns the balance 40% equity. NIPCO Gas has established 15 CNG running stations in Benin to provide an alternative for the Gasoline run automobiles. Presently it is in the process of constructing further 15 stations in and around Benin City. More than 5,600 vehicles have been converted to CNG for motorist in and around Benin City. As a result, nation's economy is strengthened as Gasoline imports are reduced.

Impressed with the impact of CNG in Benin, FG directed NIPCO Gas to expand its operations into other parts of the country. Hence a mega CNG station was commissioned at Ibafon, Ogun state, to convert automobiles to CNG as well as to supply nearby industries. Presently NIPCO Gas owns about 67 CNG cascades to ease CNG supply and distribution to industries in Ibafon axis. The Ibafon CNG station along with a city gas station has a larger compressing facility (12,000 scmt) for loading CNG to the nearby industries.

ES1.3 Project Location

The project area spanned two different states in the south western region of Nigeria. The project covers 60km of the land area along the Lagos- Ibadan Expressway located along the set back of the busy expressway. The right of way to lay the gas pipeline belongs to the Federal Ministry of Works and Housing. The Natural Gas will be used as fuel gas to power gas generators & boilers and feed stock to plants with emphasis on operational safety, efficiency and flexibility with a view to providing industry standard remote supervision and control.

ES1.4 Objectives of the EIA

The objectives of the EIA study are to:

- Determine and evaluate the potential positive and significant negative impacts of the gas pipeline construction activities;
- Provide mechanism for public disclosure of project information.
- Integrate the opinions and views of all stakeholders particularly host communities into the project in order to ensure that the gas pipeline project is both environmentally and socially sustainable;
- Proffer appropriate mitigation measures for the negative impacts;
- Develop an appropriate Environmental Management Plan (EMP); and

- Ensure compliance to relevant statutory requirements and Company good practices.

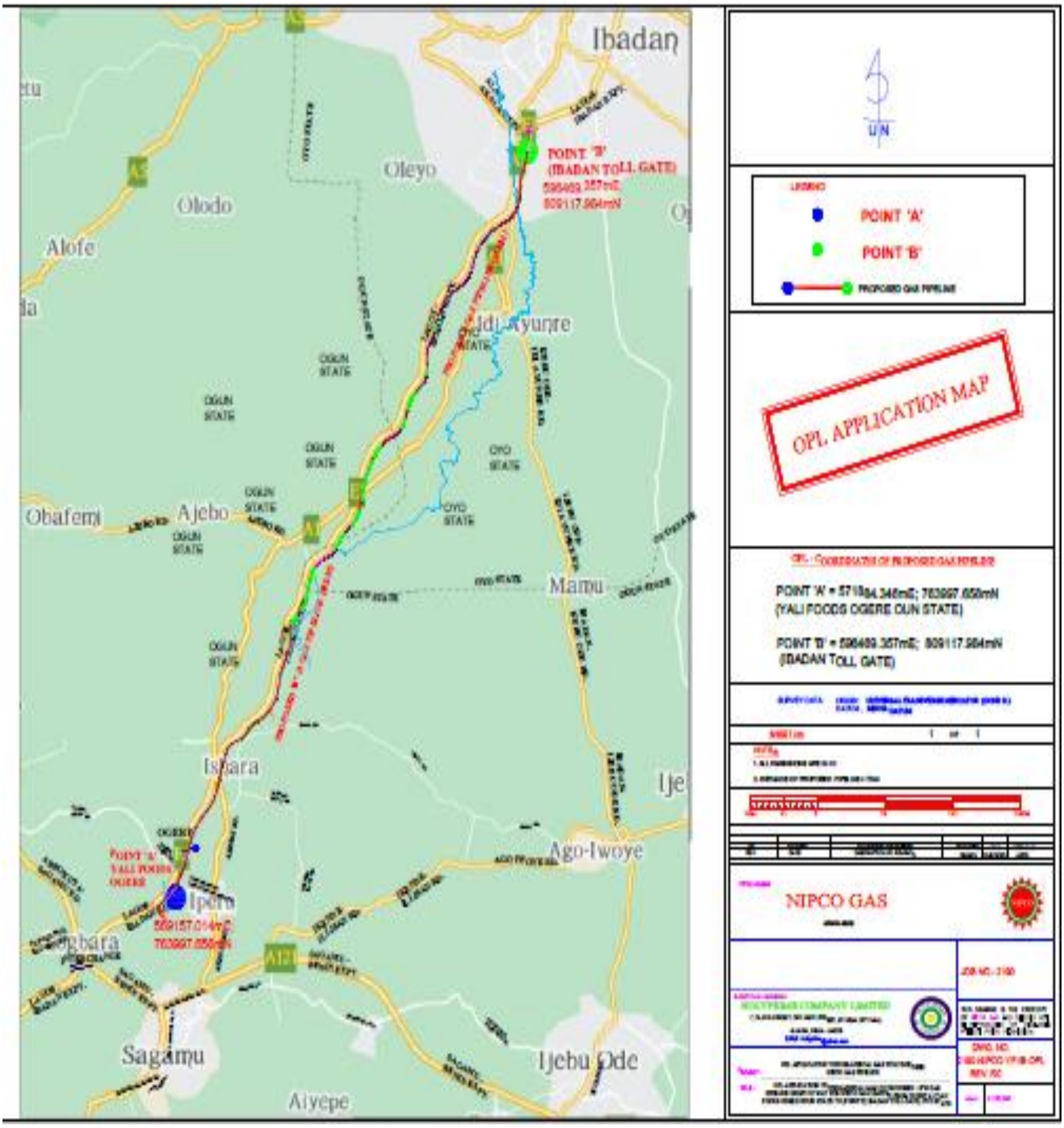

Fig 0.1: Showing the project location

E1.5 Scope of the EIA

The key premises that affect EIA process were established from the initial stages of the project and have provided the general guidance, framework, and commitment to standards acceptable nationally and internationally.

E1.6 Benefits of the EIA

The benefits of conducting an EIA will among other things include:

- Obtaining authorization; this is required by regulatory authorities prior to commencement of gas pipeline project;
- Providing a forward planning tool for proper environmental accounting with other issues early enough, so as to allow for important decisions to be built into the project design;
- Serves as an adaptive, organizational learning process, in which the lessons of experience are feedback into policy, institutional and project design - enhancement of positive aspects;
- Providing a designing tool that will allow a systematic evaluation of potential environmental problems and risks from the proposed activity and identification of key issues that require special consideration for effective environmental management and controls;
- Guides formal approval, including the establishment of terms and conditions of gas pipeline project implementation and follow-up;
- Incorporate stakeholder analysis by involving all stakeholders through consultation so as to address common problems, impacts and mitigation measures that might be proposed; and
- Informing and assisting management with a view to establishing and achieving long term management objectives and plans associated with specific activities, in order to minimize associated financial and environmental risks.

E1.7 Institutional and Legislative Framework

The regulatory framework that shall guide the implementation of the proposed project include Nigerian statutes such as EIA Act CAP LFN E12 2004, FMEnv EIA Sectoral Guidelines, 1995; Nigerian Upstream Regulatory Commission (NURC) FOMERLY Department of Petroleum Resources Environmental Guidelines and Standards for the Petroleum Industries in Nigeria (EGASPIN); Part VIII (A) of 2018 as well as other national and International Regulations. Inclusive are Ogun and Oyo State environmental laws, Nipco Gas Limited Community Affairs, Safety, Health, Environment and Security policy. In addition, the project shall comply with the International Finance Corporation (IFC) Performance Standards for Social and Environmental Sustainability standards.

ES2.0 Project Justification

ES2.1 Need for the Project

The proposed project by Nipco Gas Limited is needed to harness the huge gas reserves potential in the project area for the benefit of electricity generation for the various tiers of Government and the populace. The project encourages industrialization and utilization of cleaner and cheaper energy thus reducing the quantum of greenhouses gases obtainable from industrial processes.

ES2.2 Project Benefits

The Project benefits among others are the utilization of natural gas to power gas turbine plants constructed in the southwest of Nigeria. To improve power supply in the project area and to provide cheaper, cleaner and more efficient fuel for the end users in particular and the country in general. To promote the use of natural gas as a substitute for liquid fuel, as well as enhancing environmental status as natural gas is friendly and further boost economic activities within the south west of Nigeria. Encourage gas utilization culture in Nigeria as fuel-of- first-choice; and to offer job opportunities in various categories to a number of Nigerian professionals, skilled and semi-skilled craftsme.

ES2.3 Value of the Project

The value of the proposed gas pipeline project consisting of land acquisition, construction, personnel, equipment, approvals, corporate social operation is put at approximately Twenty Billion Naira (₦20,000,000,000). A higher percentage of the project amount would be injected into the Nigerian economy through contracts, subcontracts and purchase of construction materials and labour.

2.4 Envisaged Sustainability

2.4.1 Economic sustainability

Gas reserves in Nigeria are huge, and can be harnessed and put into commercial use. There is presently high demand for the utilization of natural gas. It is hoped that the project shall be able to generate revenue and contribute substantially to the revenue generation and industrial development in Nigeria.

ES2.4.2 Technical sustainability

This project shall be technically sustainable based on Nipco Gas Limited proven best available gas technology and strict adherence to national, international best practices and standards. The technical sustainability of the proposed project stems from the application of the best available technology (BAT).

ES2.4.3 Environmental Sustainability

The project's activities are guided by national and international environmental regulatory guidelines and standards. The incorporation of the findings and recommendations of this EIA at various stages of the project shall be strictly ensured so as to guarantee that the project is environmentally sustainable. The project is designed and will be constructed to be eco-friendly based on the concept of building with nature (BWN).

ES2.4.4 Social Sustainability

The gas pipeline project has an elaborate Social Action Plan and continued consultation with relevant stakeholders throughout the life cycle of the project. A Grievance Redress Mechanism (GRMs) shall be developed and established for the project to forestall any future disagreement between the proponent and the host community. The social sustainability of the project shall emanate from Stakeholders engagements such as empowerment, employment and business opportunities.

ES2.5 Project Options

ES2.5.1 Do nothing Option

This option would continue the reliance on existing inadequate Power Supply and the use of alternative diesel generators. This alternative was rejected because the present power generation in the country cannot meet the energy demand of industries coupled with the current cost of diesel fuel and the impact on the environment.

ES2.5.2 The 'Delayed' Option

This option is usually taken when conditions are unfavourable to project implementation such as in war situation, or where the host community is deeply resentful of the project. The consequence of any delay is that it would be a discouragement for private/local investors.

ES2.5.3 Go Ahead Option

The option of project development is thus the best of all the possible options considered economically, technologically and environmentally. The construction of the Gas Pipeline Project with the utilization of gas to produce power for electricity is cleaner and more environmentally friendly. Considering the economic viability and the numerous advantages of gas utilization as a source of energy to provide constant supply of power for industries in Nigeria, this option was accepted.

ES 2.6. Project Alternatives

ES 2.6.1 Transportation Alternative

(a) Road Trucking: The shortcomings are the specialty is strong, the transportation goods are too specialized, and the transportation items are limited. Poor transportation infrastructure possesses a high risk to the alternative.

(b) Pipelines: Transmission pipeline industry is an irreplaceable component of our society's infrastructure. The advantages of piping over trucking are: gas can be transported continuously, is not affected by the weather, and has high reliability throughout the day. The pipeline can take shortcuts and the transportation distance is short and the transportation volume is large as well as high environmental benefits and no harmful substances. The energy consumption is small, which is the lowest among various modes of transportation. Safe and reliable, no pollution, low cost while closed transportation can be realized with less loss.

ES 2.6.2 Route Alternative

The three choice routes selected as alternatives in order to choose the most suitable due to availability of adequate land needed, considerably adequate access and least impact with the existing environment. Appropriate site selection in minimizing the associated ecosystem impacts and exploring restoration opportunities of degraded ecosystems aim to preserve the natural ecosystem functioning as much as possibly considering requirements such as habitat connectivity, indigeneity, trophic web integrity, physical-chemical water quality and system resilience. Therefore, all the selection criteria outline above were summarized into three management and decisions components namely availability and Source of Gas, route topography, terrain conditions and accessibility and absence of obstacles.

E3.0 Project Description

ES3.1 Project Components

The scope of work includes Engineering, Procurement & Construction (NGL), and commissioning of the 18" x 55km Gas Pipeline. The highlights of this scope are;

- Engineering design and procurement of materials/equipment
- Mobilization to site
- Survey verification

- Right of Way Survey / Clearin. Pipeline Stacking and Stringing;
- Trenching;
- Welding and Non Destructive Testing;
- Field Joint Coating;
- Holiday Detection;
- Lowering;
- Horizontal Directional Drilling;
- Backfilling;
- Hydrotest, Cleaning and Drying;
- Nitrogen Purging;
- Paint coating of above ground installation
- Commissioning

ES3.2 Project Phases

The various activities of the gas pipeline operation can be divided into phases:

1. Pre-Construction/Mobilisation phase;
2. Construction phase;
3. Operation phase; and
4. Decommission phase

ES3.3 Project Schedule

The gas pipeline which is proposed to commence operation in June 2023 with construction phase expected to last twelve (12) months provided no hiccups are experienced along the way. The duration of the project is from Q4 2022 (completion and approval of EIA) to Q4 2023 (commissioning).

ES4.0 Baseline Environmental Conditions

ES4.1 Study Approach

The EIA Biophysical study was based on existing information of the study area, site-specific data gathering fieldwork and laboratory analysis of samples judgmental sampling was applied in the selection of study stations, taking into account ecological features, geographical location of communities and past studies in the study area. A total of 30 stations for soil and air quality/noise plus 2 controls were examined, 2 stations for surface water and sediment with 2 controls. A total of 5 groundwater stations and I control were sampled. The baseline was produced based on a one-season (wet season) field exercise carried out between 8th and 30th September, 2022. Past approved FMEnv Environmental Impact Assessment study reports within the project area served as second season (Dry Season) for biophysical parameters.

ES4.2. Bio-Physical Environment

ES4.2.1 Climate and Meteorology

During the period of environmental survey, five key microclimatic variables were monitored and their average records were 29.0 °C, 68%, 3.80 m/s, SW 1045 mbar and 0.95 mm for ambient temperature, relative humidity, wind speed, wind direction, atmospheric pressure and rainfall amount, respectively. The dispersion dynamics of the lower troposphere within the study environment based on the wind profile was moderate. The microclimatic pattern during the course of field observations shows moderate sunny situation, light rain, moderate cloudy and light wind condition dominated the entire environment. The study area features Koppen's Aw tropical wet climate. The study environment is situated in the Bi-modal rainy climate zone, with first phase occurring from May to July and other phase from September to November when the zone of moisture discontinuity reverses southward. The dry season is from December to February/mid-March. Monthly rainfall for 30 years (1990-2022) for the study environment shows that June, July and September are the peak rainy periods, while that of the dryer months December-January falls below 25 mm. The highest maximum temperature for the area was in December i.e. 31.6°C and lower in July-September i.e. 27°C. The south-westerly wind is the prevailing wind direction between February and November, while the northeasterly prevails between December and January. The average annual wind speed for the area is between 2-4 m/sec while relative humidity is high all-round the year i.e. a range between 77-88%.

ES4.2.2 Air quality

The noise levels measured for the entire project environment ranged from 45-70dB(A). The average ambient air quality for the study area monitored shows that there are no significant levels of suspended particulate matter i.e. $PM_{2.5}$, and PM_{10} (between 4-45µg/m^3) for all the stations sampled. Records show that the national, WHO and World Bank acceptable limits were generally not exceeded. Average records of other air quality parameters indicates Nitrogen (<0.2 ppm), sulphur dioxide (<0.1 ppm), carbon monoxide (1-6 ppm), VOC (<0.1-1 ppm), CH4 (< 3 ppm), while hydrogen sulphide (H_2S) and ozone (03) were <0.1 ppm.

ES 4.2.3 Aquatic Environment

ES4.2.3.1 Surface water

There are major rivers in the study area called river Olomo and Ogunmakin in Ogun State stretch and river Ona in Oyo State Stretch. The drainage pattern typical of the study area is trellis which is controlled by the structures. All surface water sampled was fresh water bodies. The pH values of the surface water system in the area fluctuated between 6.2 and 9.4 with mean value of 6.8 in wet season and the mean value was 6.55 in the dry respectively. These values reveal that the waterbodies studied were neutral in nature during both seasons as there are no much activities going on around the waterbodies and shows no significant seasonal variation in the pH values. There wasn't trace of petroleum hydrocarbon in the waterbodies in both seasons because the levels were generally below the detection limit (0.01mg/l) of the employed analytical instruments.

Electrical conductivities value of 213µS/cm in the dry season while a range of 74 – 89µS/cm with an average value of 81.8µS/cm was recorded in the wet season. The mean BOD values of 0.84 mg/l and 4.20m/l were recorded in wet and dry season respectively. These values were below the FMEnv maximum permissible limit of 10.0mg/l stipulated for an Aquatic environment. Surface water nutrients, particularity dissolved Phosphate, Nitrate and Sulphate were of the mean concentrations of 0.1 mg/l, 0.48mg/l and 2.0mg/l respectively in the wet season and 2.10mg/l, 1.64mg/l and 11.10mg/irrespectively in the dry season. Heavy metals ions were practically low/absent in the waterbodies in both seasons, as their concentrations were below the respective detection limits of the analytical instruments except for Iron in wet season with average value of 1.655mg/l and 0.41 in dry season.

In Aquatic ecosystem, the sediments act as sink and therefore preserve or retain the quality of the environment. The pH value of the sediment was generally acidic with values which varied from 5.3 -5.82 in the wet season with mean pH value of 5. Redox potential (mV) with average values of 138.2mV wet season value ranges from 122 - 171 mV. The nutrients were moderate in concentration, with mean values of 0.64mg/kg for available phosphate, 56.8mg/kg for chloride, 11.0mg/kg for the sulphate, 18.8mg/kg for Carbonate and 1.26mg/kg for nitrate in the wet season. Iron recorded the highest concentrations, amongst other metals determined in sediment as its values ranged from 1596.8 - 4994.5mg/kg (mean value of 3274.92mg/kg) in the wet season.

ES4.2.3.2 Groundwater

The groundwater in the project area can be regarded as deep groundwater contained within the topmost 9-12 m from the ground level based on the hydrogeological characteristics. The weathered basement and the fractured basement columns constitute the main Aquifer unit; in a typical basement complex environment. The major source of Aquifer recharge in the project area is surface precipitation (rainfall). Additional recharge is through base flow. The pH levels of the groundwater with values varying from 5.9 — 8.7 and 6.56—6.91 in wet and dry seasons with average of 6.8 and 6.67 respectively. Total Dissolved Solids (TDS), salinity, nitrate, and sulphate were within their respective FMEnv limits. The groundwater was free of both petrogenic and biogenic hydrocarbon pollutants as oil & grease and THC levels were below the analytical instruments' detectable limit of 0.001mg/i. The values recorded for both season were relatively lower probably due to dilution from availability of rainwater. The total heterotrophic bacteria and fungi were moderate in population densities. The presence of coliform bacteria, particularly faecal coliform, in both wet and dry seasons is indicative of groundwater pollution.

ES4.2.5 Soil

The soil porosities were of the mean values of 0.35 for both top and bottom soil in the wet season respectively. Similarly, the project area soils could be classified as fairly permeable, with values which exceeded not soil permeability critical level of 0.15 cm/s for a farmland. In the south western, Nigeria the soil drainage varies from well drained to poorly drained soil. The soil in Ogun State is observed to vary from well drained to somewhat poorly drained, some areas varies from moderately to poorly drained to very poorly drained. In Oyo state, it is observed that the soil in the east varies from well drained to very poorly drained soil; in the west, the soil is shown to be moderately well drained

In the topsoil, soil reaction (pH) in the wet season were generally acidic with values ranging from 4.25 - 8.15 and mean value of 5.90 while the dry season, the pH values ranged from 6.68 - 6.91 with mean value of 6.73 respectively. Similarly, the bottom soil pH values ranged between 3.45 and 8.40 with mean value of 5.82 in the wet season and varied from 6.66 - 6.79 with mean value of 6.73 in the dry season. Soil reaction (pH) in the wet season were generally acidic with values ranging from 4.18 - 8.05 and mean value of 5.85 while the dry season, the pH values ranged from 6.68 - 6.91 with mean value of 6.73 respectively. Similarly, the bottom soil pH values ranged between 3.98 and 8.11 with mean value of 5.76 in the wet season and varied from 6.66 - 6.79 with mean value of 6.73 in the dry season. Soil around the proposed Gas pipeline route after Ogere Sagamu, Ogun state were measured to be more acidic with lowest pH value of 3.98 and 4.18 respectively while the highest pH value was recorded around Toll Gate, Ibadan, Oyo state with values of 8.20 and 8.41 respectively

ES4.2.6 Vegetation

A total of sixty-four (64) tree/shrub species were encountered and enumerated. In consideration of the tree/shrub species along the Oyo state stretch of the proposed gas pipeline project, a total of forty-one species were encountered which were within twenty- two families. The herbaceous species encountered along the proposed gas pipeline project were considered generally as they exist in turf. They are highly contiguous and overlapping across project area. However, a total of forty- eight species of herbs were identified and documented. In the study area, a total of forty-two wildlife species were observed to be existing in the area. In relation to the impact of the project, vegetation loss, habitat fragmentation, biodiversity and ecosystem disturbances are possible outcome, therefore, it is recommended that the project should be restricted to the areas approved for the project without further encroachment into very fragile and adjoining ecosystems as to reduce ecological disequilibrium or upset along Lagos-Ibadan Expressway.

ES4.2.7 Wildlife

Several wildlife species were observed to be existing in the area in spite of the high level of habitat fragmentation and human encroachment into their habitats and niches. From the field observations, taking into cognizance the focus group discussions, oral interviews, semi structured interview and adoption of surrogate measures through ground truthing and observations, it was observed that some very common wildlife species are present in the area such as *Naja nigricolis, Agama agama, Rsittusfrstbes, Thyonomis swinderianus, Cricetotiys gambianus, Varanus niloticus, Milvus migrans, Ploceus detipiens, Atheruras africanus* and *Python regius etc.*

ES4.2.8 Geology/Hydrogeology

ES4.2.8.1 Geomorphology

The project area falls within the Precambrian Basement Complex of Southwesten Nigeria composed of migmatite-gneiss complex; slightly migmatised to unmigmatised paraschists and metaigneous rocks; charnockitic rocks; older granites and unmetamorphosed dolerite dykes, pegmatites and quartz veins. The southwestern Nigeria is made up of rocks which are mainly Precambrian in age. The study area belongs to the Precambrian Basement complex of southwestern Nigeria which lies to the rest of the West African Craton in the region of late Precambrian to early Paleozoic orogenesis. The Nigeria basement complex extends westward and is continuous with the Dahomeyan of the Dahomey — Togo - Ghana region to east and the south Mesozoic recent sediments of Dahomey and Niger coastal basins over the basement complex.

ES 4.3 Socioeconomics

ES 4.3.1 Community History, Religion and Social Organisation

An estimated two hundred (200) people made up of indigenes, residents, women, men and youths were randomly interviewed. A total of two hundred (200) questionnaires using the simple random method were distributed filled and 170 were retrieved. This was done to validate and/or complement the information given by the general respondents. The smallest social unit in each of the communities is the individual households, headed by a male (very few households are headed by women) with a wife/wives and children. Christianity is evidently the dominant religion in all of the project communities. A handful of the inhabitants still practice the "Traditional African Religion (ATR). Two levels of governance structures can be identified in the project area communities; the formal governmental and the local/traditional administration. 70% of the sampled population across the affected communities is married.

ES4.3.2 Public Consultations

Community members agreed that the proposed project activities have the capacity to impact them negatively in more ways than one, but they are also hopeful that increased employment opportunities, social infrastructural development accruable from the development activities if properly executed shall compensate for the negative externalities. Their suggestions therefore, were tailored towards the improvement of their socioeconomic conditions and lessening of the negative impacts on their livelihoods and health

E.4.4. Human Health Environment

ES4.4.1 Health Care Facilities

Over 70% of the people have access to Primary health care, the findings do not reflect a corresponding use of these facilities as expected. Primary health care facilities ought to be the first point of contact with the national health care system. Prevalent disease was basically malaria (76.2%). Majority (85%) of the houses in the communities are made from cement block with zinc roof while 15% are made from mud wall and zinc roof. Majority of the people deposit their refuse in locations near the houses in dustbins or waterway. Incineration of solid waste is common in the communities. Sewage disposal is mainly through pit latrine while others use modem toilet facilities.

ES5.0 Associated and Potential Impacts

The anticipated associated and potential impacts of the proposed project activities on the biophysical environment were identified based on the interaction between project activities and environmental sensitivities.

Significant Positive Impacts

- Promote the use and commercial capacity of Gas;
- Vegetation clearing will take place and may lead to loss of some vegetation. However, this shall be restricted to the Work, acquired right of way and additional areas essentially needed for the development.
- Biodiversity: The project area is rich in plant and animal life as revealed by the list of species. Some of these organisms will be displaced or even killed at worst. The overall impact will be minimized by restricting habitat fragmentation and bush clearing to strict dimension. However, none of the species is classified as endangered or rare neither is there any biodiversity Hotspot nor Important Bird Area (IBAs) within the ROW.
- Create employment opportunities at various levels;
- Support significant associated community development projects, offering immediate and sustained benefits to the surrounding communities;
- During construction local spending will increase, thereby benefiting the surrounding communities Negative Impacts

- Land Use: During the pre-construction phase Survey lines shall be selected carefully to avoid social and agricultural resources. Arrangement shall be made to compensate landowners and farmers with agreed sum for both land and economic crops promptly. No community shall be displaced.

-

- Surface and Ground waters: Rivers may be partially polluted by unproperly disposed waste or spill runoff.

- Road Traffic: The total vehicular traffic loading generated by surveying and construction activities will be relatively high and significant. Construction traffic particularly frequent lorry and truck movements may be disruptive and could create significant environment impact. There may be accidents and traffic disruptions as a result of careless driving, and inappropriate road crossings by trucks, lorries and bulldozers

- Soil: Clearing of the vegetation would cause increase in soil temperature, fluctuating moisture regimes, erosion pattern and topographic changes.

- Air Quality: Short-term air quality degradation may result from construction related operations, and vehicular traffic loadings. Airborne particulates could result from soil disturbance during construction activities. All diesel-powered equipment such as power generators, bull-dozers, trucks and heavy machineries would emit SO_x, CO_2, CO, NO_x, and other hazardous gases. These combustion gases can cause air pollution problems and health related hazards.

- Noise and Vibration: Construction activities and relatively high volume of traffic will generate considerable amount of noise, which may exceed the national exposure limit of 90dB (A) daily for 8- hour working period. Human receptors will be construction crew and nearby communities. Continuous exposure may cause hearing impairment.

- Socio-economic: The project activities will result in significant population increase if most of the personnel recruited are from outside the project area and the underlisted negative impacts may manifest:

E6.0 Mitigation measures

Mitigation measures have been developed for the identified negative environmental impacts. Necessary measures shall be put in place during construction phase to ensure health of workers and environmental safeguard and to minimize the risk of possible incident. The slight increase in dust emissions from construction activities will be properly addressed by spraying water in construction sites to reduce powder dispersion. The construction activities will be carried out, also, in accordance with applicable regulations on noise. The major increment in vehicular movements will occur during construction phase, however, the Project will have minor effects on the existing vehicular transit on main road axes. Temporary and occasional impacts on vibrations are expected, but considering the distance between the project site and other premises and nearness to water body there are limited sensitive receptors at risk of project vibrations. Minor impacts on wildlife are expected and time limited, associated to diurnal hours. Current fruition of the existing fauna will not change. Waste production during construction phase will be managed by the regulatory procedures. A negligible population increase by the near host communities associated to the realization of the Project is expected. Dedicated policies and actions will be adopted to safeguard the host communities from impacts due to the influx of workers, however the host communities will particularly benefit of the increase of both direct and indirect employment.

During operation & Maintenance phase all the necessary measures to ensure health of workers and environmental safeguard and to minimize the risk of possible incidental will be put in place. No significant effects are expected on air quality during operation phase, since the pollutants concentrations at ground level will be in compliance with air quality regulatory/standards guidelines and with occupational exposure limit values. The initiative will not positively increase air pollutants emissions into the atmosphere likely to negatively affect the existing quality of ambient environment around the complex. The project has a negligible health impacts on host communities. The same population increment by the near host communities will be managed in a proper manner to safeguard the health of host communities deriving from possible exposure to infective/transmissible diseases. Also an acceptable increase of vehicular traffic is expected and will be adequately managed with established Traffic management plan in order to minimize possible socio economic impacts and potential associated hazards.

E7.0 Environmental Management Plan

Environmental Management Plan (EMP) The EMP for this Nipco Gas Pipeline Project has been developed to meet long term objectives of the project activities and operations. The EMP is designed to guarantee and achieve the implementations of the ETA findings highlighted in this report through the provision of project execution and maintenance guidelines, audit procedures, waste management plan, monitoring programme, resource requirements, responsibilities and training procedures. The project execution guidelines cover areas such as waste management and contingency and monitoring plans. The management plan includes strategies to enable proactive resolutions of the environmental and social impacts expected, procedures for training, development of adequate capacity; plans for monitoring environmental, social, occupational and health issues as well as management of the effects of the impacts and minimization of the risks, parameters to be measured/monitored, frequency and location of monitoring. Interface with supervising regulatory authorities are enshrined in the environmental monitoring programme.

E8.0 Remediation Plan after Decommissioning/Closure

The gas pipeline in the event of shut-down will progress through decommissioning, remediation and redevelopment. The site reuse options though not always possible, helps to know early in the process to inform clean-up decisions and determine the appropriate level of work needed in each stage of the assessment, clean-up and redevelopment process. Nipco Gas Limited shall develop a strategy for managing the decommissioning process that serves his or her business needs. Remediation shall start with collection of Biophysical samples to investigate and document any contamination. Plan for clean-up shall be developed and established once approved by Federal Ministry of Environment.

E9.0 Conclusion and Recommendation

The environmental impact assessment has identified the adverse environmental, social and health impacts associated with the gas pipeline project. The implementation of the proposed mitigation measures and strict adherence to the environmental management plan shall guarantee the environmental sustainability of the project. The economic, social, technological and environmental gains for the local community and governments (LGA, State and Federal) from the gas pipeline project and for Nipco Gas Limited outweigh any residual impacts. The EIA has demonstrated that the overall impacts associated with the Gas Pipeline Project can be managed within reasonable and acceptable limits by applying all recommended mitigation measures. The EIA study has not detected potential adverse impacts of sufficient magnitude to interrupt the execution of the project. However, the assessment recognized the need to incorporate environmental considerations into every stage of the proposed project. This will ensure the rational use of natural resources, minimize the potential impacts on the environment and promote development policies that are sustainable.

CHAPTER ONE

INTRODUCTION

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1.1 Background Information

The increase in the availability of electric power shall play significant roles to improve quality and reliability of electricity supply within the country ensuring sustainability of the entire operations of the electricity industry within the country, boost economic activities through availability of reliable energy to power homes and business activities and bridging the gap in the demand for electricity required by the huge commercial activities in the immediate environs. With the present tremendous increase in the electricity demand from the industries within the project area, potential to generate needed revenue for government and employment for the youths Nipco Gas Limited Plans to grow the Gas sale network grid consistent with the commitments of the FGN Gas master plan to stimulate the multiplier effect of Domestic gas utilization for third party gas off-takers and guarantee gas security around Nigeria's South Western corridor. This opportunity will be delivered through the construction of a 55 km of 18" gas pipeline from Yalli Foods Limited (Ogun State) through Lagos-Ibadan Expressway to Ibadan Toll Gate (Oyo State) main line serving as a backbone to supply and provide natural gas through spur lines to third party gas off-takers and other future customers within the axis with clean energy to drive accelerated business growth and industrialization along this corridor. Once completed, the project is expected to meet the increasing demand for supply of gas and most importantly complement the Federal Government's efforts in boosting the power supply capacity of the country, hence bridging the power supply gap in the country. It will also boost revenue earnings accruing to all tiers of government.

1.2 Proponent

Nipco Gas Limited is an experienced and relaible Nigerian company licensed to carry out independent Power generation. It has its headquarters at 15 Dockyard Road, Apapa, Lagos State Nigeria. Nipco Gas is principally engaged in the business of acquiring, developing, owning, and operating Compressed Natural Gas distribution system. In March 2007, NIPCO Plc made its presentation of its CNG project to the Inter-ministerial team of the Federal Government. In the same month FG accorded it's approval to commence the proposed project at Benin City. NIPCO Gas was formed as

Joint Venture Company between NIPCO and Nigerian Gas Company Limited (NGC) to implement the CNG project.

Currently NGC which is subsidiary of NNPC owns 55% of equity while NIPCO owns the balance 40% equity. NIPCO Gas has established 15 CNG running stations in Benin to provide an alternative for the Gasoline run automobiles. Presently it is in the process of constructing further 15 stations in and around Benin City. More than 5,600 vehicles have been converted to CNG for motorist in and around Benin City. As a result, nation's economy is strengthened as Gasoline imports are reduced.

Impressed with the impact of CNG in Benin, FG directed NIPCO Gas to expand its operations into other parts of the country. Hence a mega CNG station was commissioned at Ibafon, Ogun state, to convert automobiles to CNG as well as to supply nearby industries. Presently NIPCO Gas owns about 67 CNG cascades to ease CNG supply and distribution to industries in Ibafon axis. The Ibafon CNG station along with a city gas station has a larger compressing facility (12,000 scmt) for loading CNG to the nearby industries.

Nipco Gas Limited proposes to carry out an Environment and Social Impact Assessment (ESIA) study of the engineering, construction, operation of the proposed project in compliance with its corporate policy on environmental protection, the Nigerian Upstream Regulatory Commission (NURC) formerly Department of Petroleum Resources (DPR), Federal Ministry of Environment (FMEnv) guidelines on EIA for projects of this nature and the environmental and safeguard requirements of International Finance Corporation's guidelines on EIA. Nipco Gas Limited has secured the services of a reputable ESIA Consultant – Diskol Environmental Consulting Limited to perform the ESIA study. The ESIA study has been be designed in line with the procedures provided in the PART VIII of Environmental Guidelines and Standards for Petroleum Industry in Nigeria (EGASPIN, 2018).

1.3 Project Location

The project is located in South West region of Nigeria which is one of the geopolitical zones of Nigeria. The zone is not entirely carved based on geographic location but also states with similar ethnic groups and/or common political history classified in the same zone merged together for effective allocation of resources. The study area spanned across two different states namely Ogun and Oyo States in the South western region of Nigeria (Figure 1.1), proposed to take-off from the Yaali Foods Limited area of Sagamu, Ogun state and terminate at Toll Gate Area of Ibadan in Osun State covering a total distance of 55 kilometres. The areas where the adopted routes transveres is covered mainly by patches of derived savanna, guinea savanna, plantations, farmlands, riparian forest, anthropogenic climax forest ecosystems, grasses forming patches of herbaceous species and a mosaic of cultivated crops (cultigens). The topography of the area was undulating but generally relatively gentle sloping hills and valleys. The water bodies (streams/rivers) within the area were mainly freshwater streams and swamps.

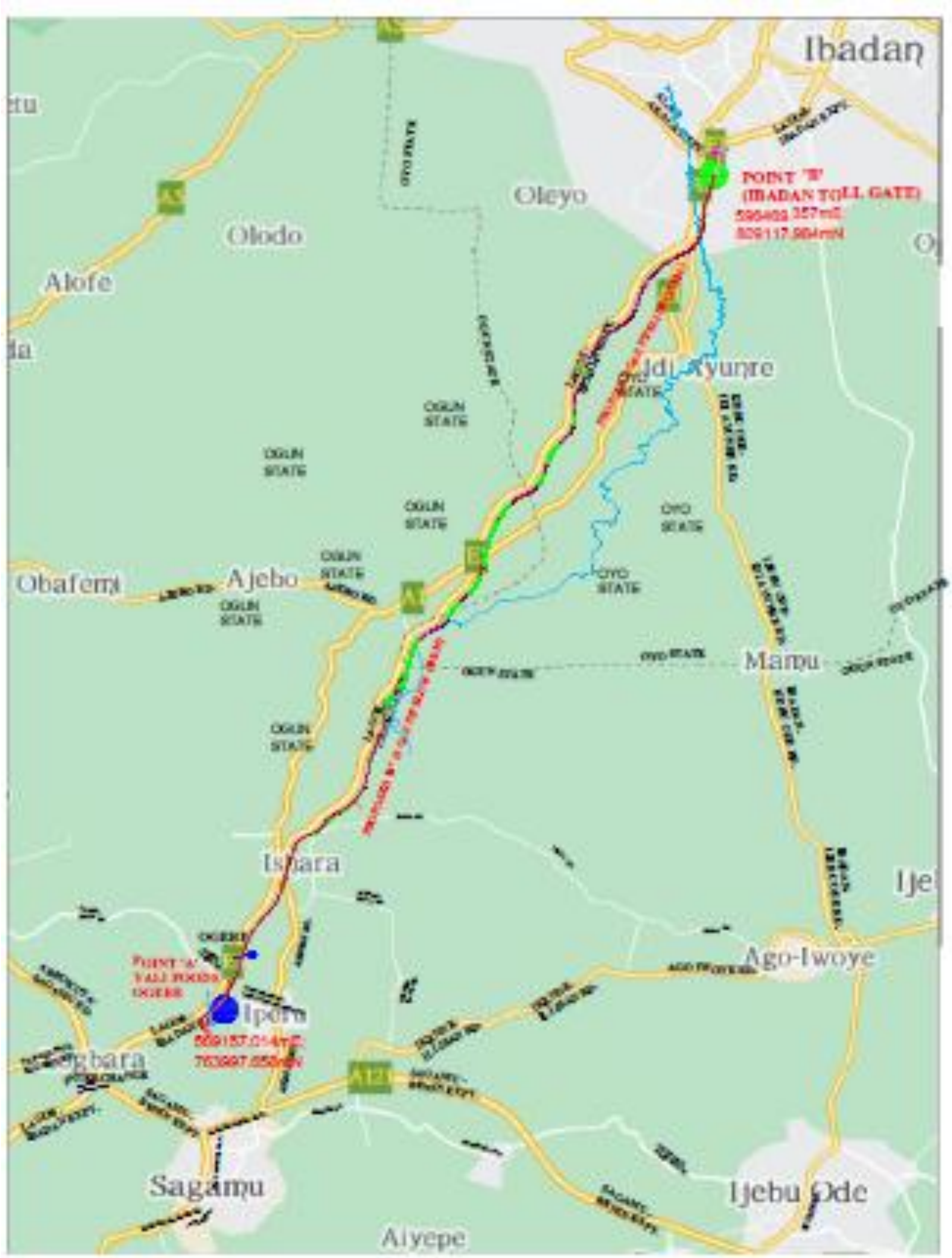

Figure 1.1: Map of proposed gas pipeline route

1.4 Objectives of the EIA

The objectives of the EIA study are to:

- Determine the baseline conditions of the environment (biophysical, socio-economic and health);
- Determine and evaluate the potential significant positive and significant negative impacts of the gas pipeline project activities on the identified environmental sensitivities as well as the interactions between the sensitivities in relation to the biophysical, socio-economic and health aspects of the receiving environment;
- Proffer cost-effective mitigation measures for the negative impacts, and where possible, enhance the positive impacts that will further assure the environmental, technological, economic and social sustainability of the project;
- Integrate the opinions and views of all stakeholders particularly host communities into the project in order to ensure that the gas pipeline project is both environmentally and socially sustainable;
- Develop an appropriate and cost effective Environmental Management Plan (EMP);
- Incorporate the recommendations of the EIA process into detailed project decisions.

1.5 Scope of the EIA

The general scope of the EIA covers all the activity that constitutes this project. It will outline the techniques and methodologies to be used in generating data, including the description of the data sources. The following broad categories were covered:

- Literature review;
- Baseline data acquisition;
- Prediction and evaluation of potential impacts;
- Determination of appropriate mitigation measures;
- Environmental management plan;
- Consultation/stakeholder engagement;
- Report preparation.

1.6 Benefits of the EIA

The advantage or gains of conducting an EIA will among other things include:

- Obtaining authorization required by regulatory authorities prior to commencement of the gas pipeline project;
- Providing a forward planning tool for proper environmental accounting with other issues early enough, so as to allow for important decisions to be built into the project design;
- Serves as an adaptive, organizational learning process, in which the lessons of experience are feedback into policy, institutional and project design - enhancement of positive aspects;
- Providing a designing tool that will allow a systematic evaluation of potential environmental problems and risks from the proposed activity and identification of key issues that require special consideration for effective environmental management and controls;
- Guides formal approval, including the establishment of terms and conditions of the gas pipeline project implementation and follow-up;
- Incorporate stakeholder analysis by involving all stakeholders through consultation so as to address common problems, impacts and mitigation measures that might be proposed; and
- Informing and assisting management with a view to establishing and achieving long term management objectives and plans associated with specific activities, in order to minimize associated financial and environmental risks.

1.7 FMEnv EIA Premises/Process

The key premises that affect EIA process were established from the initial stages of the project and have provided the general guidance, framework, and commitment to standards acceptable nationally and internationally. The premises include:

- The area is within the exclusive jurisdiction of the Federal Government of Nigeria. Therefore, Federal laws, including the Environmental Laws apply;
- The project recognizes the laws and regulations of the Federal Republic of Nigeria as represented by the Federal Ministry of Environment, the State and the Local Governments Environmental Agencies, and insist that best options will be adopted for the project execution;

- The work will be designed and operated to comply with local, national laws and guidelines together with all the international protocols, agreements and conventions which Nigeria is signatory to;
- The agreements and understanding reached with third parties including government officials during the course of the EIA process will be respected and honoured;
- Extensive consultations have and will continue to be held with Federal, State, and Local Governments together with the host communities and
- An Environmental Management Plan (EMP) was developed and shall form the cornerstone for managing the significant impacts.

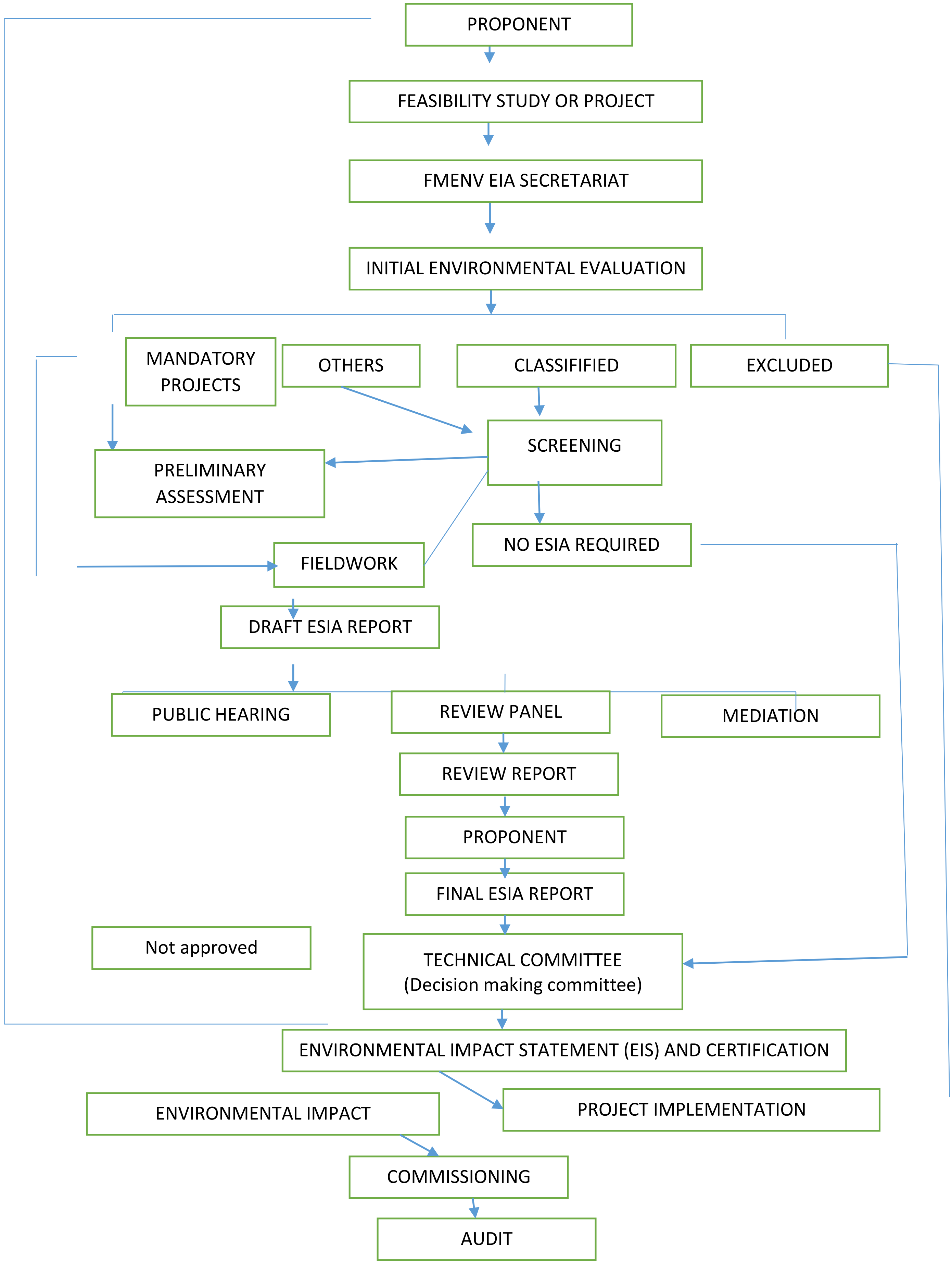

Figure 1.2: Flow Chart of the FMEnv EIA Procedure

(*Source: EIA Procedural Guidelines, 1995*)

1.8 Policy, Legal and Administrative Framework

Operations and all forms of development activities in the Oil & Gas Exploration and Production - Onshore sector are regulated by several specific laws, guidelines, and standards. These statutes together with applicable International Conventions and with company Health, Safety and Environment (HSE) Policy provide a basis for the EIA of the 160km x 12" gas pipeline project.

1.8.1 Federal Regulations/Guidelines

1.8.1.1 The Environmental Impact Assessment Act CAP LFN E12 2004

The Environmental Act makes EIA mandatory for all new major public and private projects in Nigeria. It sets out to:

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

1.8.1.2 National Environmental Protection (Effluent Limitations) Regulations (S.I.8) of 1991

This regulation makes it mandatory for industries generating wastes to install anti-pollution and pollution abatement equipment on site. The regulation is specific to each category of waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystems. Appropriate penalties for contravention are also specified in the regulation.

1.8.1.3 National Environmental Protection (Pollution Abatement in Industries Producing Waste) Regulation (S.I.9) of 1991

The National Environmental protection (Pollution Abatement in Industries Producing Waste) Regulation of 1991 regulates the release of toxic substances, requirement for pollution monitoring unit, machinery for combating pollution and contingency plan by industries. It also provides that industries producing wastes should submit lists and details of chemicals used by such industries to FMEnv as well as permissible limits of discharge into public drains.

1.8.1.4 Federal Ministry of Environment (FMEnv) National Guidelines for Environmental Audit in Nigeria 1999.

Guidelines prepared by Federal Ministry of Environment to assist operators, environmentalists and other stakeholders to conduct effective environmental compliance audits.

1.8.1.5 Guidelines and Standards for Environmental Pollution Control in Nigeria 1991

The FMEnv Guidelines and Standards for Environmental Pollution Control in Nigeria Part I, Chapter 2 contains the water quality guidelines for various industries. Section 2.2 of the same chapter states requirements for water and wastewater monitoring. The Ministry requires that industries monitor their effluents in-house while FMEnv will also crosscheck the effluent characteristics to ascertain the degree of compliance with the guidelines. Contained in Chapter 3 are interim gaseous emission and ambient air quality limitations. Section 3.1 of this chapter states "Guidelines for emission limits from stationary sources represent maximum allowable levels of pollutants from a site, process, stack, vent, etc. with the objective of achieving a desired air quality". The prescribed emission limits depend on social and political considerations.

Section 3.2 pertains to ambient air standards and states. "Since emissions from industries and other sources have impact on ambient air, it is of utmost importance to prescribe guidelines for safe levels of air pollutants tolerable to humans, Aquatic organisms and vegetation". Guidelines for Nigerian ambient air limits for conventional pollutants and specific substances in the air are listed.

1.8.1.6 The National Environmental Protection Management of Solid and Hazardous Wastes Regulations (S.I.15, 1991)

Management of Hazardous and solid wastes regulation defines the requirements for groundwater protection, surface impoundment, land treatment, waste piles, landfills, incinerators, etc. It also describes the hazardous chemical products and dangerous waste constituents.

This Regulation provides that the objective of solid and hazardous waste management shall be to:

- Identify solid, toxic and extremely hazardous wastes dangerous to public health and environment,
- Provide for surveillance and monitoring of dangerous and extremely hazardous wastes and substances until they are detoxified and safely disposed,
- Provide guidelines necessary to establish a system of proper record keeping, sampling and labelling of dangerous and extremely hazardous wastes,
- Establish suitable and provide necessary requirements to facilitate the disposal of hazardous wastes;
- Research into possible re-use and recycling of hazardous wastes.

1.8.1.7 Forestry Law, CAP 51, 1994

The Forestry Act 1958 which was amended as the Forestry Law CAP 51(1994) prohibits any act that may lead to the destruction of or cause injury to any forest produce, forest growth or forestry property in Nigeria. The law prescribes the administrative framework for the management, utilization and protection of forestry resources in Nigeria, which is applicable to the mangrove and other forests of the Niger Delta.

1.8.1.8 Land Use Act of 1978

This law was enacted on 28th March, 1978, principally to facilitate the availability of development land to individuals, groups, institutions and governments. The law provides for the granting of statutory rights of occupancy over urban land and of customary rights of occupancy over rural land. Both types of rights require the issuance of certificates of occupancy. Furthermore, the law specifies the maximum sizes of land which may be granted to each applicant for various reasons-crop farming (500 ha.); livestock grazing (5,000 ha); quarrying of building materials (400 ha). The law forbids the surrender or alienation of rights of occupancy or even the certificates conveying those rights, except under very stringent conditions.

1.8.1.9 Nigeria's National Health 2014 Act 2014 (NHA)

Nigeria's National Health 2014 Act 2014 (NHA) was signed into law on October 31, 2014. It provides a legal framework for the regulation, development, and management of Nigeria's Health System. This study assessed the knowledge and perception of the NHA 2014 by health professionals.

1.8.1.10 National Environmental Standards and Regulation Enforcement Agency (NESREA) Act 25 of 2007

This National Environmental Standards and Regulation Enforcement Agency was established with the responsibility to ensure the regulated community complies with all environmental laws and regulations in Nigeria.

- **S.1.22 National Environmental (Surface and Groundwater Quality Control) Regulations 2011.**

As the title indicates, it is meant to restore, enhance and preserve the physical, chemical and biological integrity of the Nations water (Surface and groundwater) The waters shall be maintained in a safe and satisfactory condition from all manner of industrial and anthropogenic activities such that the water can be used for various uses spanning from industrial, agricultural, recreation, public water supplies, hydro-energy etc.

- **S.I.26 National Environmental (Wetlands, River banks and lake shores) Regulations, 2009**

The Regulation amongst other objectives specifically relates to this project by (a) ensuring conservation and wise use of the waterbodies, (b) Control pollution of the river (c) ensure that the wetlands of the community are protected as habitats for flora and fauna species.

- **S.I.28 National Environmental (Sanitation and Waste Control) Regulations 2009**

The purpose of this regulation is to ensure that management of the company applies the regulations in all issues of sanitation and all categories of wastes generated by the project. Secondly ensures the adoption of sustainable and environment friendly practices in environmental sanitation and waste management in order to minimize pollution.

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

The Regulation seeks to ensure maintenance of a healthy environment, tranquility of the project surroundings and their psychological wellbeing by: regulating noise levels for optimum standard of living; prescribing maximum permissible noise levels to which persons may be exposed and providing technologies/methods for control, and mitigating measures for reduction of noise.

1.8.1.11 The Petroleum Act CAP Pl0 LFN 2004

Section 22 of the Petroleum Act CAP Pl0 LFN 2004 stipulates that subject to the provisions of all the relevant laws and on such terms and conditions as may be approved by the Minister, the licensee or lessee shall be entitled to such way-leaves for the laying, operation and maintenance of pipelines, telephones and the like through or across the surrendered area or areas as he may reasonably require—

(a) for the carrying on of operations under the licence or lease; or

(b) for inter-communication and passage between retained areas (and, in the case of licences or leases in the continental shelf, between retained areas and onshore lands), and any such way-leaves shall form part or be included in the calculation of the amount of the retained areas.

Section 22 further states that there shall be reserved to the Minister over the retained part such way-leaves, easements or other rights as in his opinion are necessary or desirable for the laying, operation and maintenance of pipelines, telephone lines and power-lines; and any way-leaves or other rights so reserved shall ensure for the benefit of any person or body to whom the Minister may subsequently grant the same to the extent that he may so grant them.

1.8.1.12: Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN), 1991 (Revised 2018)

In 1991, the Nigerian Upstream Regulatory Commission (NURC) formerly Department of Petroleum Resources (DPR) issued the first Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN). These regulations are a comprehensive guide covering all sectors of operation in the oil and gas industry. They have been reviewed and updated since then, with the latest revision published in November 2018.

The DPR Environmental Guidelines and Standards of 1991 (amended 2018) contains in Part VIII (A), sections 3, 4, 5 and 6, the EIA report process, significant effects/impacts, content of an EIA report and environmental screening.

Part VI (A) 3.1 of EGASPIN identifies the sources of wastes associated with pipeline operations, while Part VI (A) 5.1 specifies that licencees/operators shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified issues are brought to an acceptable minimum.

1.8.1.13: The Mineral Oil (Safety) Regulations, 1963

Sections 37 and 40 of the mineral oil (safety) regulations, 1963, require provision of personal protective equipment (PPE) and the safety measures for workers in drilling and production operation in accordance with international standards.

1.8.1.14 Oil Pipelines Ordinances (CAP) 145, 1956 and Oil Pipelines Act, 1965

The oil pipelines ordinance (CAP 145), 1956, as amended by the Oil Pipelines Act 1965 provides under Section 4(2) for a permit to survey (PTS) a pipeline route to be issued to the applicant by the Minister of Petroleum Resources, for the purpose of transporting mineral oil, natural gas, or any product of oil or gas to any point of destination to which such a person requires such oil, gas or product, thereof, for any purpose connected with petroleum trade or operations. Such a survey should include the approximate route or alternative routes proposed, in order to determine the suitability of the land for laying and construction of the pipeline and ancillary installations. Section 15(1) of the Oil Pipelines Ordinance (CAP) 145 prohibits the holder of an OPL to enter upon, take possession of or use any of the following lands unless the occupiers or persons in charge thereof have given their assent:

(a) Any land occupied by a burial ground or cemetery,

(b) Any land containing any grave, grotto, and trees or thing held to be sacred or the object of veneration,

(c) Any land under actual cultivation

1.8.1.15 DPR Requirements

The Department of Petroleum Resources (DPR) facilitates the growth of the oil and gas industry in conformity with legal and other requirements affecting the industry. DPR encourages seismic, exploration and exploitation activities, which boost the national reserves and production level. With regards to environment, the DPR is empowered to ensure that petroleum and other associated industry operators in Nigeria do not degrade the environment in the course of their operations. The DPR also enforces the cleanup of oil spills and restoration of 'impacted' environment to acceptable levels, as well as control new projects that may adversely impact the environment. Thus, the power of supervision over the entire operations of oil and gas industry is vested on NURC. Consequently, NURC requires, by legislation, that holders of prospecting, exploitation, refining, transportation and marketing licenses of petroleum resources take/adopt practical precautions to prevent pollution, and cause as little damage as possible to the environment in their areas of operation. To actualize its mandate, the department developed and issued a set of guidelines and standards for petroleum industry operators in Nigeria - Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN, 1991), revised 2018.

The EGASPIN among others, contain guidelines and requirements for:

- air emissions and gas flaring;
- water effluents;
- management of conventional wastes; and
- decommissioning of facilities.

NURC, which also controls the conception, planning and execution of new projects that may affect the environment, makes the use of EIA mandatory (in many cases) as an environmental management tool and therefore adopts it as an additional enforcement strategy.

1.8.1.16 National Oil Spill Detection and Response Agency (NOSDRA)

The functions of the agency as provided in the Act is essentially to co-ordinate and implement the National Oil Spill Contingency Plan for Nigeria in accordance with the International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC 90). Additionally, the agency is responsible for surveillance/ detection of oil spills in the petroleum sector; monitor reports of oil spillages and co-ordinates response activities throughout Nigeria. Objectives of the Act relevant to this project include the following:

- to establish an organisation that ensures a safe, timely, effective and appropriate response to all oil pollution as well as hazardous and noxious substances in the petroleum sector;
- identify high-risk areas as well as priority areas for protection and clean up;
- ensure funding and appropriate and sufficient pre-positioned pollution combating equipment and materials, as well as functional communication network system required for effective response to major oil pollution;
- provide a programme of activation, training and drill exercises to ensure readiness to oil pollution preparedness and response and the management and operational personnel;
- co-operate and provide advisory services, technical support and equipment for purposes of responding to major oil pollution incidents;
- develop and implement an appropriate audit system for the entire plan;

1.8.1.17 Oil Pipelines Act and the Oil and Gas Pipelines Regulations of 1995

The Oil Pipelines Act and the Oil and Gas Pipelines Regulations of 1995 regulate the right to establish, maintain and operate gas pipelines and ancillary facilities in Nigeria. The Act requires that applications for permit to survey an oil pipeline route be submitted to the Minister for Petroleum Resources. This application shall specify the approximate route or alternative routes proposed for the pipeline to any specified point or destination for purposes connected with petroleum trade or operation. Upon completion of the survey, the holder of a permit to survey may apply to the Minister of Petroleum Resources for an Oil Pipeline License, subject to the payment of the prescribed fees. The license shall entitle the holder and his officers to enter and take possession for use a strip of land of width not exceeding 200 ft (60m) or other such width as may be specified in the license and thereafter to construct, maintain and operate the pipeline and ancillary facilities.

This provision is supplemented by Section 28 of the Land use Act that provides that a right of occupancy may be revoked for making land available for mining purposes or for oil pipelines or for any purpose connected therewith. Nevertheless, the license holder is liable to pay compensation to any person whose land or interest in land is injuriously affected by the exercise of the rights conferred by the license; or who suffers damage by reason of the neglect of the holder or his agent to protect, maintain or repair any work done under the license. Furthermore, the license holder is liable to pay compensation to any person who suffers damage in consequence of any breakage or leakage from pipeline or ancillary facilities. The Oil and Gas Pipelines Regulations of 1995 provides detailed regulations for the design, construction and inspection of gas pipelines. In addition, guidelines are provided in the Regulations for the design and construction of gas transmission and distribution pipelines, procedures for upgrading pipelines or changing of substances transmitted by the pipeline for the discontinuance or abandonment of the pipeline system. The duration of a pipeline license may not exceed twenty years. From the foregoing, the Oil Pipeline Act and the Oil and Gas Pipeline Regulations of 1995 do not require project proponents to conduct an EIA, but only to undertake a route survey. However, integrating the requirements of the Act and Regulations into the framework of the EIA is the most expedient approach to ensuring that all the provisions contained in these statutes are fully complied with. These requirements have been integrated into the Environment Management Plan (EMP) and other relevant sections of this EIA report.

1.8.1.18 Oil Pipelines Act 2006

This Oil and Gas Pipelines Act of 2006, makes provision for licenses to be granted to an applicant for the establishment and maintenance of pipelines incidental and supplementary to oilfields and oil mining and ancillary facilities to such pipelines by the Ministry of Petroleum Resources. The Part II of the Act details the application requirements and procedures to obtain route survey permits and sets the boundaries of what the permit holder can do. While the Part III provides application requirements and procedures for oil pipeline license. It also defines the terms and conditions of the pipeline license, rights/ obligations of the license holder, pipeline and installations disposal, penalties and fines, etc. The requirements, conditions and procedures/guidelines for land acquisition including compensation are contained in Part IV of the Act. It sets restrictions on land acquisition for certain public facilities and provides guidelines on the use of adjoining lands etc.

1.8.1.19 National Gas Policy

The Nigerian gas policy was developed to encourage sustainable development and use of the Nigerian gas.

The policies developed are listed below:

- The nation's gas resources shall be harnessed and optimally integrated into the national economy, energy mix and industrial processes;
- The nation shall engage intensively in gas exploration and development with a view to increasing the reserve base to the highest level possible;
- The nation shall put in place necessary infrastructure and incentives to encourage indigenous and foreign companies to invest in the industry;
- The nation shall put in place necessary infrastructure and incentives to ensure adequate geographical coverage of the gas transmission and distribution network.

The aims of the policies shall be achieved by:

- eliminate the flaring of associated gas in Nigeria;
- expanding the utilization of natural gas as industrial and domestic fuel, as well as for power generation;
- increasing the use of natural gas as industrial feedstock for petrochemical, pharmaceutical facilities, etc;
- using gas to diversify the foreign exchange earnings base of the nation;

- accelerating the process of technology acquisition and diffusion in the gas industry;
- encourage indigenous entrepreneurial capability in the gas industry including the development of end-use devices; and determining the level of gas reserves available to the nation.

Strategies put in place by the Nigerian Government to ensure these aims are achieved are:

- encouraging the oil-producing companies to gather and utilize associated gas to eliminate flaring;
- imposing appropriate and effective penalties to discourage gas flaring;
- encouraging the establishment of the necessary infrastructure for the effective gathering, transmission and distribution of gas nationwide;
- formulating suitable urban and regional planning regulations needed for the effective distribution of natural gas to, and its utilization by, domestic and industrial consumers;
- providing necessary incentives to indigenous and foreign entrepreneurs to facilitate their participation in the gas industry;
- providing incentives to encourage industrial and domestic consumers to use gas or to convert to gas;
- providing incentives to encourage the introduction and use of LPG appliances in areas not accessible to natural gas to encourage the consumer preference for gas;
- establishing a suitable infrastructure for the export of natural gas;

In line with the National Gas Policy, the Gas Master Plan was developed and approved by the Federal Executive Council to provide a framework for Nigeria to maximize value from its gas resources through leveraging the multiplier effect of gas in the domestic economy and optimizing Nigeria's share in the high-value export market.

The Nigerian Gas Master Plan is hinged on 3 critical elements, which are:

- gas pricing policy;
- domestic gas supply obligation; and
- gas infrastructure blueprint

1.8.2 State Regulations

1.8.2.1 Ogun and Oyo State (s) Environmental Laws

The Nigerian Constitution allows States to make legislation, laws and edicts on the environment. The EIA Act CAP E12 LFN 2004 recommends the setting up of state environmental agencies/ministries to participate in regulating the consequences of project development on their environment.

The state Agencies functions include among other things to:

- Advise the Government on State environmental policies, priorities, scientific and technological activities affecting environment and ecosystem in the State;
- Monitor and survey water including ground water, air, land and soil environments and ecosystem and determine pollution levels and collect baseline data from them
- Conduct pre and post environmental impact assessment of projects and make recommendations for corrective measures;
- Based on above, the EIA will be conducted in accordance with regulation of all the states and FCT as stated below:
- The regulations, guidelines, and standards of the State(s) ministries of environment

1.8.3 Local Government Council Regulations

Local Government Councils develop and establish bye-laws relating to environmental sanitation activities including waste management within its jurisdiction. The Local Government Council as the third tier of Government also helps to implement Federal and State laws within its jurisdiction.

1.8.4 International Conventions and Guidelines

Nigeria has ratified or acceded to numerous International treaties and conventions, as described below:

1.8.4.1 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979)

The Bonn Convention concerns the promotion of measures for the conservation (including habitat conservation especially for endangered species listed in Bonn's) and management of migratory species.

1.8.4.2 Convention on Biological Diversity (1992)

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

1.8.4.3 Convention Concerning the Protection of the World Cultural and Natural Heritage Sites (or World Heritage Convention, 1978)

The convention sets asides areas of cultural and natural heritage for protection. The latter is defined as areas with outstanding universal value from the aesthetic, scientific and conservation points of view.

1.8.4.4 Basel Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal (1987)

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

1.8.4.5 United Nations Framework Convention on Climatic Change (1992)

In order to achieve sustainable social and economic development, development in developing countries needs to grow taking into account the possibilities for achieving greater energy efficiency and for controlling greenhouse gas emissions in general. This also includes the application of new technologies on terms that made such an application economically and socially beneficial, determined to protect the climate system for present and future generations.

1.8.4.6 International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines (1996)

The World Conservation Union — IUCN Red List of Threatened Animals provides taxononiic, conservation status and distribution information on species that have been evaluated using the IUCN Red List categories. This system is designed to determine relative risk of extinction and the main purpose of the red list is to catalogue the species that are regarded as threatened at the global level i.e. at risk of overall extinction. The 1996 red list also included information on species that are categorized as extinct; on species that cannot be assessed because of insufficient data; and on certain species in the lower risk category. Nigeria, as a member of this body, categorizes species using the red list.

1.8.5 World Bank's Safeguard Policies

The objective of the World Bank's environmental and social safeguard policies is to prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for bank and borrower staffs in the identification, preparation, and implementation of programs and projects. Safeguard policies have often provided a platform for the participation of stakeholders in project design, and have been an important instrument for building ownership among local populations. (World Bank, 1999-2006). Aligned objective of the World Bank's environmental and social safeguard policies is to prevent and mitigate undue harm to people and their environment in the development process. They are a cornerstone of its support to sustainable poverty reduction. Recognizing the paramount importance of safeguard policies, the Agency/Bank is making major efforts to further strengthen their implementation.

- **World Bank Safeguard Policy 4.01-Environmental Assessment**

The environmental assessment process provides insights to ascertain the applicability of other World Bank safeguard policies to specific projects. This is especially the case for the policies on natural habitats, pest management, and physical cultural resources that are typically considered within the EA process. The policy describes an environmental assessment (EA) process for the proposed project. The breadth, depth, and type of analysis of the EA process depend on the nature, scale, and potential environmental impact of the proposed project. The policy favors preventive measures over mitigatory or compensatory measures, whenever feasible.

Triggered (Yes/No): YES

- **Bank Safeguard Policy 4.04-Natural Habitats**

This safeguard policy requires that the study use precautionary approach to natural resources management to ensure environmental sustainability. The policy requires conservation of critical habitat during project development.

Triggered (Yes/No): YES

- **Bank Safeguard Policy 4.36-Forests**

This safeguard policy provides measures for protection of forests through impact evaluation and conservation of forest during project development. The area is fully settled with various land uses.

Triggered (Yes/No): YES

- **Bank Safeguard Policy 4.09-Pest Management**

This policy promotes the use of ecologically based biological or environmental pest management practices. The policy requires that procured pesticides should meet the WHO recommendations and not be among those on the restricted list of formulated products found in the WHO Classes IA and TB or Class II. This policy is triggered since routine operation works may involve the use of pesticides or Agrochemical materials to control pest snakes etc. In practice clearance of grass lawns in the project area is done using mechanical methods especially slashing of grass.

Triggered (Yes/No): YES

- **Bank Safeguard Policy 4.11-Physical Cultural Resources**

This policy assists in preserving physical cultural resources and helps reduce chances of their destruction or damage. The policy considers Physical Cultural Resources (PCR) to be resources of archeological, paleontological, historical, architectural, and religious (including graveyards and burial sites), aesthetic or other cultural significance.

Triggered (Yes/No): YES

- **Bank Safeguard Policy 4.12-Involuntary Resettlement**

Resettlement due to infrastructure development is not a new phenomenon in Nigeria but the government has no Policy Document or Act that aims at ensuring that persons who suffer displacement and resettlement arising from such development activities can be compensated adequately for their losses at replacement costs. The proposed project does trigger resettlement and relocation of sort in the project area especially for livelihood of persons.

Triggered (Yes/No): YES

- **Bank Safeguard Policy 4.12-Indigenous People**

This policy requires project to be designed and implemented in a way that fosters full respect for Indigenous Peoples' dignity, human rights and cultural uniqueness and so that they receive culturally compatible social and economic benefits and do not suffer adverse effects during the development process.

Triggered (Yes/No): YES

- **Bank Safeguard Policy 4.37-Safety of Dams**

This policy aims to assure quality and, safety in the design and, construction of new dams and, the rehabilitation of existing dams and in carrying out activities that may be affected by an existing dam. This policy is not triggered as the proposed project has no dam radius.

Triggered (Yes/No): YES

- **Bank Safeguard Policy 7.50-Project on International Waterways**

This policy applies to the international waterways that forms boundaries or flows between two or more states that can be bank members or not. The policy lists projects that require its observation. The policy is not triggered by the project as the proposed project is not listed under sub-section 2 (a) of the OP as projectsrequired to observe the safeguard policy. The project will not traverse or cross at any point of international waterways;

Triggered (Yes/No): NO

- **Bank Safeguard Policy 7.50- Project in Disputed Areas**

It is known that projects in disputed areas may raise a number of delicate problems affecting relation not only between the bank and its member countries, but also between the countries in which the project is carried out. In order to reduce this impact, it is recommended any dispute over area earmarked for project development should be dealt with at the earliest possible stage. This policy is not being triggered by the proposed project as the project areas are not shared by any other country to grant such disputes.

Triggered (Yes/No): NO

• **World Bank Safeguard Policy BP 17.50- Public Disclosure**

This BP encourages Public Disclosure (PD) or Involvement as a means of improving the planning and implementation process of projects. This procedure gives governmental agencies responsibility of monitoring and managing the environmental and social impacts of development projects particularly those impacting on natural resources and local communities. The policy provides information that ensures that effective PD is carried out by project proponents and their representatives. The BP requires that Public Involvement should be properly integrated with people oriented issues of development projects. Monitoring and grievances address mechanism should also be incorporated in the project management plan.

Triggered (Yes/No): YES

1.8.6 Nipco Gas Limited Environmental Assessment Policies

Nipco Gas Limited policies and commitments take into consideration relevant Nigerian regulations, international laws, guidelines, conventions and treaties. Nipco Gas Limited shall in the course of executing this proposed project ensure that all relevant standards and conditions are complied with and where double standards exist Nipco Gas would as much as possible comply with the more stringent one. The project shall be managed in accordance with all relevant sections of Nipco Gas Limited 's Health, Safety and Environment (HSE) Governing Policy. The Nipco Gas Limited 's HSE policy at work imposes responsibilities on all levels of management, supervision and all employees, for which they will be held accountable.

Nipco Gas Limited's Community Affairs, Safety, Health, Environment and Security {CASHES} Policy

Nipco Gas Limited operates under the guidelines of International standards and complies strictly with them. Where national standards and regulations are more stringent than Nipco Gas Limited guidelines, Nipco Gas Limited's policy is to comply with the existing national legislation. It is Nipco Gas 's policy that all activities are planned and executed in a manner that:

- Preserves the health, safety and security of its employees, the employees of Nipco Gas Limited contractors, and all members of the public who may be affected by Nipco Gas Limited operation.
- Minimizes the impact of its operations on the environment.

- Is sensitive to the needs and concerns of Nipco Gas Limited's host communities

Nipco Gas Limited's Environmental Assessment Policy

It is Nipco Gas Limited's policy to:

- Carry out Environmental Impact Assessments and Evaluation in relation to all aspects of the natural and social environment that may affect or be affected by its activities;
- Identify any such interface for the complete life cycle of both new and existing facilities and operations;
- Enhance positive effects, prevent intolerable impacts from occurring;
- Limit the nature and extent of any residual negative impacts, however caused, such that they are as low as practicable;
- Consult relevant stakeholders;
- Leave the environment at the end of the useful life of any operation in a condition suitable for future use;
- Routinely monitor the environmental status of each operation and take corrective action as necessary.

Nipco Gas Limited's Waste Management Policy

It is the policy of Nipco Gas Limited to:

- Take all practical and reasonable measures to minimize the generation of solid and liquid wastes as well as emissions and otherwise;
- Manage and dispose of wastes in an environmentally responsible manner;
- Track and maintain records of waste streams and provide an auditable trail as to their management and disposal.

1.9 Structure of the Report

The report shall conform to International standard and Federal Ministry of Environment reporting format which is summarized as follows:

- Title Page

- Table of Contents
- List of Tables
- List of Figures
- List of Maps
- List of Plates
- List of Acronyms and Abbreviations
- List of Preparers
- Acknowledgement
- Executive Summary
- Chapter One — Introduction; - Background information, Administrative and Legal framework, Terms of reference, Declaration
- Chapter Two — Project Justification; - Project background, project objectives, need for the project, value of the project, envisaged sustainability, alternatives considered (including no project alternative), development options considered, site selection.
- Chapter Three - Project Description, - Type of project, scope, location, material input/output and by-products, waste generation, technical layout and process, operation and maintenance, schedule.
- Chapter Four — Description of the biophysical, socio-economic and health environment, - Study approach, literature review, baseline data acquisition method and QA/QC, geographical location, field data, climatic conditions, air quality, noise level, vegetation cover characteristics, land use and landscape pattern, ecologically sensitive areas, terrestrial fauna and wildlife, soil studies, Aquatic studies including hydrobiology and fisheries, ground water resources, social, economic and health studies, prediction of changes in the baseline condition without the development in place. Consultation, - Identification of stakeholders, consultation with regulators, consultation with communities, community concerns and observations, and Participatory Rural Appraisal (PRA).
- Chapter Five, - Associated and Potential Environmental Impacts, - Scoping, impact prediction methodology, impacts of project activities (site clearing, construction, transportation, excavation, sand filling, etc), impacts on resource utilization, process impacts (operation), short term/long term impacts, reversible/irreversible impacts, cumulative impacts, direct/indirect impacts,

adverse/beneficial impacts, risk assessment (HAZOP, HAZID, QRA), social impacts, health impacts, etc.

- Chapter Six, - Mitigation Measures and Alternatives, - Control technology, compensation, alternative site, alternative route or location, compliance with health and safety hazards requirements.
- Chapter Seven, - Environmental and Social Management Plan, - Guidelines for specific project activities, emergency response procedures, mitigation plan, costing of alternatives and budget requirements, monitoring programme (scope, parameters, frequency, location, methodology), auditing and inspection procedures, waste handling procedures, training program, roles and responsibilities.
- Chapter Eight - Remediation Plan after Decommissioning/Closure
- Chapter Nine - Conclusion and Recommendation
- References
- Appendices

1.10 Terms of Reference (TOR)

The Terms of Reference (TOR) for this EIA is based on standard requirements of Federal Ministry of Environment (FMEnv) and international standards. The EIA establishes the environmental issues that will result from the operation of the proposed facilities within the study area, quantify and evaluate their impacts, suggest and evaluate alternatives with regard to cost effectiveness and environmental friendliness. In addition, it will recommend mitigation measures and put in place an Environmental Management Plan (Post-EIA). Nipco Gas Limited recognizes the importance of comprehensive environmental planning and management to the success of this project and is committed to undertaking the necessary studies needed to understand the environmental system of the project in order to address areas where significant impacts (physico-chemical, ecological, and socio-cultural) may be experienced. Accordingly, the Terms of Reference (TOR) for the EIA are tailored towards achieving the following:

- Establish a baseline database covering detailed ecology, meteorology and socio-economic condition of the project area, via a statutorily required environmental assessment;
- Identify, evaluate and predict the potential environmental impacts of the gas pipeline project development plan;

- Develop control strategies with a view to mitigating and ameliorating significant impacts the project would have on the totality of other measurable environmental characteristics;
- Identify the best practicable environmental options or alternatives to execute the project;
- Identify relevant regulations, local and international, including protocols and treaties signed by the Nigerian Government;
- Carry out an inventory and consultation of stakeholders in relation to the project and ensure they are carried along on major decisions; and
- Prepare a detailed EIA report, which will form the basis for the issuance of the necessary approvals by the Federal Ministry of Environment (FMEnv) as well as the incorporation of EIA recommendations into the gas pipeline project detailed design and other stages of the project development.

CHAPTER TWO

PROJECT JUSTIFICATION

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 Need for the Project

In Nigeria today, the power supply is lower than the demand due to the total installed power is lower than the demand. The endemic power crisis in Nigeria which came as a result of the inability of the existing power plants to meet the ever increasing demands poses as a challenge to the development of the country. Residential homes, office buildings and industries generate their own electricity through alternative sources to make up for irregular power supply. To address the problem of power shortage in Nigeria, Gas turbine power plants began to serve as the best option to overcome the electricity crisis because of the presence of large natural gas reserves in the country. More gas turbine power stations were needed because of the abundant gas reserves to power gas turbines and gas turbine burns very clean. The gas turbines can be operated off-grid and features in all the opportunities identified in the power generation sector. The Laying of 18inch diameter, 60Kilometers in length of 3 Layer Polyethylene Carbon Steel Pipeline to convey Natural Gas from Yaali Foods, Ogere, Ogun State to Ibadan Tollgate, Oyo State. This pipeline is a continuation/extension of our existing pipeline infrastructure from our Compressed Natural Gas (CNG) Station Ibafo Ogun State that currently terminates at Yaali Foods, Ogere, Ogun State to feed the Gas Pipeline Project in Ibadan and major industries along the row in order to:

- Utilize natural gas to power gas turbine plants constructed by industries and any government around the project area. This will improve power supply in the project area;
- Provide cheaper, cleaner and more efficient fuel for the end users in particular and the country in general;
- Promote the use of natural gas as a substitute for liquid fuel, as well as enhancing environmental status as natural gas is friendly;
- Boost economic activities within the area and country at large;
- Encourage gas utilization culture in Nigeria as fuel-of-first-choice;
- Offer job opportunities in various categories to a number of Nigerian professionals, skilled and semiskilled craftsmen.

2.2 Project Benefits

The development of clean modern energy services is an enormous challenge facing the African continent since energy is fundamental for socio-economic development and poverty eradication. Energy is a foundation stone of the modern industrial economy and provides an essential ingredient for almost all human activities. Modern energy services are a powerful engine of economic and social development and no country has managed to develop much beyond a subsistence economy without ensuring at least minimum access to energy services for a broad section of its population. Energy is a requirement for industrial development and activity, which without an effective energy supply neither is possible. This is concerning as energy is an essential building block for fighting poverty and promoting sustainable development. The provision of safe and affordable energy is an important, if not vital, condition for their achievement. Access to power expands the number and variety of business and job opportunities available. At the realization of the project the benefit will include but not limited to:

- Job creation;
- Income generation;
- Reduction in rural urban drift;
- Industrialization
- Besides, gas-for-money will be generated for all parties.

2.3 Value of the Project

The value of the proposed gas pipeline project consisting of land acquisition, construction, personnel, equipment, approvals, corporate social operation is put at approximately twenty billion Naira (N20,000,000,000). A higher percentage of the project amount would be injected into the Nigerian economy through contracts, subcontracts and purchase of construction materials and labour. Consequently, the cost of the gas pipeline and subsequent development of gas turbines will boost industrialization.

2.4 Envisaged Sustainability

2.4.1 Economic and Commercial Sustainability

Throughout its estimated 30-year lifespan, the gas pipeline project is envisaged to be economically and commercially sustainable because of the confirmed gas volume present in the field. Gas reserves in Nigeria are huge about 170 trillion cubic feet (tcf) and can be harnessed and put into commercial use. There is presently high demand for the utilization of natural gas. Part of this demand will be met by the Nipco Gas Industrialization project. It is therefore hoped that the project shall contribute substantially to the revenue generation and industrial development in Nigeria and the West African sub region can be sustained economically for a long time. With the proposed gas revolution and given the political driver for power development in the country, coupled with the other domestic customers, market for the gas is assured. The revenue that will accrue from sale of hitherto flared gas will substantially increase the foreign exchange earnings of the Federal government through the Nigerian Gas Company (NGC), in addition to the revenue from oil and condensate. The elimination of routine gas flaring will significantly reduce environmental pollution, thus helping to improve the social and health standards of the area covered by the project.

2.4.2 Technical Sustainability

The proposed project is expected to be technically sustainable because of the proven technology for the pipping and auxiliary facilities being used. Strict adherence to internationally accepted engineering design and construction standards as well as codes of practice that shall be adopted at all stages of the project are expected to ensure technical sustainability. Innovative technologies that are economically viable and having minimal environmental, social and health impacts shall be utilised in the execution of the proposed project.

2.4.3 Environmental Sustainability

The gas pipeline is designed and will be constructed to be eco-friendly based on the concept of building with nature (BWN). The proposed gas pipeline project is environmentally sustainable. In addition, strict adherence to the EMP shall ensure that every aspect of the proposed project is sustainable with minimum impact, especially as it concerns the natural environment and the people who inhabit it. Incorporation of the recommendations of the EIA at the appropriate stages of the project development is expected to ensure that maintenance of the ecosystem such that there are no significant adverse effects to health or social status of life within that ecosystem as a result of the operations of the gas pipeline.

2.4.4 Social Sustainability

The project has elaborate Social Action Plan and continues consultation with relevant stakeholders throughout the life cycle of the project. A Grievance Redress Mechanism (GRMs) shall be developed and established for the project to forestall any future disagreement between the proponent and the host community. A Grievance Redress Mechanism (GRMs) shall be developed and established for the project to forestall any future disagreement between the proponent and the host community. The social sustainability of the project shall emanate from the extensive consultations, which have been held with host community and which shall be sustained, are expected to continue to create a good working relationship between Nipco Gas Limited and the project communities.

2.5 Project Options

2.5.1 Do nothing Option

It is best practice in Environmental Impact Assessments (EIA) to consider the Do Nothing ʻalternative — i.e. where no project occurs. Under a Do Nothing ʻalternative, the strategic gas pipeline infrastructure and its associated development would not be constructed. This option would favour the continued reliance on existing inadequate Power Supply and the use of alternative diesel generators. The implications include the fact that land will not be acquired; there will be no disturbance of the people and structures as a result of the decision to maintain the existing power supply of the area as it is presently constituted, which shall also be at variance with the increased demand for energy and vision for sustainable development of the area. The option will reduce and stunt effective social development of the nation. This option was rejected because it under-exploits a proven strategy to empower the people and the nation. The project will have many social, economic and environmental benefits such as jobs creation, revenue generation, social development, reduction in crime etc. This alternative was rejected because the present power generation in the country cannot meet the energy demand of industries and again, the current cost of diesel fuel is expensive.

2.5.2 The ‘Delayed’ Option

This option implies that the planned project will be delayed until a much later date. Such option is usually taken when conditions are unfavourable to project implementation such as in war situation, or where the host community is deeply resentful of the project. Also, if the prevailing economic climate is not quite favourable to the project, then delayed project option may be feasible. None of these conditions is applicable. Indeed, the social, economic and the political environment are most favourably disposed towards the project. Therefore, the implication of delayed project option will mean that all the preliminary work and associated efforts/ costs incurred would have come to nothing. Also, because of inflationary trends, such a delay may result in unanticipated increase in project costs, which may affect the final profit from the project. The consequence of these is that it would be a discouragement for private/local investors. In consideration of the above concerns and assessment of the current proposed site the Delayed option of the project is not viable option. These, and other related problems make impracticable to adopt the delayed option. It is therefore unattractive to adopt the "Delayed Project" option.

2.5.3 Go Ahead Option

Gas is readily available in Nigeria, thus the utilization of gas to produce power for electricity is cleaner and more environmentally friendly, than liquid or solid fuels (gas burns effectively and produces very little or no smoke), and will enhance constant power supply to boost production. Transmission pipeline industry is an irreplaceable component of our society infrastructure. These pipeline systems have safely transported products from wells to refineries and ultimately to the necessary markets, including consumers and businesses. Pipelines have historically been the safest means of transporting natural gas and historically liquids. Considering the economic viability and the numerous advantages of gas utilization as a source of energy to provide constant supply of power for industries in Nigeria, this option was accepted. The option of project development is thus the best of all the possible options considered economically, technologically and environmentally. During the proposed project design development, alternatives were considered in compliance with the requirements of Nigeria's EIA procedures together with international best practices. This is the preferred option.

2.6 Project Alternatives

2.6.1 Transportation Alternative

(c) Road Trucking

High pressures and explosions make it difficult to transport compressed natural gas in tankers. Due to scientific advancements in the mid-20thcentury, natural gas can be turned to liquid at extremely low temperatures and transported as liquefied natural gas (LNG). Compared to natural gas, liquified natural gas spreads to a smaller volume thereby allowing it to be transported in far distances in a cost-efficient manner. They can even be transported to areas where no pipelines or no natural gas source exist. Similarly, refueling stations by the roadside as well as fuelling equipment need to be suited for cryogenic temperatures. Though this immediately boosts the cost of using natural gas, the latter offers relevant benefits to the environment. Special trailers that can carry liquefied natural gas are able to deliver natural gas from storage tanks to fueling stations. Once delivered, natural gas needs to be stored in insulated tanks at the fueling station. Refueling stations are also necessary along with storage tanks for the cold natural liquid. The shortcomings are the specialty is strong, the transportation goods are too specialized, and the transportation items are limited. Poor transportation infrastructure possesses a high risk to the alternative.

(d) Pipelines

Transmission pipeline industry is an irreplaceable component of our society infrastructure. These pipeline systems have safely transported products from wells to refineries and ultimately to the necessary markets, including consumers and businesses. Pipelines have historically been the safest means of transporting natural gas and historically liquids. Pipelines play a very critical role in the transportation process because most of the oil and gas move through pipelines for at least part of the route. Strategic planning involves determining the shortest and most economical routes where pipelines are built, the number of pumping stations and natural gas compression stations along the line, and terminal storage facilities. The advantages of piping over trucking are that:

- It can be transported continuously, is not affected by the weather, and has high reliability throughout the day.
- The pipeline can take shortcuts and the transportation distance is short;
- The transportation volume is large.
- High environmental benefits and no harmful substances.
- The energy consumption is small, which is the lowest among various modes of transportation;
- Safe and reliable, no pollution, low cost;
- Closed transportation can be realized with less loss.

2.6.2 Route Alternative

The three choice routes selected as alternatives in order to choose the most suitable due to availability of adequate land needed, considerably adequate access and least impact with the existing environment. Appropriate site selection in minimizing the associated ecosystem impacts and exploring restoration opportunities of degraded ecosystems aim to preserve the natural ecosystem functioning as much as possible considering requirements such as habitat connectivity, indigeneity, trophic web integrity, physical-chemical water quality and system resilience. To achieve the objective of distributing Gas from the Sagamu Interchange — Ibadan gas pipeline through very sensitive terrains three (3) options were contemplated.

Selection Criteria

Considering the sensitivity of the various ecological areas that the 160km x 18 metres 12" pipeline from Sagamu Interchange (Ogun State) - Ibadan (Oyo State) will traverse, important physico-biological, cultural and socio-economic parameters will be considered. Careful evaluation and understanding of the parameters will be necessary to ensure sustainable project that will not allow for environmental degradation and un-sustainability. The main considerations in evaluation and adoption of scenarios taken are:

- The cumulative length of the pipeline route
- Access to site (Construction and operations)
- Length through existing Right of Way if any
- Existence of forest reserve
- Number of existing river/creek crossing
- Number of existing major road crossing
- Number of existing pipeline crossing
- New land intake (the extent)
- Number of built up areas traversed
- Number of existing livelihood sources sites to be traversed (i.e. farm land, fishing area, lumbering/timber forest, wine tapping etc.)

Therefore, all the selection criteria outline above were summarized into three management and decisions components namely:

- Availability and source of gas
- Route topography, terrain conditions and accessibility
- Absence of obstacles

Confirmation of Optimum Option

As conceived, out of all the options, the one with less major roads crossing, major river crossing and least cumulative distance to be covered by pipeline compared to other options will be considered. In consideration of all the factors evaluated in the concept selection including such factors as communities, population density, ecosystem integrity, constructability, absence of infrastructure and obstacles which amount to environmental considerations and the lower project implementation cost, will be adjudged the best route. The general characteristics of the line route to consider in accordance with the terms of reference of the mission are:

- short, to minimize cost and the impact on the environment
- rectilinear, to minimize the angles and the footprint
- accessible, near roads, to facilitate maintenance
- bypassing towns and villages, to minimize the demolition of the built environment and relocation of populations

The factors to avoid are:

- exclusion zones of airports and airfields
- factories, industries, power installations, major water distribution network,
- hills and ridges
- protected areas, forest reserves, classified forests, Ramsar sites and other ecologically sensitive sites, which aim to protect natural areas and species

Some routes have more inherent environmental/ecological footprints than others. Such routes can usually be avoided in favour of routes which have fewer constraints and the maximum capacity to sustainably assimilate the development. Designed for the proposed development, the consideration of alternative routes focuses on route Alternatives relating to the identification of the route alignment. An environmental screening is conducted before the EIA to justify choice of gas pipeline route. Taking into account the potential need for an EIA, a route corridor appraisal of Option 1, 2 and 3 was undertaken that evaluated a number of alternatives in a large study area and subsequently identifies a preferred route for which an EIA was conducted. A preferred route with minimized socioeconomic impact on the local population, by skirting major towns and villages, avoiding areas of ecological and archaeological importance, where practicable, or by using sensitive construction methods, for example, trenchless river crossings and by minimizing traffic disruption by avoiding roads where possible. Issues considered in deciding which of the options is suitable are approximating the total length (km), accessibility to site, constructability, operability, conditions of the terrain to be encountered, number of rivers (and or creeks) to be encountered, number of major roads to be crossed, number of existing transmission lines to be crossed, number of communities/settlements to be traversed and existing livelihood sources' sites that may be traversed (e.g. farming, fishing, timber etc.). The quantitative ranking of the options was conducted. Generally, the main principles adopted in the selection of the transmission line route were to: All the constraints have been summarized in a constraint map (Figure3.1) after the option was selected showing the restricted areas. This lead to a defined corridor where the transmission line would run without significant impacts to the above constraints (ecological, physical structures, existing infrastructures, etc). Up to this phase, the route planning has been examined almost exclusively by aerial photography and existing geospatial data. Subsequently, the features in the composite corridor were verified by the routing and survey team through both ground and aerial based field surveys. During these field surveys, project staff documented landscape features (such as new buildings, building types) and used this information to update geospatial data. This level of verification provided the routing team with the most up to date data needed to develop alternate routes. The Linkert Scale methodology used is a quantitative computer-based methodology as a tool in evaluating the suitability of an area for locating new overhead transmission lines. It is informed by geospatial information (where features and activities occur on the landscape) and, with the help of models at each step through the process, considers three broadly conceived perspectives that apply to land use. The three perspectives are as follows:

- Built environment perspective, concerned with limiting the effect on the socio-economic environment
- Natural environment perspective, concerned with limiting the effect on the biophysical environment
- Engineering environment perspective, concerned with cost, system reliability, constructability and other technical constraints

The following details list of most appropriate factors selected for the Project:

- Engineering:
  - Linear infrastructure
  - Spannable water bodies
  - Geotechnical considerations (e.g., floodplains/wetlands)
  - Mining operations/quarries
  - Slope

- Natural:
  - Aquatic s
  - Special features (e.g., managed woodlots, conservation lands)
  - Land cover (e.g., agriculture, grassland, forests)
  - Wildlife habitat (e.g., waterfowl, ungulates)

- Built:
  - Proximity to buildings
  - Building density
  - Proposed future development
  - Soil capability/agricultural use
  - Land use (e.g., livestock, crops)
  - National, regional, and municipal historic sites
  - Proximity to heritage and archaeological sites
  - Landscape character (e.g., residential, campgrounds)
  - Edge of field (e.g., road allowances, quarter sections)

The various corridors suggested intended to give a starting place for the routing team to make informed decisions with respect to the development of the route planning area. The routing team then used experience combined with knowledge of technical, environmental and built considerations to make decisions about the boundaries of the route planning area. A final step involved developing suitability values for each feature (e.g., slope class, distance to residences, building density class, wildlife habitat type, etc.). For each feature, numbers between 1 and 5 were used to represent degrees of suitability for routing the transmission line across (or in proximity to) this feature with 1 being most suitable and 5 being least suitable.

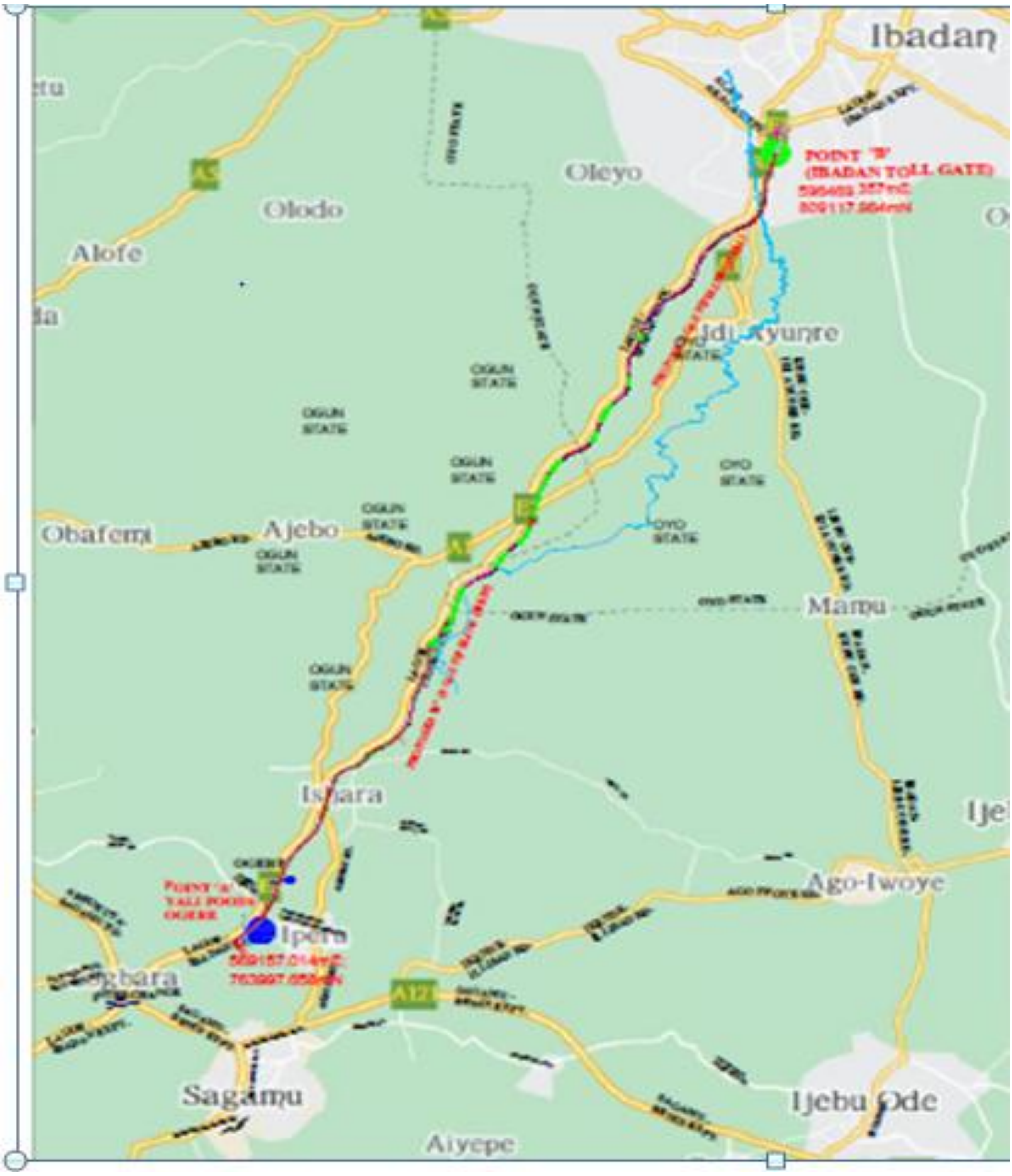

Figure 2.1: Line route options

Table 2.1: Quantitative ranking of route options

Parameters	Option 1 (Red Line)	Option 2 (Green Line)	Option 3 (Yellow Line)
Total length (approx..)	60km	55km	49km
No of bends (IP Points)	177	212	224
Major Road crossing (tarred)	4	20	30
Major River cross (>50m)/length	3	5	2
Minor Creek cross (<50m)/length	5	10	12
Local Govt. Areas by ROW (approx.)	10	14	15

Summary of the Route Options

Parameters	Option 1 (Red Line)	Option 2 (Green Line)	Option 3 (Red Line)
Engineering	1	3	5
Natural	2	2	2
Building Density	1	4	5
Remarks	Recommended	Not Recommended	Not Recommended

On a Linkert scale of 1 - 5

- 1 = Minimum effect
- 2 = Low effect
- 3 = Moderate effect
- 4 = Important effect
- 5 = Major effect

The aim is to ensure achievement of the built environment perspective (protecting people, places and cultural resources), the natural environment perspective (protecting water resources, plants and animals) and the engineering perspective (minimizing costs and schedule delays). Based on the Linkert scale shown in Table 3.1 resulted in suitability groupings (Major, moderate or low) for an underground gas pipeline. Areas that have high suitability (ranked I or 2) do not contain known sensitive resources or physical constraints and therefore should be considered as suitable areas for the development of corridors. Areas with moderate suitability (ranked 3) contain resources or land uses that are moderately sensitive to disturbance or that present a moderate physical constraint to an underground gas pipeline construction and operation. Resource conflicts or physical constraints in these areas can generally be reduced or avoided using standard mitigation measures. Areas with low suitability (ranked 4 or 5) contain resources or land uses that present a potential for significant impacts that may not be readily mitigated. The statistics generated by the alternate route evaluation and preference determination provided a clear understanding of the strengths and weaknesses associated with each option and the routes used to connect to the project start point. Overall options 3 was the preferred route with less impacts and most suitable. Details of line route showing avoidance of settlements and structures are presented as Kmz file format used to display geographic data in an Earth browser such as Google Earth. On a linker scale of 1-5

1	=	Minimum effect
2	=	Low effect
3	=	Major effect
4-5	=	Significant effect

CHAPTER THREE

PROJECT DESCRIPTION

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Project Overview

Nipco Gas limited intend to construct and install a 60km x 18" gas pipeline with associated facilities to deliver natural gas with 3 Layer Polyethylene Carbon Steel Pipeline to convey Natural Gas from Yaali Foods, Ogere, Ogun State to Ibadan Tollgate, Oyo State. This pipeline is a continuation/extension of Nipco Gas Limited existing pipeline infrastructure from its Compressed Natural Gas (CNG) Station Ibafo Ogun State that currently terminates at Yaali Foods, Ogere, Ogun State (which is the start point for this particular project) with Custody Transfer and Metering Station (CTMS). When installed, the proposed pipeline shall enable delivery of gas for commissioning of power generating plants by industries and realize its strategic business objective of increased revenue. This will impact positively on the achievement of the set National agenda for domestic gas utilization and industrialization. Nigeria needs to develop her downstream industries by setting up more industries that could utilize part of the abundant gas resources, such as in petrochemicals and fertilizers, to mention but few, instead of only exporting the gas as LNG to developed countries. This in the long run will create job opportunities for her citizens in line with our President 7-point agenda. The components and information for the gas pipeline project are as follows:

Table 3.1: Project Specification

DESCRIPTION	INFORMATION
Tie in Source	*NIPCO GAS NGMC JV*
Pipeline Size	18 inches
Pressure at tie in (Sagamu)	Between 28 barg and 33 barg
Capacity at maximum operating pressure	100 MMSCF/D
Right of way width	18 meters
Coating for external corrosion protection	31pe
Depth of burial (swamp) Minimum cover	Minimum 3m
Depth of burial (land)	1.8 – 2.3m
Depth of burial (across road and railways)	Minimum: 8m
Depth of burial (under water courses)	Minimum: 8m

No of proposed metering stations	2 (Sagamu & Ibadan)
Parameters	**Value**
Maximum Pressure (Bar G)	75
Minimum Pressure (Bar G)	35
Minimum Gas Pressure (Bar G)	75
Maximum Gas Pressure (Bar G)	35
Maximum Temperature (Deg.C)	35
Minimum Temperature (Deg.C)	15
Maximum Gas Flow (SCMH)	6000
Minimum Gas Flow (SCMH)	700
Poisson's ratio	0.29
Young's Modulus of Elasticity of Steel (Gpa)	200 Gpa
Thermal Co-efficient of expansion (in/100 Ft. F)	0.0078
Design Code	ASME B 31.8
Corrosion Allowance (MM)	1.5 MM
Rating (ANSI Class)	600#
Pipeline Gas Composition(average)	
Components	Mole (%)
Carbon (IV) Oxide	2.54
Nitrogen	0.69
Methane	87.36
Ethane	6.35
Propane	1.88
i-Butane	0.38
n-Butane	0.43
i-Pentane	0.14
n-Pentane	0.09
n-Hexane	0.1
n-Heptane	0.03
n-Octane	0.01
Total	**100**

3.2 Project Scope

The scope of work covered by this section is the Engineering, Procurement, construction, testing and commissioning of the 18″ X 60km Nipco Gas gas pipeline. The highlights of this scope are listed below:

- Engineering design
- Procurement of materials/equipment
- Mobilization to site
- Survey verification and boundary re-opening
- Right of Way (RO′ clearing
- Stringing of pipes along the Right of Way
- Weld, NDT and lay
- Trench excavation
- Lowering of the pipe into the trench
- Installation of saddle weights
- Backfilling of the trench
- Road and rivet crossings
- Reinstatement of graded working strip
- Pipeline cleaning and gauging
- Installation of pig trap and mainline valve
- Paint coating of above ground installation
- Commissioning

3.3 Pipeline System Design

The pipeline system will be designed according to the highest industry standards and best practices to ensure safety and ease of maintenance during operation. The overall design philosophy is to minimize risk, maximize integrity through diligent application of the appropriate location classes (with respect to population density), engineering principles, materials and wall thickness, technology for protection and control of a high pressure pipeline system for continuous transportation of natural gas.

3.3.1 Design Codes, Standards and Regulatory Requirements

The pipeline system will be designed in accordance with the following code, standards and regulatoryrequirements:

3.3.1.1 American Petroleum Institute (API)

- API RP 520 Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries Part 1 — Sizing and Selection
- API RP 521 Guide for Pressure Reliving and Depressurizing Systems
- API 526 Flanged Steel Pressure Relief Valves
- API 5L Specification for Line Pipe
- API RP 1102 Steel Pipelines Crossing Railroads and Highways
- API STD 1104 Welding of Pipelines and Related Facilities
- API RP 5L1 Recommended Practice for Railroad Transportation of Line Pipe
- API RP 5L5 Recommended Practice for Marine Transportation of Line Pipe
- API 600 Steel Gate Valves — Flanged and Butt Welding Ends
- API 6D Specification for Pipeline valves

3.3.1.2 American Society of Mechanical Engineers (ASME)

- ASME VIII Boiler and Pressure Vessel Code
- ASME B16.1 Cast Iron Pipe Flanges and flanged fitting
- ASME B16.5 Steel Pipe flanges and flanged fittings
- ASME B.16.9 Factory made wrought Steel Butt welding fitting
- ASME B31.3 Chemical Plant & petroleum Refinery Piping
- ASME B31.8 Gas Transmission and Distribution Piping System

3.3.1.3 Det Norske Veritas (DNV)

- DNV-RP- E305 On-Bottom Stability Design of Submarine Pipeline
- DNV-RP- F105 Free Spanning Pipelines

Codes and Standards

- **Electrical**
  - IEC60826-2003: Design criteria of overhead transmission lines.
  - IEC 61865: Overhead Lines-Calculation of the electrical component of distance between live parts and obstacles- Method of calculation.
  - IEEE C2-2012: National Electrical Safety Code (NESC).
  - IEEE 516-2009: IEEE Guide for Maintenance Methods on Energized Power Lines.
  - GB 50545-2010: Code for design of 110-750kV overhead transmission line Electricity utilities specification

- **Civil Work**
  - ASCE 7-05: Minimum Design Loads for Buildings and Other Structures
  - ASCE 10-97: Design of Latticed Steel Transmission Structures
  - IEEE Std 691™ 2OO1: IEEE Guide for Transmission Structure Foundation Design and Testing American concrete institutes (ACI)

- **Material**
  - IEC61 089: Round wire concentric lay overload electric standard conductor.
  - IEEE 812: Definition of terms relating to the fiber optics.
  - IEG 60120: Dimensions of ball and socket coupling for string Insulators.
  - ISO 898: Mechanical properties of fasteners made of carbon steel and alloy steel.
  - ASTM: American Society for Testing and Materials.
  - GB/T 700-2006: Carbon structural steels.
  - GB/T 1591-2008: High strength low alloy structural steels.

- **Tower Code for Design**
  - ASCE 7-05 for load computation.
  - ASCE 10-97 for tower design.

- **Structure Code for Design**
  - IEEE Guide for Transmission Structure Foundation Design and Testing (IEEE Std 69lTM 2001)
  - American concrete institutes (AC1318)
  - American Society for Testing and Materials (ASTM)

3.3.2 Pipeline Materials Selection

The materials selection study for the project was based on the detailed corrosion prediction study/analysis for the Nigerian Gas Company main lines, flow lines and Gas Plant sales gas. Duplex (22Cr) has been proposed for the gas pipeline materials stemming from the results of the corrosion prediction analysis so far carried out. The choice of duplex stems from the following:

- High corrosion rates predicted due to the presence of CO_2 and free H_2O (approx. 5mm/year at the inlet and decreasing to about 2mm/year).
- High corrosion rates suggest use of corrosion resistant material or corrosion inhibition system with allowable corrosion allowance (CA) — 8mm maximum as per STEP 99-5661.
- High corrosion rates suggest unacceptable CA for carbon steel and Inhibitor System Availability requirement is above 90% - historically a big challenge.
- All lines are critical for achieving the overall project objective of providing gas to the client.
- Carbon steel with inhibition seems unsuitable for this service.
- Although duplex has the higher initial CAPEX, its lifecycle cost is only marginally above that of carbon steel, even though it is assumed that the carbon steel pipelines will not be replaced within the 20 years under consideration. In addition, duplex offers better corrosion resistance, reliability and guarantee for integrity over the design life.

3.4 Raw Materials Use and Waste Generation

3.4.1 Raw Materials

The basic raw material fed into the gas pipeline is non-associated gas. The primary component of natural gas is methane (CH_4), the shortest and lightest hydrocarbon molecule. It also contains heavier gaseous hydrocarbons such as ethane (C_2H_6), propane (C_3H_8) and butane ($C=H_{10}$) as well as other sulfur containing gases. It is found in oil fields and natural gas fields and in coal beds (as coalbed methane). Before natural gas can be used as a fuel, it must undergo extensive processing to remove almost all materials other thanmethane. The current composition of gas stream is given in the Table 3.2 below and shall be used to design the gas facilities and pipeline.

Table 3.2: Natural gas composition

Component	**Composition (Mole %)**
N_2	0.10
CO_2	0.50
Cl	87.40
C2	4.00
C3	3.20
iC4	0.90
nC4	1.30
iC5	0.60
nC5	0.50
C6	0.50
C7	0.50
C8	0.40
C9	0
C10+	0.10
Molecular Weight	20.52
Gravity (air = 1)	0.708
Viscosity (cP)	0.9159
C10 + Mol wt	142.686

Source: NGC 2014

3.5 Project Phase

The Scope of the proposed construction of 60 km x 18" gas pipeline from Yaali Foods Limited (Ogun State) – Toll Gate Ibadan (Oyo State) include the following activities of the whole gas pipeline project are as follows:

3.5.1 Pre-Construction:

Pre-mobilization phase: The activities in this phase are essentially desktop works involving feasibility, technical and financial investigations/considerations. Pre-construction activities during this phase include:

- Engineering design
- Procurement of materials/equipment
- Permit to re-survey existing ROW
- Gas Pipeline Route survey
- Environment Impact Assessment (EIA)
- Oil Pipeline License (OPLL)
- Survey verification and boundary re-opening
- Mobilization of equipment and personnel to site

3.5.2 Construction phase:

Construction of the gas pipeline will be executed in accordance with a standard planning framework to ensure maximum efficiency in construction, minimum adverse environmental and health impact, earliest completion time, and compliance with regulatory requirements. This involves the following:

- Material Procurement and Transportation
- Bush clearing within ROW
- Excavation/Trenching
- Construction (Tie-in Points and Receiving Gas Station)
- Pipe laying (pipe stringing/welding, hydrostatic testing Non-destructive Weld Inspection, Lowering and Backfilling and cathodic protection).
- Commissioning and Handover

3.5.2.1 ROW survey and bush clearing

The total land take for the project is 60km. Prior to commencement of any construction works, Nipco Gas Limited shall perform a detailed pipeline corridor survey to establish all crossings (road, creeks and rivers) including locations of existing facilities. Nipco Gas Limited surveyors shall re-open the pipeline Right of Way (ROW) and confirm all set-out boundaries along the ROW. Nipco Gas Limited shall also be responsible for ensuring that the existing survey pillars are maintained and not destroyed by construction activities. Nipco Gas Limited shall clear, grade and strip the ROW and prepare the areas where the new lines shall be laid. Grading operations shall be carried out only on dry land. The ROW shall be cleared for its complete width. At minor road crossings, removal of topsoil shall be kept to a minimum, and surface materials shall be removed (where necessary) only at the time of crossing. Nipco Gas Limited shall provide adequate room for handling of materials and equipment on site. All worksites shall be prepared in accordance with International Standard Construction Specifications sections 2, 3 and 4.

3.5.2.2 Trenching

Trench dimensions shall be at least 30cm more than the outside diameter of the pipe. Trench depth and width shall be increased as necessary where the pipeline approaches crossings or other specialized route sections. Where required, the excavated trench shall be secured against collapse by suitable means e.g. timber planks, sheet piles, etc. All existing structures shall be located by manual excavation. After completion of pipeline installation activities, timber planks, sheet piles, etc. shall be completely removed.

3.5.2.3 Stringing & Bending

Nipco Gas Limited shall string the line pipes along the ROW beside the open ditch with suitable equipment and handling tools. Stringing of pipes shall be interrupted where necessary to allow passage of vehicles, livestock, etc. Coated pipes shall rest on padded supports or timbers to avoid damage to coating. This shall apply also during transportation of pipes. Strung pipes shall be provided with caps at both joint ends to keep the joint free from dirt and extraneous materials. Joint and weld numbers shall be permanently marked on the external surface of the pipe at suitable locations to allow proper recording of welds. Factory-made hot bends having a minimum bend radius of 15D shall be used in the project. Horizontal and vertical deviations shall be obtained as much as possible by stress free elastic bends.

3.5.2.4 Bevelling, Welding and Non-destructive Weld Inspection

An approved pipe cutter or thermal cutting and bevelling machine shall be used to perform joint bevelling. Manual cutting shall not be permitted. Bevels shall conform to the requirements of the welding specification. Pups required for tie-ins shall be cut from undamaged pipes. The minimum length of pup to be inserted in the line shall be 1.Om. The line pipes will be laid and welded by separate crews. They will be laid on padded supports or timber skids for welding along the ditch. The tents have a dual purpose of protecting the welds from the elements and provides for easy collection and disposal of welding waste. Insert shows auto welding equipment and operator.

Non-destructive testing of welds using radiographic procedures, which expose the full circumference of the joint, will be carried out following the completion of the weld. One hundred percent radiography of all weld joints shall be employed. All radiography films will be processed and interpreted on site to facilitate quick repairs of defective welds. Fillet weld joints shall be subjected to dye penetration tests. Nipco Gas Limited QA/QC representative on site prior to acceptance must certify the entire weld joints okay.

3.5.2.5 Crossings

(a) Road Crossing

There are only one major (grade A) road crossings (Ibadan to Iwo dual carriage expressway) a number minor tarred road (grade C) and a couple of earth track crossings along the route. The minor track shall be by “Open Cut”, while the major road shall be by “Thrust Boring”. Horizontal thrust boring shall be done with a 26” cased auger section which shall be pulled out after boring shall be deployed as shown in Figure 3.1

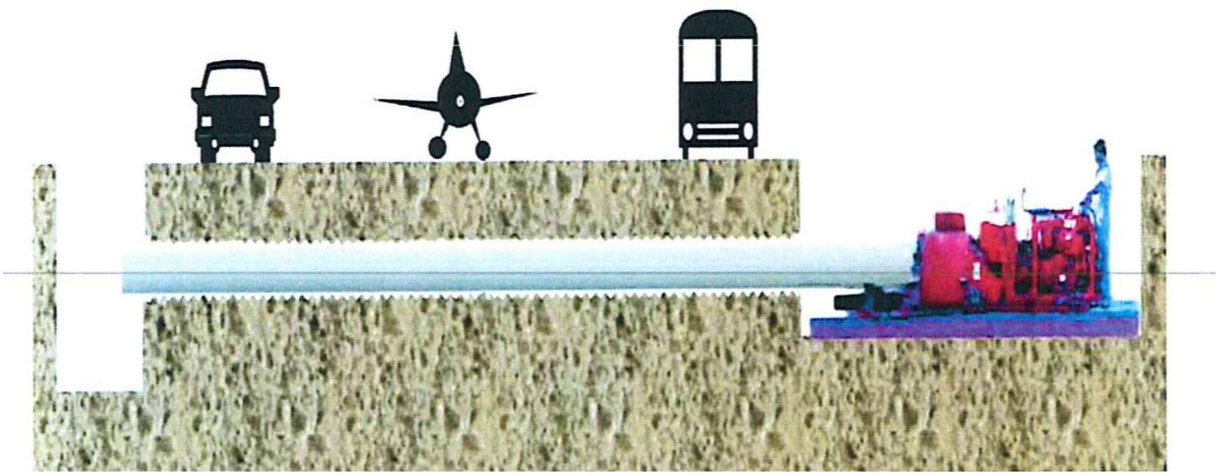

Figure 3.1: Imagery of horizontal thrust boring

(b) River Crossing

River crossing is a specialized pipeline construction technology that avoids open trenching of pipeline across rivers. It is done with a technology known as HDD: Horizontal Directional Drilling (HDD). Figure 3.2 describes the various components of HDD.

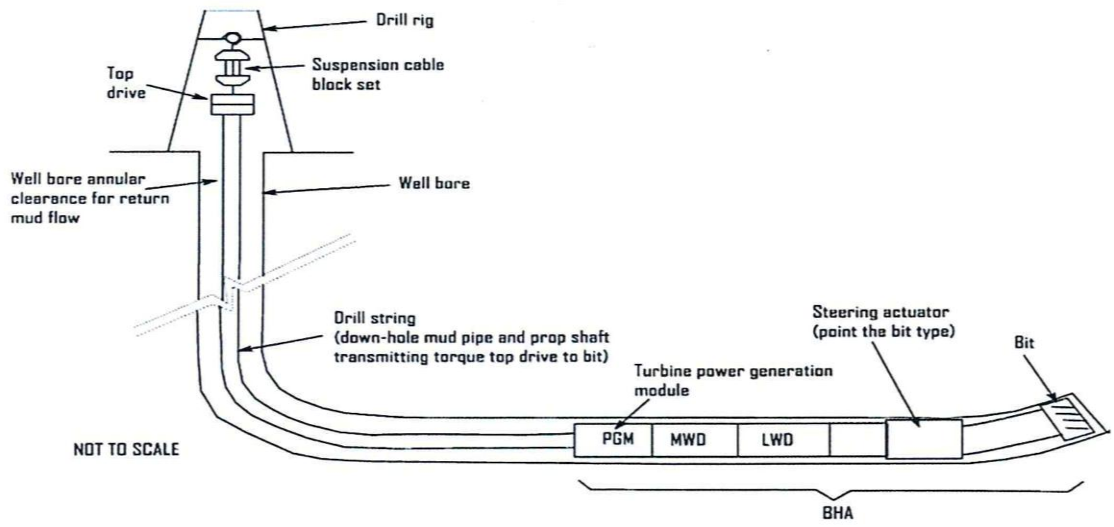

Figure 3.2: A typical HDD Components

3.5.2.6 Lowering and Backfilling

3.5.2.6.1 Lowering

The welded pipe shall be lowered gently into the ditch without subjecting the line to any stress. The pipes will conform to the ditch and substantially supported by the ditch bottom. The bed underneath the pipe shall be prepared by installation of soft material (medium sand bed) to obtain a soft surround for the installed pipe. The material shall be free of stones, rocks, timber, roots, debris and any other material, which may damage the pipe coating. The sand bed shall have a minimum depth of 150mm. During lowering in dry land special care shall be taken to ensure the pipe coatings sustain no damage. Coated pipes shall be handled with rubber-covered broadband slings adequate for the pipe diameter. Strings shall be constructed so that they can be removed from under the pipe without dragging any metal parts against the pipe coating.

3.5.2.6.2 Backfilling

Initial backfilling shall be carried out by installation of soft material (medium sand bed) to obtain a dampened surround for the installed pipe. Initial backfill material shall be free of stones, rocks, timber, roots, debris and any other material, which may damage the pipe coating. The sand bed shall have a minimum depth of l50mm. Stockpiled spoil and shall crown it (heap up) along the top of the trench line. Backfilling operations shall be carried out with due attention to avoid pipeline uplifting.

3.5.2.7 Cathodic Protection

The cathodic protection test stations will be done in two phases. The below ground installation (cable connections) will be carried out soon after lowering-in prior to backfilling. The above ground installationwill be carried out on completion of the back-filling exercise. The Cathodic Protection system would comprise a transformer-rectifier combination for the provision of direct current and a deep well-grounded approved anode material.

3.5.2.8 Cleaning, Gauging, Pressure testing and De-watering

The new line shall be cleaned using brush-cleaning pigs. The pipeline shall also be gauged using aluminium gauging plate(s). The new line shall be flushed clean and pressure tested to 1.25 times the design pressure for 24 hours. Hydrostatic test shall be conducted to ensure integrity of the pipeline system prior to commissioning to avoid leaks and possible fire and environmental issues. Freshwater shall be taken from the closest River for the hydrotesting, and because the water is fresh inhibitors might not be used. In accordance with International Standard Construction Specification, borehole water will most likely be used and the time the water kept in the pipes will be kept to a minimum so to eliminate the use of inhibitors. Nipco Gas Limited site representative shall supervise the pressure test. Calibrated pressure and temperature charts shallbe used to record pressure and temperature respectively during the pressure test. The new line shall be dewatered after pressure testing using compressed air and foam pig. The released water shall be treated before discharged to the environment.

3.5.2.9 Concrete Works

All civil works involved in the hook-up of the new line such as manifolds for spur lines shall be carried out in accordance with the International Standard Construction

Specification. All existing concrete works damaged by the construction exercise shall be re-instated to its original grade.

3.5.2.10 Commissioning and Handover

A pre-commissioning audit of the new lines to verify their conformity with the construction drawings shall be carried out. All spades and temporary connections shall be removed and a physical check will also be carried out on all facilities to confirm their operability prior to commissioning the lines. Engineering contractor personnel commission the new line. Crew support shall be provided during start-up andintroduction of gas into the line. Baseline Cathodic Protection (CP) Survey and intelligent pigging shall be carried out prior to handover to the asset owner

3.5.2.11 Site Clean-up and Demobilization from Site

At the end of site works, Engineering contractor in conjunction with Nipco Gas Limited shall ensure that the ROW and work site are properly cleaned and reinstated. All identified scrap/surplus materials shall be documented and appropriately disposed.

3.5.3 Operation and Maintenance of Facilities

Integrated gas operations with minimum intervention, in line with the approved International operations philosophy/strategy and code of practice shall be adopted. In line with the existing NGC guidelines, an Nipco Gas Limited asset based organisational structure shall be in place to promote strong ownership and accountability for the pipeline operations. Maintenance activities will normally be carried out during the day. The basic requirement is to minimize operating costs and exposure of staff while not affecting the security of gas supply. In line with the above principle, minimum facility and intervention strategy shall be adopted which will form the basis for the determination of the additional resource and training requirements.

In accordance with existing Nipco Gas Limited practice the pipelines have been designed for unmanned operations. The pipeline at the manifold shall be equipped with on-line access sampling points. To enhance bulk line operations and increase service life, the lines shall be operated at full capacity flow, thus minimizing the chances of deposits that are likely to arise from low flow conditions. The design shall provide for safe and efficient means of freeing the bulk lines of all hydrocarbons (gas, condensate). All maintenance and inspection activities shall be carried out with the objective of achieving or restoring 100% design integrity and availability at minimum cost throughout the lifecycle of the project. The design shall ensure that isolation is possible with minimum hardware manipulation and effort.

3.6 Execution risks

The proposed Laying of 18inch diameter, 60Kilometers in length of 3 Layer Polyethylene Carbon Steel Pipeline to convey Natural Gas from Yaali Foods, Ogere, Ogun State to Ibadan Tollgate, Oyo State. This pipeline is a continuation/extension of Nipco Gas Limited existing pipeline infrastructure from its Compressed Natural Gas (CNG) Station at Ibafo, Ogun State that currently terminates at Yaali Foods, Ogere, Ogun State (which is the start point for this particular project).

However, the ROW from the start point lies on the shoulder of federal and state highways which is government owned and will incur no compensation to any individual or community. Nipco Gas Limited CLOs shall carry out community relations contacts early to minimize community problems during project execution. Pre-fabrication works shall be carried out as much as possible in order to limit on-site welding works in the project area.

3.7 Decommissioning and Abandonment

The design of the pipeline recognized the need to decommission at the end of their operational life. The activities planned for this phase of the project include:

- Dismantling of all surface equipment;
- Excavation; and
- Removal and disposal of concrete works and pipes.

The abandonment procedure involves removal of all equipment and machinery from the site, removal and disposal of wastes and re-instatement of adversely impacted sites. Adequate commitment shall be maintained with stakeholders to mutually ascertain alternative needs and possible use of the facilities, by other parties. Nipco Gas Limited will maintain a record of the abandoned facilities and a copy will be given to the regulators.

3.8 Waste Generation

Majority of these wastes are of low toxicity. To fully comply with NURC and Federal Ministry ofEnvironment policies, a Waste Management Programme has been prepared for the activities of this project. The disposal methods for the enumerated wastes have been clearly defined. Wastes refer to any material - (solid, liquid, gaseous or mixture) that is surplus to requirements. Nipco Gas Limited shall take all practical and cost effective measures to minimize the generation of wastes, by employing the four R's (Reduce, Reuse, Recycle, and Recover) through process of optimization or redesign, efficient procedures and good housekeeping. Waste shall be managed in the following ways;

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

The types of wastes generated during the construction activities shall be classified as: Solid wastes, liquid wastes, and gaseous wastes. The solid wastes will include food waste, papers, rags, empty cans and bottles, pipe off-cuts, coating tapes, electrode butts and general garbage. Liquid wastes will include: sewage, spent chemicals (adhesives, lubricants, grease, etc). Generally, there are three likely kind of waste that shall be handled during the project, these include;

- Solid waste
- NGPueous waste
- Gaseous waste

3.8.1 Solid Wastes

These types of waste include cleared vegetation, domestic refuse, pigging trash, scrap metals, filters, welding torches and spentelectrodes. Trees would be felled along ROW and cut into useable lengths. In line with waste management procedures, identified solid wastes will be sorted and disposed of in designated areas. All chemicals used by Nipco Gas Limited would be handled and ultimately disposed of according to the requirements of Safe Handling of Chemicals (SHOC) system. There shall be maintained records of all chemicals stored on site, identifying their Health, Safety and Environmental implications. Nipco Gas Limited would work to ensure that records are maintained and storage facilities are in good handling practices. Solid wastes would be disposed of in the following manner:

- Plastic containers depending on their size will be returned to the supplier, cleaned for reuse or crushed;
- The disposal of industrial wastes would be conducted in designated areas in accordance with regulation.

3.8.2 NGPueous /Non NGPueous Wastes

3.8.2.1 Black and Grey Water

Black water refers to sewage whereas grey water is domestic wastewater. These shall be disposed of by use of mobile toilets which shall be used during the course of the project in accordance with national standards and guidelines.

3.8.2.2 Hydrotest Water

Prior to operation, the pipeline will be pressure-tested using fresh water from the closet River. The waste water is free from additive and safe to be returned to the river after storage in a makeshift pool and treated.

3.8.2.3 Diesel/Oil/Condensate

These wastes would emanate from working equipment such as welding machines, excavators, bulldozer etc.These wastes shall be scooped, contained and disposed of in designated sites.The wastes expected in this gas pipeline project and options/ methods for managing them are summarizedin Table 3.3.

Table 3.3: Waste Streams from the gas pipeline Project

Project Stages	Types of Wastes to be Generated
Preconstruction	- Domestic waste - Packaging materials (papers, nylons and pallets).
Construction	- Vegetation wastes / off cuts - Excavated soil - Concretes (leftover) - Metal pipes and Cement Papers - Wood Used for foundation constructions - Oil from equipment service - Packaging materials (papers, nylons and pallets). - Reels (used for wire winding) - Domestic waste
Operational stage	
Abandonment	- Oil from heavy duty vehicles - Scrap metal from pipes

3.9 Storage yards

There shall be no construction camps to accommodate workers along the RoW. Temporary storage yards shall be created within the acquired ROW for accommodating only equipment and materials such as pipeline for safe keeping especially overnight when workers have closed for the day. Workers shall be accommodated in hired houses or hotels located in fairly large communities to reduce the workforce impact to the barest minimum on rural communities. The existing water sources (open dug wells, mono pumps) of local communities will be monitored by the NGL contractor to ensure that the boreholes of the project will not affect the existing resources of water for the local communities.

3.10 Manpower requirements

Construction of the project would require at least one prime contractor and multiple subcontractors. The project contractor will work closely with the village administration to identify and maximize sourcing of skilled, semi-skilled and unskilled workers from the communities where the proposed transmission line will traverse. Approximately 50 workers would be employed during the peak of the construction period which is expected to last about 6 months. The construction workforce would include transmission line construction, ROW access, logging, substation construction, environmental compliance and quality assurance. Local unskilled labour and skilled out of town labour factors would depend on local labour market condition, contractor's labour force availability, construction status and time of year. Local unskilled labour could be between 30 — 40 % of the total workforce and skilled out — of town labour would comprise the rest of the workforce. The NGL contractor shall adopt the option related to worker housing of housing the work force in nearby urban areas and transport them to the jobsites against erecting temporary camps at strategic locations along the selected route. The impact avoidance objective on rural setting for the gas pipeline construction will be short term and is not expected to have a significant impact. The contractor would provide and maintain a detailed schedule throughout the construction period with construction of the project progressing either in an orderly fashion from one end of the project to the other, with each activity taking place sequentially or more likely it would progress in a rather random pattern around numerous obstacles. Some of the factors that would determine the flow of work include weather, soil conditions, access, seasonal environmental restrictions, avoidance of sensitive resources and the contractors' available resource.

3.11 Time Schedule

The duration of the project is expected to be two years. Timing indicated here is subject to modification as detailed designs are developed. The anticipated timelines of key project activities are captured in Table 3.4 below.

Table 3.4: Project Schedule

S/N	Task	2022		2023				2023				2053
		Q3	Q4	Q1	Q1	Q2	Q2	Q3	Q3	Q4	Q4	
1	EIA Study Approval											
2	Engineering Design											
3	Procurement											
4	Construction											
5	Commissioning											
6	Operations											
7	Decommissioning											

CHAPTER FOUR

DESCRIPTION OF THE EXISTING ENVIRONMENT

CHAPTER FOUR

DESCRIPTION OF EXISTING ENVIRONMENT

4.1 Study Approach

The purpose of the baseline data acquisition was to establish, the status of the various environmental components in the proposed project area. In order to achieve this, environmental parameters were determined from literature survey, fieldwork, laboratory and data analyses. The components of the environment evaluated covered biophysical, social and health. The approach adopted was to obtain ecological baseline data from desktop, field and laboratory studies, interviews and consultations with individuals/representatives of the communities of the project area. This approach would provide adequate information for establishing the baseline status of the environment of the study area. The scope of the study covered meteorology, air quality/noise, soil, land use/cover, vegetation, wildlife, geology, hydrogeology, surface water, sediment, hydrobiology, public & occupational Health and socio-economics. Literature review is conducted prior to field data gathering campaign in order to obtain relevant background information on the soil, water, and air of the study area. Further research was also conducted at the end of the field data gathering exercise in order to compare literature information with generated field data and for additional information on the study area. Generally, literature research involved consulting relevant textbooks, journals and publications, researches as well as technical presentations.

The baseline was produced based on a one- season (wet season) field exercise carried out from 8th to 20th September, as approved by the Federal Ministry of Environment. The samples were analysed at Searchgate Laboratories Limited, Lagos, a NURC and FMEnv accredited laboratory. A past approved FMEnv Environmental Impact Assessment within the project area served as second season (Dry Season) for biophysical parameters. Specific examples of previous studies consulted in generating comparative based data for describing the existing environment of the project area for dry season include Environmental and Social Impact Assessment (ESIA) of proposed 6MW Independent Power Generation (Project Edison) in British American Tobacco Oluyole LGA, Oyo State and Environmental Impact Assessment of NGL PVT Africa Limited, Sagamu, Ogun State.

4.2 Spatial Boundary

The map showing the study area inclusive of sampling stations is presented in Figure 4.1 and Appendix 4.3. The Sampling points were geo-referenced by means of Global

Positioning System (GPS) on the field. Judgmental sampling was applied in the selection of study stations, taking into account ecological features, geographical location of communities and control points in apparently undisturbed areas. The overriding considerations in the selection of sampling points included:

- Ecological features at 0.5km (were sensitivity of physical and biological receptors (e.g. location of water body, flora andfauna, settlements, existing facilities)
- The environmental, natural and man-made features within 2 km radius of the right of way was surveyed and mapped for biophysical components.
- The buffet distance 2 km for health and socio economics components used here was chosen at the time as it is considered likely to be the distance beyond which the project and related activities are unlikely to exert an influence.
- Accessibility;
- Security;
- Geographical dynamics of the study area such as wind direction, upstream! downstream system and topography of the area
- Areas of interest from satellite imageries; and
- Situating control points in undisturbed areas outside the project area but within the same ecological zone. (2.5km)
- 0.5km radius for biophysical sampling (Table 4.1)

Figure 4.1: Sampling Map

A systematic sampling design according to the Terms of Reference (TOR)/Scope of work(SOW) approved by FMEnv was adopted to cover the entire area both surface water and soil, air quality and meteorological with emphasis on the gas pipeline project and its immediate environs.

Table 4.1: Sampling Protocol

S/N	Environmental Components	No of Samples Collected	Description of Sampling Design
1	Surface Water	**3 samples + 1 control**	Samples taken surface water crossing point and at control stations to be taken upstream of each water body where accessible.
2	Sediment	**3 samples + 1 control**	Use of Eckman grab Samples taken at surface water crossing point and at control stations taken upstream of each water body where accessible.
3	Vegetation	**40**	Transects of 2km radius and at control stations.
4	Soil	**30 stations + 5 controls**	Composite samples shall be collected from any side of the route at 2 km distance. Sampling was at two depths namely To soil (0-15cm) and Bottom soil (15-30cm). Control samples were collected at evert 18km and off the start and termination points.
5	Meteorology	**30 stations + 2 controls**	Local meteorology at 2km distance and control stations collected at every 20km distance at pristine environment where accessible.
6	Ambient Air/Noise	**30 stations + 2 controls**	Structured questionnaire administration in at least 10 communities
7	Socio-economics	**>10 communities**	
8	Health Impact	**>10 communities**	Survey at 2km radius at each station for portable water, waste disposal, health care system. Structured questionnaire administration in at least 10 communities.
9	Aquatic Biology	**3 samples + 1 control**	Samples were taken at surface water crossing point and control stations taken upstream of each water body where accessible.

10	Wildlife	**NA**	Hunters interviewed, animal droppings and other clues to be used
11	Groundwater	**5 samples + 1 control**	Samples were collected from community hand dug wells, mono-pumps at 10km distance each. Control samples were collected at 2km off the start and termination points

Source: NGP Field Survey 2022

Field sampling and observations was conducted for biophysical components through in-situ measurements with appropriate equipment of certified calibration and ex-situ laboratory analysis of samples using standard methods.

Table 4.2: In-situ parameters determined during fieldwork

S/N	Environmental Components	Parameters
1	Surface Water	Temperature, pH, DO, Turbidity, electric conductivity, TDS
2	Noise	Sound level, disturbances
3	Soil	Temperature, pH, Conductivity, moisture content
4	Meteorology	Air temperature, rainfall, atmospheric pressure, cloud cover, relative humidity, wind speed and direction
5	Ambient	VOC, SOx, NOx, CxHy, CO_2, NH_3, H_2S and suspended particular matter

4.3 Sampling Methodology

The field procedures employed in samples/data collections are summarized in Table 4.3 . In situ field measurements recommended by FEPA (1991) and NURC (2018) in situ measurements were carried out on some parameters like meteorology (temperature- minimum and maximum, relative humidity(RH), wind speed and direction), Air quality/Noise (suspended particulate matter (SPM), CO, CO_2 SOx, NOx, NH_3, H_2S, HC and noise), Vegetation lifeform, species frequency and floristic composition, Soil quality – colour, pH, electrical conductivity) and Water quality (pH, temperature, dissolved oxygen concentration, total dissolved solids conductivity, turbidity and salinity).

Table 4.3 Environmental components and associated methodologies

Environmental Components	Methods
Meteorology	Literature survey, field studies with rain gauge, Thermography, Wind Vane
Air Quality Noise	Electronic air quality monitor, high volume sampler Noise meter
Vegetation	Transects, Quadrats, key informant interviews, FGD, Questionnaires and Direct observations
Land Use/Cover	Observations, interviews and sample collections. Environmental baseline survey (EBS) by remote sensing (satellite imagery interpretation), Direct physical observations.
Fauna (wildlife) Terrestrial invertebrates, Amphibians, Reptiles, Birds, Mammals	Direct observations, key informant interviews, Focus group discussions (FGD)
Hydrogeology and Geotechnics	Boreholes and Geophysical Measurements, Vertical electrical sounding (VES)
Surface Water/Hydrodynamics	Observations, water sampler, current meter, pH meter, DO meter, sediment grab, TDS meter, Turbid meter and conductivity
Soil Quality	Soil samples with an auger, and description of each sample with Munsell colour chart
Microbiology	Collection of water samples with Hydrobios water sampler into sterile McCartney bottles; Soil sampoles with soil auger into aluminium foil. Sediments samples with van Veen grab sampler into aluminium foil.
Aquatic biology Sediment Phytoplankton Zooplankton Fish species and Fishers	Collection with van Veen grab Collection with plankton net Collection with plankton net Observation, collection, interviews and laboratory analyses
Social Environment	Key information interviews, Focus Group Discussion (FGD), direct observation, Administration of structured questionnaires and collection of secondary data.
Health Studies	Key informant interviews, FGD, Administration of structured questionnaire and interviews, Physical examination of volunteers, Walk-through survey and Collection of secondary data.
Waste Management	Physical examination, inventorisation and walk-through survey

4.3.1 Sampling Points

The sampling ppoints are shown in Table 4.3.1 below

Table 4.3.1: Showing the sampling points

S/N	Coded Location	Latitude, N	Longitude, E	Elevation (m)
1	NGP 1	06^{0}54. 7356	03^{0} 37. 4942	6.42
2	NGP 2	06^{0}55. 2224	03^{0} 38. 0532	7.2
3	NGP 3	06^{0}56. 4607	03^{0} 38. 6940	4.9
4	NGP 4	06^{0}57. 8244	03^{0} 39. 4711	7.6
5	NGP 5	06^{0}59. 0042	03^{0} 39. 9869	3.2
6	NGP 6	06^{0}59. 1644	03^{0} 40.2623	4.3
7	NGP 7	07^{0}00. 7667	03^{0} 41. 5500	3.6
8	NGP 8	07^{0}00. 7942	03^{0} 41. 5600	6.1
9	NGP 9	07^{0}10. 3015	03^{0} 42. 1419	1.9
10	NGP 10	07^{0}10. 8967	03^{0} 42. 3541	6.6
11	NGP 11	07^{0}10. 7991	03^{0} 45. 5343	4.5
12	NGP 12	07^{0}30. 7652	03^{0} 42. 7781	6.3
13	NGP 13	07^{0}30. 7678	03^{0} 42. 8611	4.1
14	NGP 14	07^{0}40. 2612	03^{0} 43. 1810	7.3
15	NGP 15	07^{0}40. 9979	03^{0} 43. 5145	7.8
16	NGP 16	07^{0}50. 5752	03^{0} 43. 6940	8.5
17	NGP 17	07^{0}50. 9928	03^{0} 44. 1774	7.1
18	NGP 18	07^{0}60. 4565	03^{0} 44. 6201	6.3
19	NGP 19	07^{0}60. 4164	03^{0} 44. 6010	1.8
20	NGP 20	07^{0}60. 8702	03^{0} 45. 0517	4.8
21	NGP 21	07^{0}70. 0969	03^{0} 45. 1533	11.3
22	NGP 22	07^{0}70. 6858	03^{0} 45. 5901	9.2
23	NGP 23	07^{0}70. 5181	03^{0} 45. 4009	6.8
24	NGP 24	07^{0}80. 8426	03^{0} 46. 0867	9.0
25	NGP 25	07^{0}90. 9955	03^{0} 47. 0249	6.3
26	NGP 26	07^{0}11. 5509	03^{0} 48. 0612	10.1
27	NGP 27	07^{0}13. 2191	03^{0} 48. 5814	6.0
28	NGP 28	07^{0}14. 5061	03^{0} 49. 2399	6.3
29	NGP 29	07^{0}17. 5718	03^{0} 51. 8841	3.6
30	NGP 30	07^{0}19. 2236	03^{0} 52. 3868	4.3
31	NGP 23	07^{0}70. 5181	03^{0} 45. 4009	6.8
32	NGP 24	07^{0}80. 8426	03^{0} 46. 0867	9.0

Plate 4.1: Showing air quality equipment at site

4.4 Quality Assurance / Quality Control

The overall focus was the application of international standards to Quality & Environmental aspects of the study thereby improving the project execution performance. The study was managed and administered according to strict Quality Assurance procedures under the control of specific procedures, which ensures that Client needs and requirements are met for all aspects of the assessment. The QA/QC programme covered all aspects of the study including sample collection, handling, laboratory analyses, data evaluation, data storage and report writing. The procedures all conformed to International Standard of Quality Management System (ISO 9001: 2015) & Environmental Management System (ISO 14001:2015). Thequality assurance programme used in the fieldwork and laboratory analyses is in accordance with international and National regulatory recommendations such as:

- Ensuring that only experienced and qualified personnel were engaged in the study

- Transportation of samples from the field to the laboratory in an advanced ultra-cold chain ice chest (< 4°C).
- Environmental biophysical samples collected were transported by chartered delivery van equipped with cooling requirements from Ibadan, Oyo State to Port Harcourt, Rivers State which served as the fast and controlled means of conveying samples from the field to the laboratory.
- Carrying out field calibrations of equipment and running distilled water blanks to reduce errors that could arise from field measurements.
- Ensuring that replicate samples were collected and used as checks of instrument performance.
- Carrying out field analytical operations in a defined sequence to avoid cross contamination of Instruments.
- Conducting in-situ Parameters such as temperature, pH, turbidity, electrical conductivity and dissolved oxygen because of their rapid change on storage as samples could be subject to microbial degradation and transformation. They were therefore analysed at minimum time after collection.

4.5 Description of the Baseline Environment

4.5.1 Climate / Meteorology

The meteorological and air quality analysis for the study area tends to underscore the state of atmospheric variables on the environment. Meteorological variables such as wind speeds and direction, relative humidity, temperature are crucial in the evaluation of pollutant dispersions and effluents from both anthropogenic and natural induced activities that take place in any environment. The atmosphere serves as sink or a medium of transfer through meteorological activities for these impacts. Rainfall is the key climatic variable and there is marked alternation of wet and dry seasons in most areas. Two air masses control rainfall — moistnorthward moving maritime air coming from the Atlantic Ocean and the dry continental air coming from the African Landmass. The climate of the area is affected by ocean and atmospheric interactions both within and outside its environment, in which the Inter-Tropical Convergence Zone (ITCZ) plays a controlling factor. The movement of the ITCZ is associated with the warm humid maritime Tropical air mass with its south-western winds and the hot and dry continental air mass with its dry north-easterly winds.

The assessment of climate variables such as rainfall, temperature, wind speed & direction, relative humidity, etc. are vital baseline variables for any proposed or ongoing project activity in any location. Ayoade (2004) emphasized that the weather producing system for the study environment is the monsoon which is determined by the wet and warm southwesterly winds coming from across the Atlantic Ocean and blowing towards the thermal low pressure system created by solar heating from the interior of West African spatial domain. Rainfall is the main climatic variable and there is obvious interchange of wet and dry seasons in the environment. Two air masses regulate rainfall regime – wet northward moving maritime air coming from the Atlantic Ocean and the dry continental air coming from the Saharan desert. The climate of the environment is enhanced by the coastal atmospheric interactions of both land and ocean in which the Inter-Tropical Convergence Zone (ITCZ) over the ocean plays a controlling factor. The movement of the Inter-Tropical Discontinuity (ITD) inland is associated with the warm humid maritime tropical air mass with its southwestern winds and the hot and dry continental air mass with its dry north-easterly winds. Automated weather instrument and noise meters were used to record weather variables and noise levels for the project environment. To determine the exact ambient concentrations of particulate matter, a particulate counter with unit in micro gram per meter cube g/m3) was used. Other air quality parameters were monitored with Bosean instrument in parts per million (ppm). Air quality parameters measured include:

a) Nitrogen oxides

b) Sulphur oxides

c) Volatile organic compounds

d) Suspended particulate matters (PM_{25} and PM_{10})

e) Carbon monoxide

f) Methane

g) Ozone

h) Ammonia

i) Hydrogen sulphide

Thrity (30) monitoring stations with five controls inclusive were established for air quality field records. The assessment of the air quality of the study environment was necessary in order to determine the status of the area and parameters determined were mainly those of public and health concern.

Table 4.4 Meteorology Statistical Analysis

Parameters	Minimum	Maximum	Mean	Standard Deviation
Air temperature (^oC)	29.0	30	29.0	0.95
Air pressure (mbar)	1040	1062	1045	25.0
Relative humidity (%)	64	83	68.0	117.1
Wind speed (m/s)	0.5	3.8	3.0	0.25

Source: Field Survey 2022

4.5.1.1 Rainfall Pattern

There were slight to moderate rainfall amount measured during the period of fieldwork amounting to about 0.8 mm. The study area is situated within the coastal climatic belt. In this belt, rainfall variation is the most important variable for the determination of season. The annual distribution begins with the early rains in March, which ceases in November. In general, there should be only two seasons, but in climatology four seasons are actually discernible for the area. These seasons too are differentiated by rainfall and they are theearly rainy season (March-July), little dry season (also called August break), late rainy season (September- November) and dry season (December-February). The most important role of rainfall to air pollution studies is that it acts as a scavenger by washing pollutants off the atmosphere. The amount and distribution of rainfall in the study area is such that it plays an important role in moving pollutants from the atmosphere to other spheres of the environment. The mean annual rainfall for the study area is above 1500mm and mean monthly rainfall distribution for a synoptic station to survey area as retrieved from existing 30 years (1990-2020) data are shown in Table 4.5. Highest rainfall value was obtained in June (374mm) while the lowest rainfall value was obtained in January (19 mm) within the period under review. It should be noted that rainfall is very important in environmental projects because of its power to cause erosion and erode soil particles from ground level surfaces.

4.5.1.2 Air Temperature

Maximum and minimum onsite temperature for was 32°C measured within 14:00 to 15:00GMT and the minimum recorded was 26 °C between 05:00 – 06:00GMT (Table 4.4). Analysis from the macro data shows that the months of July-September recorded lower temperatures (28-29°C) due to rainy periods while the months December to March recorded higher temperatures (32-34°C) due to intense solar radiation prevalent in the dry season (Table 4.5). The degree of air temperature is dependent on the amount of solar radiation received and this impact on the stability pattern of the atmosphere in the area.

4.5.1.3 Relative Humidity

The maximum relative humidity observed during fieldwork was 94%, recorded during periods of the dawn. The minimum recorded was 64% recorded during the afternoon periods. Relative humidity which measures water vapour in the atmosphere is noted to be low during dry season and high during the peak of rainy season due to the influence of moisture laden south-westerly's as seen from the macro average monthly results (Table 4.3). Also relative humidity was minimum during the afternoons and maximum at nights as indicated from the field data (Table 4.4). Figure 4.2 shows relative humidity and temperature values moving in opposite directions as ambient temperature increases percentage humidity decreases and vise-versa.

Table 4.5: Average Weather Trend for Lagos (1991-2021)

S/N	Month	Average Temp (°C)	Rainfall (mm)	Cloud Cover (oktas)	Pressure (mbar)	R/H (%)	Wind Speed (m/s)	Wind Dir.
1	January	30.5	17	5	1010	78	2.7	NE
2	February	31.2	51	6	1009	82	3.3	SW
3	March	30.6	87	6	1009	84	3.6	SW
4	April	29.7	140	6	1009	86	3.6	SW
5	May	29.2	249	7	1009	86	3.7	SW
6	June	28.3	379	7	1012	87	4.1	SW
7	July	27.6	239	7	1013	87	4.5	SW
8	August	27.9	95	7	1013	88	4.5	SW
9	September	27.4	210	7	1012	89	4.2	SW
10	October	28.2	169	6	1011	86	3.6	SW
11	November	30.1	62	6	1010	82	2.9	SW
12	December	31.6	19	5	1010	77	2.6	NE

Source: NIMET, Lagos.

4.5.1.4 Wind Speed/Direction

Mean diurnal wind speed measurement during field survey was 1.5 m/sec. Mostly, wind speeds were slightly moderate during the periods of afternoons/evenings and lower at dawn. The prevailing wind direction during field survey was the southwesterly winds as presented in the wind rose below (Figure 4.2). This implies that any released air emissions will be blown mainly towards the northeast direction of the studyenvironment. Figure 4.2 show the direction in which the wind is heading to during period of field survey. Wind speed classification shows that range 0.5 - 2.lm/s constituted 75.9% while other ranges were insignificant (Figure 4.3). This low wind observation indicates the vast vegetation that overwhelms the environment thereby breaking the free flow of surface winds. It is however the period of calm that is of importance in evaluating pollutants emissions. If the air is calm, pollutants cannot disperse, and then the concentration of these pollutants will build up. On the other hand, when strong, turbulent winds blow, pollutants disperse quickly, resulting in lower pollutant concentrations. In pollution meteorology calms are associated with inversions (temperature increasing with height). Inversion may result in fumigation; meaning that emissions are trapped at ground level close to their source as against other situations where it is dispersed and diluted much more easily. Inversion is widely known to be frequent during the early hours of the day. A 30-year mean macro data shows that wind speed over the study environment is generally moderate and this signifies a moderate dispersive potential of the local boundary layer atmosphere.

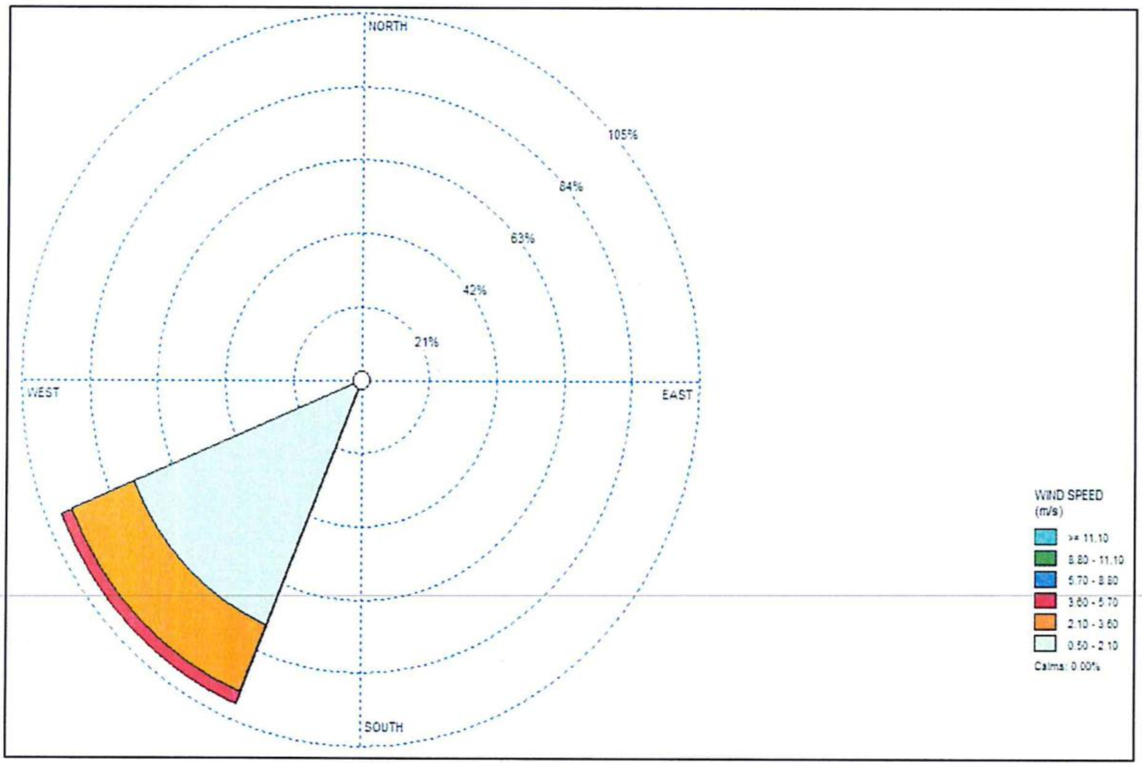

Figure 4.2: Diurnal wind rose pattern of study environment for September, 2022

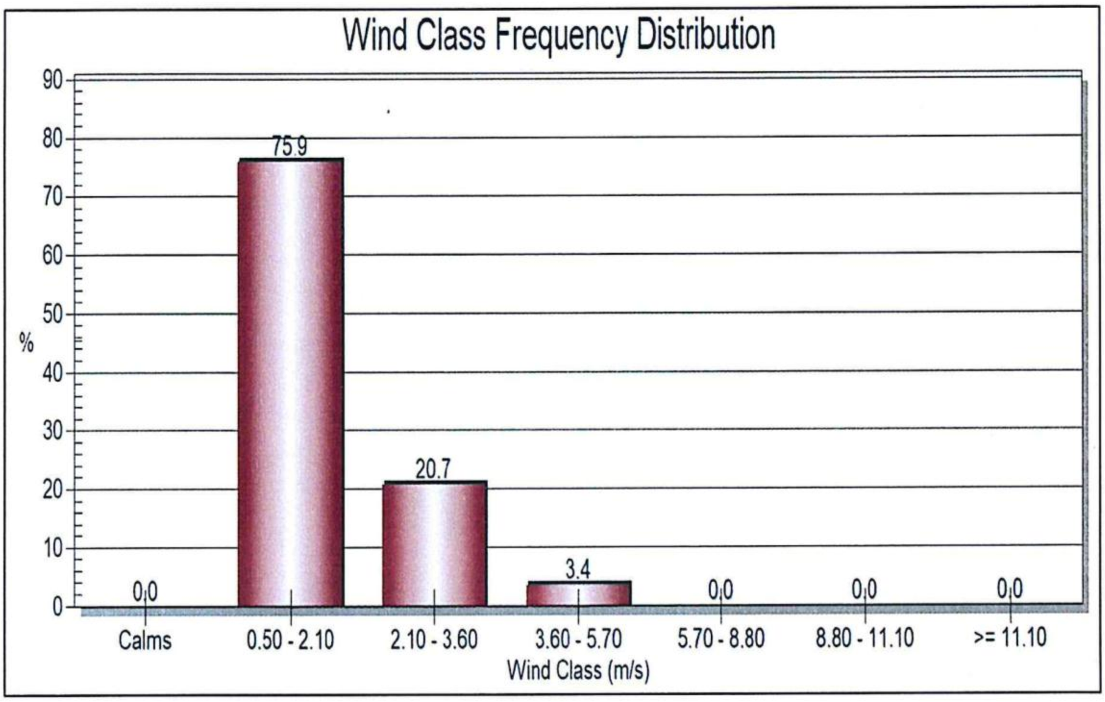

Figure 4.3: Diurnal wind speed record for study environment for September, 2022

Figure 4.4: Aerial View of Wind Direction Pattern for Study Environmental for September, 2022

4.5.1.5 Cloud Cover

Mostly the weather condition during the period of field observation was moderately cloudy. Average cloud cover for the area from 1991-2021 indicated values of about 6-7 oktas throughout the year. This long term trend signifies the high rate of rising moist air mass due to the abundant water content in the study area which gives rise to convective clouds. The lapse rate pattern for the area under review tends towards the moist adiabatic lapse rate (MALR). High amounts of cloud inhibit instability that decreases the dispersion of plumes and lower amounts promote unstable conditions which enhances atmospheric dispersion of plumes. Cloud cover is prominent during rainy periods and minimal during dry seasons which allow the penetration of solar energy leading to increased heat during these periods.

4.5.1.6 Atmospheric Pressure

Atmospheric pressure at sea level measured during the period of field survey was between 1035-1045 mbar. An important characteristic of the atmosphere is its pressure as it often determines wind and weather pattern across an area. The normal range of the earth's air pressure is from 970mbar to l050mbar. Air pressure differences across various locations are the results of unequal heating across surfaces. This leads to wind blowing from high pressure areas towards low pressure areas. High pressure areas are usually associated with

high winds. Areas were air is warmed often have low pressure because the warm air rises and are called low pressure systems. Lows normally produces clouds, precipitation and other bad weather such as tropical storms and cyclones. Unlike areas of low pressure, the absence of clouds means that areas prone to high pressure experience extremes in diurnal and seasonal temperatures since there are no clouds to block incoming solar radiation or trap outgoing long wave radiation.

4.5.2 Ambient Air Quality Assessment

4.5.2.1 Criteria Pollutant

The assessment of the air quality of the study area was necessary in order to determine the baseline status of the area and investigated the possible contribution of the proposed project activities when it commenc es. The air quality parameters determined were mainly those of public and health concern. Average ambient air quality for the study area monitored shows that there are no significant levels of suspended particulate matter i.e. $PM_{2.5}$, and PM_{10} (between 4-45g/m^3) for all the stations sampled. Records show that the national, WHO and World Bank acceptable limits were generally not exceeded. Average records of other air quality parameters indicates Nitrogen (<0.2 ppm), sulphur dioxide (<0.1 ppm), carbon monoxide (0.9-3.06 ppm), VOC (<0.1-1 ppm), CH4 (< 3 ppm), while hydrogen sulphide (H_2S) and ozone (0) were <0.1 ppm. All pollutants were far below the ambient air quality acceptable limits.Ambient air quality measured for observed pollutants indicated a very low concentrations and far below set limits.

Table 4.6: Air Quality and Meteorology Measurement

PARAMETER	NGP1	NGP2	NGP3	NGP4	NGP5	NGP6	NGP7	NGP8
SOx (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NOx (ppm)	<0.1	<0.1	<0.1	<0.1	0.13	0.15	0.08	0.1
CO (ppm)	1	1	2	1	2	1	2	2
CxHy (ppm)	2	1	0	0	0	0	0	0
H_2S (ppm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
O_3 (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NH_3 (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC (mg/m^3)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Temperature (^{0}C)	26	27	28.5	29.3	29.5	31.5	31.8	29.5
Pressure (Mbar)	1056	1056	1064	1064	1064	1053	1054	1054
Relative Humidity (%)	94	90	85	80	80	72	68	66
Wind Director	SW	SW	SW	SW	SW	SW	SW	SW
Wind Speed (m/s)	2.0	1.9	1.8	1.4	1.3	3.0	2.4	1.6
$Spm_{1.0}$ (µg/m^3)	42	41	32	20	31	23	12	09
$Spm_{2.5}$ (µg/m^3)	37	36	28	18	26	19	11	07
Noise (dBA)	58	63	65	63	68	67	68	68

PARAMETER	NGP9	NGP10	NGP11	NGP12	NGP13	NGP14	NGP15	NGP16
SOx (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NOx (ppm)	0.10	0.09	0.03	0.06	0.03	0.03	0.04	0.01
CO (ppm)	1	1	1	1	1	1	1	1
CxHy (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
H_2S (ppm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
O_3 (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NH_3 (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC (mg/m^3)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Temperature (^{0}C)	31.2	30.5	30.9	31.6	30.9	30.9	32.0	31.1
Pressure (Mbar)	1058	1057	1056	1056	1056	1056	1047	1047
Relative Humidity (%)	70	72	72	76	72	72	75	76
Wind Director	SW	SW	SW	SW	SW	SW	SW	SW
Wind Speed (m/s)	2.4	2.0	2.2	3.4	2.2	2.2	3.0	3.1
$Spm_{1.0}$ (µg/m^3)	9	9	11	13	11	11	11	13
$Spm_{2.5}$ (µg/m^3)	8	7	10	12	10	10	10	12
Noise (dBA)	54	65.5	66	63	66	66	53	58

PARAMETER	NGP17	NGP18	NGP19	NGP20	NGP21	NGP22	NGP23	NGP24
SOx (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NOx (ppm)	<0.1	<0.1	<0.1	<0.1	0.103	<0.1	<0.1	<0.1
CO (ppm)	1	1	1	1	1	1	1	1
CxHy (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
H_2S (ppm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
O_3 (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NH_3 (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC (mg/m^3)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Temperature (^{0}C)	27.9	28.3	27	27.4	29.2	28.4	29.0	29.0
Pressure (Mbar)	1057	1057	1050	1050	1057	1057	1055	1057
Relative Humidity (%)	86	86	93	92	84	87	80	85
Wind Director	SW	SW	SW	SW	SW	SW	SW	SW
Wind Speed (m/s)	1.3	1.3	1.1	1.2	1.0	1.1	1.0	1.2
$Spm_{1.0}$ (µg/m^3)	15	12	11	10	85	11	11	11
$Spm_{2.5}$ (µg/m^3)	12	11	10	9	61	10	9	9
Noise (dBA)	43	49	46	50	44	47	44	44

PARAMETER	NGP25	NGP26	NGP27	NGP28	NGP29	NGP30	NGPC1	NGPC2
SOx (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NOx (ppm)	<0.1	<0.1	<0.1	<0.1	0.103	<0.1	<0.1	<0.1
CO (ppm)	<0.1	<0.1	<0.1	1	1	1	1	<0.1
CxHy (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
H_2S (ppm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
O_3 (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NH_3 (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC (mg/m^3)	<0.1	<0.1	<0.1	0.004	<0.1	<0.1	<0.1	<0.1
Temperature (^{0}C)	30.4	30.9	30.9	30.9	29.8	29.4	29.7	29.7
Pressure (Mbar)	1047	1047	1047	1046	1047	1046	1046	1044
Relative Humidity (%)	80	76	75	75	81	83	80	89
Wind Director	SW	SW	SW	SW	SW	SW	SW	SW
Wind Speed (m/s)	1.1	1.5	2.2	1.2	2.8	1.0	1.0	1.0
$Spm_{1.0}$ (µg/m^3)	11	11	6	9	11	14	16	15
$Spm_{2.5}$ (µg/m^3)	10	10	6	8	10	14	14	13
Noise (dBA)	43	46	54	59	56	58	60	61-68

Table 4.6.2 Air Quality Statistical Analysis

Parameters	Minimum	Maximum	Mean	Standard Deviation
SOx (ppm)	0.004	0.05	0.00864	0.000044
NOx (ppm)	0.018	0.146	0.04142	0.00036
CO	0.90	3.06	1.202208	0.48
CH_4 (ppm)	0.00	2.00	0.175160	0.11
H_2S	0.01	0.04	0.010211	0.0000008
O_3 (ppm)	0.01	0.03	0.027044	0.000012
NH_3 (ppm)	0.004	0.051	0.004102	0.00012
VOC (ppm)	0.001	0.1800	0.018518	0.000003
PM_{10}	3	85	16.0335	86.7
$PM_{2.5}$	4	45	13.4113	51.8
Noise (dBA)	45	70	56.0	39.6

Source: Field Survey 2022

Table 4.7: Nigerian Ambient Air Quality Standard

Pollution	Time of Average	NURC Limit	FMEnv Limit
Particulates	Daily average of daily	60-90	250 µg/m3
	Values 1 hour	150-230	600 µg/m3
Sulphur Oxides (SOx)	Daily average of hourly values 1 hour	100-150 350	0.01ppm (26 µg/m3) 0.1ppm (260 µg/m3)
Non-Methane Hydrocarbon	Daily average of hourly values 3 hour	-	160 µg/m3
Carbon monoxide	Daily average of hourly values 8 hourly average 1-hour mean	10 30	10ppm (114 µg/m3) 20ppm (22.8 µg/m3)
Nitrogen Oxides	Daily average of hourly values (range)	150 400	0.04ppm-0.06ppm (75.0 µg/m3 – 112 µg/m3)
Photochemical Oxidant	Hourly values		0.06ppm

Source: FEPA, 1991.

Climate and Meteorological conditions play a crucial role in ambient air pollution by affecting both directly and indirectly the emissions, transport, formation, and deposition of air pollutants. The obtained differences between the dry and wet season results (Table 4.8) are found appropriate to suggest a relationship between the change in pollution levels and climatic variables, also to derive possible predictions of sequences of climate change in regard to air pollution. It is very clear that the contributions of these meteorological factors cannot be over-emphasized as they assist in predicting the behavior of air pollutants i.e. plume rise, transport and dispersion in the atmosphere. Air movements influence the fate of air pollutants necessitating the study of local weather patterns (meteorology) during the air pollution study.

Table 4.8: Wet and Dry Season Result Comparison

Parameters	**2022 (Wet season)**	**2020 (Dry season)**
SOx (ppm)	<0.1	<0.1
NOx (ppm)	0.03-0.15	0.01-0.3
CO	3.60	1-5
CH_4 (ppm)	0.1-2	0.1-1.2
O_3 (ppm)	<0.1	<0.1
NH_3 (ppm)	<0.1	<0.1
VOC (ppm)	<0.1	<0.1
SPM (µg/m^3)	2.85	9-198

Source: Fieldwork 2022

4.5.2.2 Air borne Metals

Air-born metals that are typically linked with chronic health effects (WHO, 1999). Air borne metals when deposited in the lungs have the potential to cause serious irritations leading to bronchitis and exacerbation of existing lung conditions such as asthma. Lung cancers have also been reported following long term exposure to metals in the air. The concentrations of heavy metals in the air environment of the project area were generally low (<0.0lppm) for Rainy season. The air-borne metals concentrations therefore represent background values and indicate that the project area is midly impacted from man-made and vehicular contributions (Ajayi and Kamson, 1983).

Table 4.9: Average Air borne Metals

Stations	Fe (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Cr (ppm)	Cd (ppm)	Ni (ppm)	Pb (ppm)
NGP	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
NGPC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01

Source: Field work 2022

Plate 4.2: Showing data gathering at site

4.5.3 Noise Levels

Noise levels were observed to be low and within acceptable limits during low and peak construction activities at the stage of field work except at cases were power generation sets as well as both smaller and bigger vehicular movements' transverses the close by road thereby increasing ambient noise levels. Noise level ranged between 45dB (A) to 70dB (A) with periods of low activity ranging between 42dB (A) to 60dB (A) and periods of more activities ranging between 60dB(A) to 78d(BA). Details of the noise level measurements captured during fieldwork are provided in the Tables 4.10 below.

Table 4.10: Noise level Statistical Analysis

Parameters	Minimum	Maximum	Mean	Standard Deviation
Noise (dBA)	45	70	60.1	39.5

Vehiclula Influenced Noise

Parameters	Minimum	Maximum	Mean	Standard Deviation
Noise (dBA)	50	78	65.1	52.5

Source:Fieldwork 2022

Depending on the distance of a monitoring station to the close by road, a passing automobile could increase the background to noise level, hence the distinction in Table 4.10 between background vehicular Noise in the study area. Traffic disturbances for various stations ranged between 50dB (A) for the most remote sampling site to 78dB (A) in stations adjacent the highway. All values recorded were below the Nigeria's Noise Exposure Limits set within the various durations (Table 4.11).

Table 4.11: Noise Exposure Limits for Nigeria

Duration per Day, Hour	Permissible Exposure Limit dB (A)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

Source: FEPA, 1991.

Table 4.12: Maximum Allowable Log Equivalent (Hourly Measurement) in dB (A)

Receptor	Day-time (7:00-22:00)	Night-time (22:00-7:00)
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Source: World Bank, 1998.

Noise levels monitored were moderate and within ambient standards, except for periods of increased human and vehicular activities which increases the noise levels.

4.5.4 Vegetation

In the study area, that is the stretch of Nipco Gas Limited gas pipe line project, a total of sixty-four (64) tree/shrub species were encountered and enumerated. This is shown in Table 4.13, it was clearly observed that from the sixty-four observed tree/shrub species occurrences, eight (8) species were abundant. The species in abundance are *Ficus exasperate, Cassia sp, Eleais guinensis, Albilazia, Anthocleista vogelii, Bambusa vulgaris, Neuwboidia leavis and Tectona grandis* in the same vein, five species were commonly found across the span of the pipe line which are given as*Rauvolfia vomitoria,* *Pjcnantus angolensis, Spondias mombin, Gmelina aborea* and *Aichornea cord jiblia*. On the other hand, there were some occasionally occurring species which were seven in number namely *Baphia nitida, Alstonia boonei, Anthonota macrophjlla, Magnjlèra indica, Heavea brasiliensis, Pentachletra macropiiylla* and *Allanblakia* floribunda. Similarly, the bulk of the tree/shrub species were rare which were forty-four in number. the species are *Nauclea derdrichic, Ficussur, Ceiba bombax, Picralima nitida, Rap hia Africana oteddoh, Melida excelsa, Terminelia catapa, Entandrophragma cylindricum,Coconucijèra, Cola nitida, Anarcadium occidentalis, Hura crepitans, Annona muricata, Chysopiyllum albidum, Aadirachta indica, Funtumia elastica Musanga cecreipoides, Ceiba buenopoenes, Sterculia tragecanthaAntidesina lucinatun, Iruingiagabonensis, Raphia hooleeri, Funtumia Africana, Juglans regia, Aistonia macrophjlla, Terminelia superba, Jacaranda mimosjlblia, Dracaena aborea, Tetrapleura tetraptera, Pterocetpus osun, Boerhia leavis, Harungana madagascariensis, Artocarpus altilis, Moringa oljlera, Ritinodendron leudelothii, Acacia sp, Phoenix reclinata, Citrus sinensis, Persea Americana, Lophira alata, Pterocatpus erinaceaus, ,Quecus sp, Parkia bicolor* and Danielli oliveri. Therefore, in terms of the total frequency of occurrence across the length of the gas pipeline project in relation to the various families, there were a total of thirty-two species families that occurred in the study area.

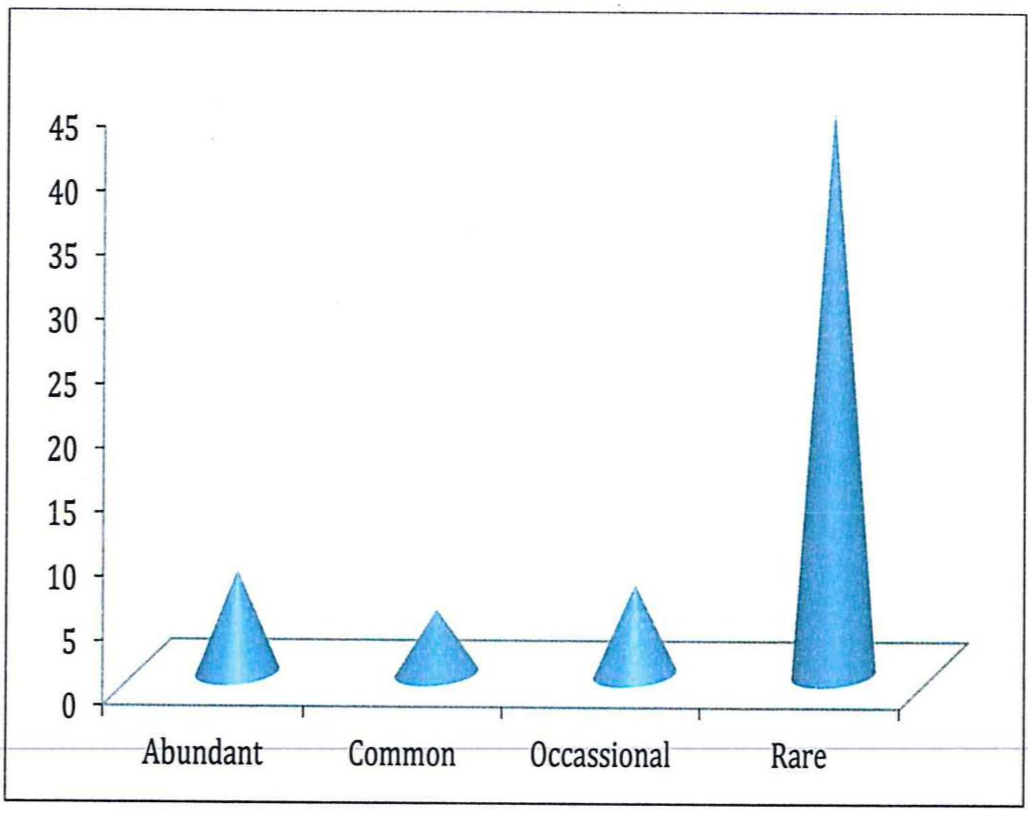

Figure 4.5: General Tree/Shrub Species Composition across the ROW

Tree/Shrub Species Composition along Ogun Stretch

Within the Ogun state stretch of the proposed gas pipeline which covered sixteen sampling stations had a total of forty-five tree/shrub species within twenty-three families which is shown in Table 4.14. From Table 4.14, five species namely *Cassia sp, Neuwboldia leavis, Alchornea cord jiblia, Spondias mombin and Eleais guineensis were* abundantly present in the area. Further, the commonly occurring species were eight in number given as Gmelina aborea, Pjicnanthus angolensis, Alstonia boonei, Ficus exasperate, Albirlia rygia, Rauvolfia vomitoria, Anthocleista vogelii and Magnjftra indica. On the other hand, there were seven species that were occasionally occurring in the area. The species were Baphia nitida, Bambusa vulgaris, Nauclea dendrichii, Ceiba bombax, Raphia Africana oteddoh, Coco nucifera and Pentachlethra macrophjilla. In the same vein, a total of twenty-five species were seen to be rare across the area of the project. The twenty-five species are Alstonia macrophjlla, Tectona grandis, Musanga cerepiodes, Entandrophragma cylindricum, Terminelia catapa, Funtumia elastic, Juglans regia, Sterculia tragacantha, Antidesima lucinatum, Picralima nitida, Ficus sur, Melicia excels, Anthonota macrophylla, Heavea brasiliensis, Cola nitida, Anarcadium occidentales, Hura crepitans, Annona muricata, Chrysophyllum albidum, Azadirachta indica, Irvingia gabonensis, Raphia hookeri and Funtumia Africana.

Table 4.13: General tree/shrubs Composition in Ogun State

S/N	Scientific Names	Common Name	Family	Frq	Ecological Status			
					A	C	O	R
1	*Alstonia macrophylla*	Milk wood	*Apocynaceae*	1				X
2	*Cassia sp*	Candle bush	*Fabaceae*	15	X			
3	*Tectona grandis*	Teak	*Lamiaceae*	3				X
4	*Gmelina aborea*	Gmelina	*Lamiaceae*	6		X		
5	*Neuwboldia leavis*	Boundary tree	*Bignoniaceae*	10	X			
6	*Musanga cecrepoides*	Umbrella tree	*Urticaceae*	3				X
7	*Ciaiba buenopozenes*	Cotton tree	*Malvaceae*	2				X
8	*Pycnathus angolensis*	African walnut	*Clusiaceae*	7		X		
9	*Baphia nitida*	Camwood	*Fabaceae*	4			X	
10	*Alchornea cordifolia*	Christmas bush	*Euphorbiaceae*	10	X			
11	*Alstonia boonei*	Stool wood	*Apocynaceae*	9		X		
12	*Teminelia superba*	Limba or Afara	*Combretaceae*	1				X
13	*Entandrophragma cylindricum*	Sapele mahogany	*Meliaceae*	2				X
14	*Terminelia catapa*	Country almond	*Combretaceae*	1				X

15	*Funtimia elastic*	Rubber	*Apocynaceae*	3				X
16	*Ficus exasperate*	Sand paper	*Moraceae*	7		X		
17	*Juglasns regia*	Persia walnut	*Juglandaceae*	2				X
18	*Spondias mombin*	Hog plum	*Anacardiaceae*	10	X			
19	*Albizia zygia*	Sterculiaceae	*Fabaceae*	9		X		
20	*Sterculia thragacantha*	African tragacanth	*Sterculiaceae*	2				X
21	*Antidesima lucinatum*	Antidesima	*Phylathaceae*	2				X
22	*Picralima nitida*	Picralima	*Apocyaceae*	2				X
23	*Rauvolfia vomitoria*	Swizzle stick or poison devils pepper	*Apocyneacea*	9		X		
24	*Eleais guineensis*	Palm tree	*Arecaceae*	10	X			
25	*Anthocleista vogelii*	Velvet bush willow	*Gentianaceae*	6		X		
26	*Bambusa vulgaris*	Bamboo	*Bambusae*	5				
27	*Nauclea dendrichii*	Opepe	*Rubiaceae*	4			X	
28	*Ficus sur*	Sand paper tree	*Moraceae*	2			X	X
29	*Ceiba bombax*	Cotton tree	*Malvaceae*	5				
30	*Raphia Africana ottedoh*	Raffia palm	*Arecaceae*	4			X	
31	*Melicia excels*	African teak	*Moraceae*	3			X	X
32	*Anthonota macrophylla*	African rosewood	*Caesalphinaceae*	3				X
33	*Magnifera indica*	Mango	*anacardiaceae*	6		X		
34	*Heavea brasiliensis*	Rubber tree	*Euphorbiaceae*	1				X
35	*Coco nucifera*	Coconut tress	*Arecaceae*	5			X	X
36	*Cola nitida*	Kolanut	*Sterculiaceae*	1				X
37	*Anarcadium occidentalis*	Cashew nuts	*Anacardiaceae*	2				X
38	*Hura crepitans*	Sand box tree	*Euphorbiaceae*	1				
39	*Pentaclethra macrophylla*	Africa oil bean	*Fabaceae*	4			X	
40	*Annona muricata*	Soursop	*Anonaceae*	1				X
41	*Chrysophyllum albidum*	Star apple (udara)	*sapotaceae*	1				X
42	*Azadirachta indica*	Neem tree	*Meliaceae*	1				X
43	*Irvingia gabonensis*	Bush mango	*Irvingiaceae*	1				X
44	*Raphia hookeri*	Raffia palm	*Areceaceae*	1				X
45	*Funtumia Africana*	African wild rubber	*apocynaceae*	1				X
			Total	192				

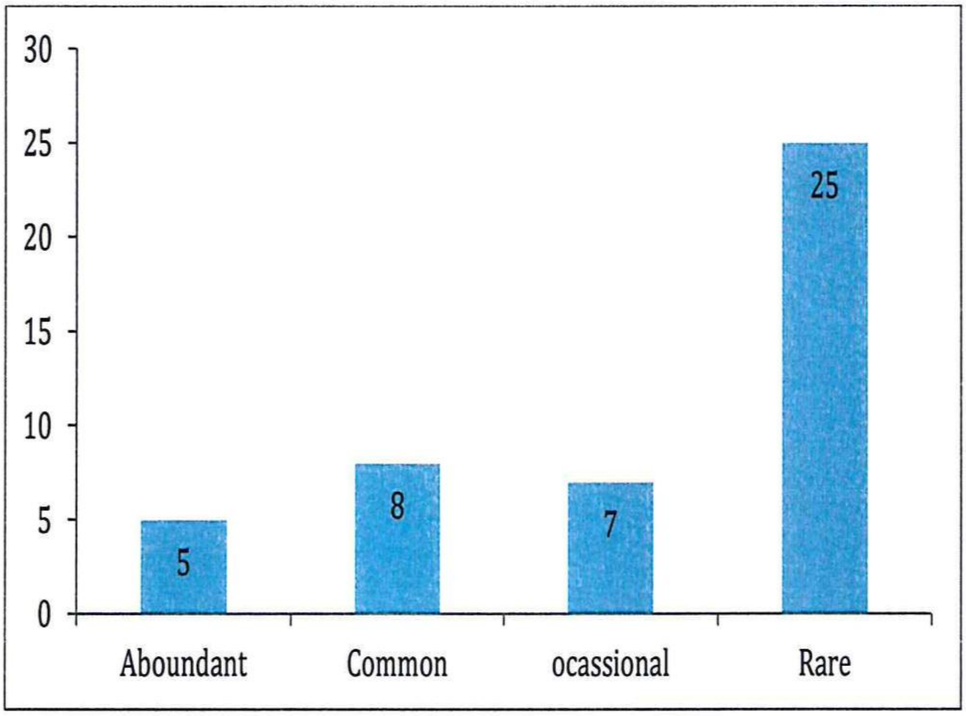

Figure 4.6: General tree/shrubs Composition in Ogun State

Tree/Shrub Species Along Oyo State Stretch

In consideration of the tree/shrub species along the Oyo state stretch of the proposed gas pipeline project, a total of forty-one species were encountered which were within twenty-two families. This is shown in Table 4.14. From Table 4.14, a total of three species were abundant namely *Eleais guineensis, Neuwboldia leavis, and Spondias mombin*. *Also, Rauvolfia vornitoria, Ficus exasperate, Cassia sp, Aichornea cordlblia, Albizja gia, Pjcnathus angolensis, Anthocleista voge1ii, Barn busa vulgaris, Grnelina aborea, Tectona grandis, and Allanbiakia floribunda*. Invariably, only two species were occasionally found in the area which are *Aistonia boonei and Anthonota nativphjilla*. Twenty-five species were rare in the area and they are as follows: *Baphia nitida, Ficus sur, Ceiba bombax, Raphia Africana oteddoh, Magnftra indica, Coco nudfera, Pentachlethra rnac-rophjlla , Annona muricata, Aadirachta indica, Funturnia elastica, Antidesirna ludnaturn, Irvingia gabonensis, Funturnia Africana, Juglans regia, Jacaranda minosifolia, Draceana aborea, Tetrapleura tetraptera, Boeorhia leavis, Harungana madagascariensis, Artocarpus altilis, Moringa oljfera, Ricinodendron heudelotii, Acacia .b, and Phoenix sp.* These species were collected from twelve sampling points along the pipeline project stretch.

Table 4.14: General tree/shrubs Composition in Oyo State

S/N	Scientific Names	Common Name	Family	Frq	Ecological Status			
					A	C	O	R
1	Baphia nitida	Camwood	Fabaceae	3				X
2	Rauvofia vomitoria	Poison devil pepper	Apocynaceae	6		X		
3	Ficus exasperate	Sand paper	Moraceae	8		X		
4	Cassia sp	Candle bush	fabacee	9		X		
5	Eleais guineensis	Palm tree	Arecaeae	10	X			
6	Alchornea cordifolia	Christmas buch	Auphobiaceae	6		X		
7	Alstonia boonei	Stool wod	Apocynaceae	4			X	
8	Albizia zygia	Nongo	Fabaceae	8		X		
9	Pycnanthus agloglensis	African nutmeg	Myristicaceae	8		X		
10	Athocleista vogelii	Velvet bush willow	Gentianaceae	7		X		
11	Bambusa vulgaris	Bamboo	Bambusae	6		X		
12	Ficus sur	Sand paper	Moracee	2				X
13	Ceiba bombax	Silk cotton tree	Malvaceae	1				X
14	Neuwboldia leavis	Boundary tree	Bignoniaceae	10	X			
15	Spondias mombin	Hog plum	Anacardiaceae	10	X			
16	Raphia African otedoth	Raffia palm	Arecaceae	2				X
17	Anthonota macrophylla	African rosewood	Caeslphinaeae	4			X	
18	Magifera indica	Mango	Anacardiaceae	3				X
19	Coco nucifera	Coconut	Necaceae	3				X
20	Petaclethra macrophylla	African beans	Fabaceae	3				X
21	Annona muricata	Soursop	Annonaceae	1				X
22	Gmelina aborea	Gmelina	Lamiaceae	9		X		
23	Azardirachta indica	Neem	Meliaceae	2				X
24	Funtumia elastic	West African rubber tree	Apocynaceae	3				X
25	Tectona gradis	Teak	Lamiaceae	7		X		
26	Antidesima lucinatum	Hanp	Phyllataceae	2				X
27	Irvingia gabonensis	Bush mango	Irvingiaceae	1				X
28	Funtumia Africana	Rubber tree	Apocynaceae	1				X
29	Juglans regia	Persian walnut	Julandaceae	3				X
30	Allabrakia floribunda	Tallow tree	Clusiaceae	6		X		
31	Jacaramda mimosifolia	Jacaranda	Bignoniaceae	1				X
32	Dracaena aborea	African dragon tree	Aspaeagaceae	2				X
33	Tetrapleura tetraptera	Aidan fruit	Fabaceae	1				X
34	Pterocarpus osu	Bokyi book	Leguminose	1				X
35	Boerbia leavis	White broomweed	Rubiaceae	2				X
36	Hurugana Madagascariensis	Dragon's blood tree	Hypericaceae	1				X
37	Artorpus altilis	Bread fruit	Moraceae	1				X
38	Moringa olifera	Moringa	Morinaceaa	1				X
30	Ricinodendron beudelotii	Akpi	Euphorbiaceae	2				X
40	Acacia sp	Wattles	Fabaceae	2				X

41	Phoenix reclinata	Date palm	arecaceae	1				X
			Total	**163**				

Source: Fieldwork 2022

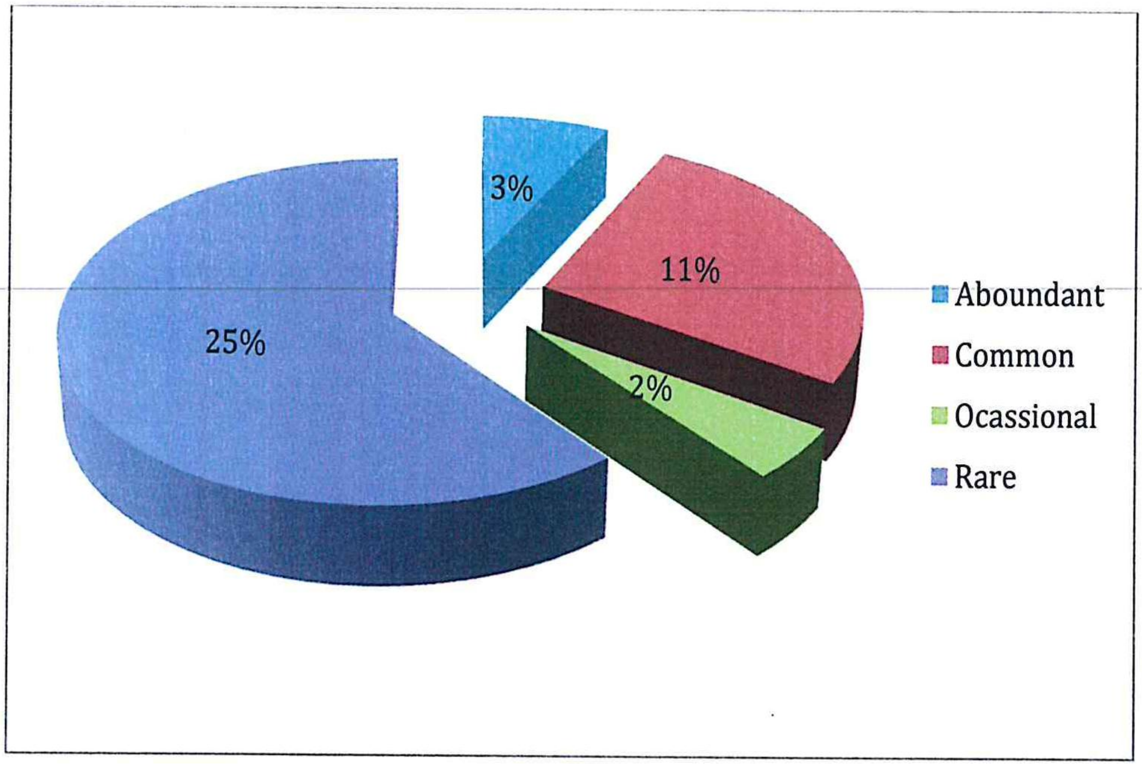

Figure 4.7: General tree/shrubs Composition in Oyo State

Herbaceous Species Composition in the Area

The herbaceous species encountered are highly contiguous and overlapping across project area. However, a total of forty- eight species of herbs were identified and documented. From the observed composition, nineteen herbaceous species were abundant in the area. The species were *Aspilia Afticana, Panicum maximum, Mimosa pudica, Amaranthus Jpinosus, Ageratum co,yoids, Cretus lobatus, .Euphorbia heterophjlla, Centrosema pubescens, Spermacole venticilata, Commelina beghalensis, Cleome ratisdoiperma, Calapogonium mucunoides, Echinochloa pjramidalis, Tridax precumbens and Chromoleana odorata.* The twenty-three species that were commonly encountered were *Indgofira linsitoila, Colena lobata, Peperonia pellucid, Boarhvia dffusa, Lapatea aesthes, Spermacole ocynoides, Eleusine indica, Laipatea ovalifolia, Aryhoriacordata, Phjllanthus amarus, Tithonia diversf blia, Andropogon tectorum, Spzgelia enthelmia, Kjillinga bulbosa, Alternanthera sessicis, Costus afer and Stachjterpheta cqyennensis, Ocimum gratissimum, Vernonia amjgdalinaandCorthorus olitorius*. On the other hand, eight species were occasionally found given as *Saccharium octic-inarium, Brachiaria dejiexa, Zea mqys,* *Caladium bicolor, Gloriosa superba, Chysopogon Aciculatus, Comma indica* and *Axonopuscampressus*. However, only one species was rare in the area namely *Sesanum* indicum.

Table 4.16: General Herbaceous Species Composition

S/N	Scientific Names	Common Name	Species Family	Ecological Status			
				A	C	O	R
1	*Aspilia Africana*	Haemohage plant	*Asteraceae*	X			
2	*Indigofera binsituta*	Indigo	*Fabaceae*		X		
3	*Urena labota*	Caditto	*Malvaceae*		X		
4	*Peperomia pellucid*	Silver plant	*Urticaceae*		X		
5	*Panicum maximum*	Guinea grass	*Poaceae*	X			
6	*Mimosa pudica*	Sensitive plant	*Fabaceae*	X			
7	*Saccharum octicinanum*	Sugar cane	*Andropogonem*			X	
8	*Boerbavia diffusa*	Red spidering	*Nyctaginaceae*		X		
9	*Larpatea aesthes*	Stringing herb	*Peperaceae*		X		
10	*Amaranthus spinosa*	Spiny amaranth	*Amaranthaceae*	X			
11	*Spermacole ocymoides*	Ezecma plant	*Rubiaceae*		X		
12	*Brachiaria deflex*	Elephant grass	*Poaceae*			X	
13	*Eleusine indica*	Bull grass	*Poaceae*		X		
14	*Larpater ovalifolia*	Striging nettle	*Urticaceae*		X		
15	*Zea mays*	Maize	*Maydeae*			X	
16	*Drymoria cordata*		*Caryophylliaceae*		X		
17	*Ageratum conyzoides*	Goat weed	*Asteraceae*	X			
18	*Croton lobutus*		*Euphorbiaceae*	X			
19	*Phyllanthus amarus*	Egg woman	*Euphorbiaceae*		X		
20	*Sida acuta*	Broom weed	*Malvaceae*	X			
21	*Caladium bicolor*	Devil's cocoyam	*Araceae*			X	
22	*Euphorbia heterophylla*	Spurge weed	*Euphorbiaceae*	X			
23	*Gloriosa superb*	Lily	*Liliaceae*			X	
24	*Centrosema pubescens*	Blue cento	*Fabaceae*	X			
25	*Tithonia diversifolia*	Mexican sunflower	*Asteraceae*		X		
26	*Spermacole venticillata*		*Rubiaceae*	X			
27	*Commelina beghalensis*	Wandering jew	*Commelinaceae*	X			
28	*Andropogon tectorum*	Giant blue stem grass	*Poaceae*		X		
29	*Cleome rutidosperma*	Consumption weed	*Corpparidaceae*	X			

30	*Calapogonium mucunoides*	Calapo	*Poaceae*	X			
31	*Echinochloa pyramidalis*		*Poaceae*	X			
32	*Paspalum arbiculane*	Ditch mullet	*Poaceae*	X			
33	*Spigelia enthelmia*	Warm weed	*Potaliaceae*		X		
34	*Imperata cylindrical*	Spear grass	*Poaceae*		X		
35	*Kyllingo bulbosa*	Sedge	*Cyparaceae*		X		
36	*Sesamum indicum*	Beni seed	*Pedaliaceae*				X
37	*Chrysopogon aciculatus*	Love grass	*Poaceae*			X	
38	*Canna indica*	Canna lily	*Cannaceae*			X	
39	*Alternanthera sessilis*	Khallei weed	*Amaranthaceae*		X		
40	*Costus after*	Bush cane	*Costaceae*		X		
41	*Axonopus compresus*	Carpet grass	*Poaceae*			X	
42	*Tridax procumbens*	Goat's button	*Asteraceae*	X			
43	*Stachyterpheta cayennensis*	Blue rat tail	*Asteraceae*		X		
44	*Chro,oleana odorata*	Siam weed	*Asteraceae*	X			
45	*Ocimum gratissimum*	Scent leaf	*Asteraceae*		X		
46	*Vernonia amygdalina*	Bitter leaf	*Lamiaceae*		X		
47	*Corchorus olitorius*	Jute leaf	*Malvaceae*	X			
48	*Kyllinga erecta*	Wire grass	*Cyparacea*	X			
		TOTAL	**48**	**19**	**20**	**8**	**1**

Source: Fieldwork 2022

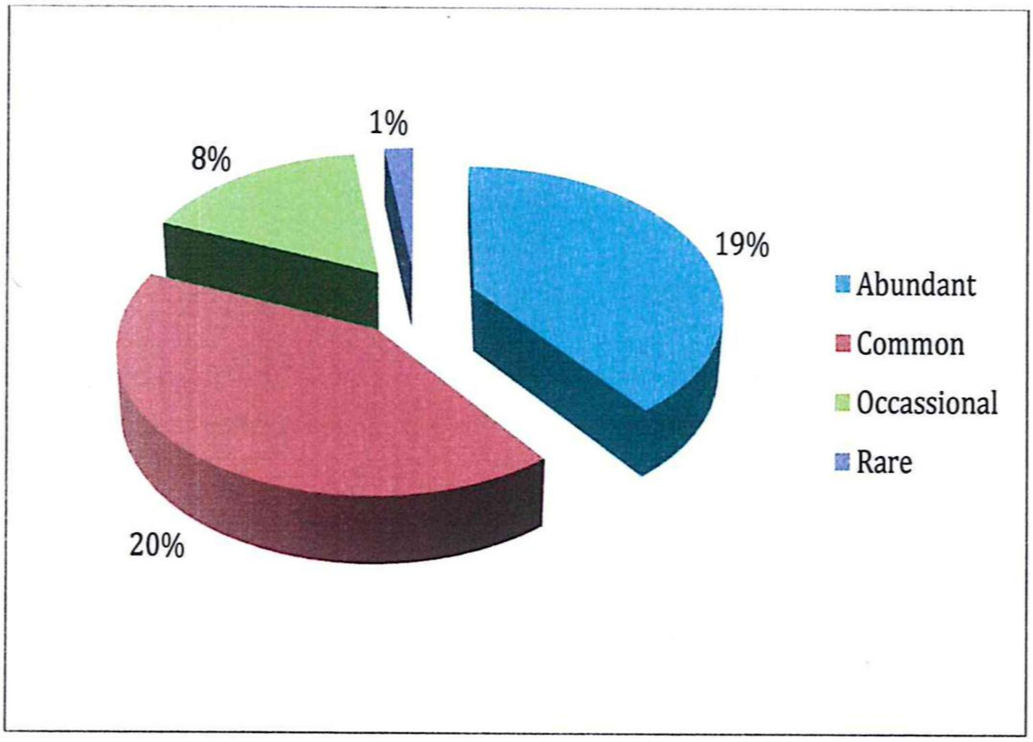

Figure 4.9: Herbaceous species composition in the area

Plant Health

Plants species were collected for the purpose of plant diseases and elemental analysis along the ROW of the gas pipeline. The species plants like *Ocimumgratissimum, Vernonia amygdalina, Amaranthus .b, Chromoleana odorata* and *Corchorus olitorius* etc. were spatially collected for the analysis. In sum, the general plant health was seemingly seen to be healthy however result of the study indicated that plant species close to the roads within the range of the RoW are impacted by dust and heavy metals due to the heavy volume of vehicular activities. However, some species from designated locations may have recorded some metal (Copper — Cu, Lead- Pb, Zinc — Zn, Iron — Fe, and Cadmium - Cd) range within and above the normal plant range. Despite the variation in metal content, even to a concentration level above the normal plant range among the species, the plants are said to be in their natural state with a tolerable metal accumulation to normal concentration standards of metal (mg/kg). There has been reflection between determining the comparison between the level of soil loading (concentration standard) with heavy metals as well as the severity with which each measured element contribute to one or other environmental factor or condition (Lacatusu et al., 1992). The quality of environment may be affected by different types of project. Similar trend could also take effect in the ecology of the vegetation on the RoW for the proposed Nipco Gas gas delivery pipeline project. This study attempted to consolidates this hypothesis by investigating the heavy metal chemistry of the flora around the pipeline vegetation complex. Plant often absorbs many poisonous substances in a concentrated form by evapo-transpiration and phytoextraction mechanism in the environment. Thus, eating plant or any other food from such site may even be more hazardous than drinking the water. Therefore the analysis of plant could be valuable source of information in the evaluation of the concentration and effect of heavy metals in the environments.

4.5.5 Wildlife (Fauna)

In the study area, a total of forty-two wildlife species were observed to be existing in the area. Given this observation, ten species were in abundance in the area namely *Bubucus ibis, Bufa reguaris, Milvus mgrans, Nectarina cupera, Queea quelea, Rattusfusczbes, Crecitomjs gambianus, Agama agama, Zenaida macruora, Streptopelia decaocto.* However, fifteen species namely *Epormorphous spp, Naja nigricois, Artherurus Africana, Buteo Jamaicensis, Rama gaamensis, Ophreodrqys vernais, Corvus abus, Thyonomjs swinderianus, Bucerotidae, Neophroen muneus, Pethona dentate, Veranus nibiticus Oranus, streptopelia Senegalensis and Numida meleagris.* The occasionally occurring animais' species were Boa constrictor, *Egreita garetta, Bitis gabonica, Xerus eythropus, Python sabae, Sunleus spp, Mysolex spp* and *Python regius. Nevertheless,* the rare species in the area were *psitaciJbrmes, leiniys erosa, genetta victoria, speothos venatians, pothamochoerus bravatus, crecodilus noliticus, nadina binotata, alcelaphinae, crecophitecus sclateri and gervittictis civetta.*

Table 4.17: Wildlife Species Composition

S/N	SCIENTIFIC NAMES	COMMON NAME	ECOLOGICAL STATUS			
			A	C	O	R
1	*Python regius*	Royal python			X	
2	*Bulbulcus ibis*	Cattle egret	X			
3	*Bufa regularis*	West African toad	X			
4	*Epormophous spp*	Fruit bat		X		
5	*Naja nigricolis*	Black cobra		X		
6	*Psittaciformes*	Parrot				X
7	*Milvus migrans*	Black kite	X			
8	*Kinixys erosa*	Serrated tortoise				X
9	*Artherurus Africana*	Brushed-tail porcupine		X		
10	*Buteo jamaicensis*	Hawk		X		
11	*Nectarinia cupera*	Copper sunbird	X			

12	*Quelea quelea*	Weaver bird	X			
13	*Agama agama*	African rainbow lizard	X			
14	*Rama galamensis*	Frog		X		
15	*Genetta Victoria*	Giant forest genet				X
16	*Speothos venatians*	Bush dog				X
17	*Sunkus spp*	Musk shrew			X	
18	*Boa constrictor*	Boa			X	
19	*Zenaida macroura*	Mourning dove	X			
20	*Ophreodrays vernalis*	Olive green snake		X		
21	*Pothamochoerus bravatus*	Bush pig				X
22	*Mysolex spp*	Mouse shrew			X	
23	*Crocodilus niloticus*	Nile crocodile				X
24	*Python sabae*	African rock python			X	
25	*Strptopelia decaocto*	Collard dove	X			
26	*Corvus albus*	Pied crow		X		
27	*Thryonomys swinderianus*	Grasscutter		X		
28	*Nadina binotata*	African palm civet				X
29	*Xerus erythropus*	Stripped ground squirrel			X	
30	*Alcelaphinae*	Duiker				X
31	*Rattus fuscipes*	Bush rat	X			
32	*Bucerotidae*	Hornbill		X		
33	*Crecitomys gambianus*	African giant rat	X			
34	*Numida meleagris*	Guinea fowl		X		
35	*Neophron munkus*	Hooded vulture		X		
36	*Egretta garzetta*	White heron			X	
37	*Bitis gabonica*	Gaboon viper			X	
38	*Pethona dentate*	Bush sparrow		X		
39	*Cercophitus sclateri*	Sclater monkey				X
40	*Civettictis civetta*	Africabn civet				X
41	*Veranus nibiticus oranus*	Nile monitor lizard		X		
42	*Streptopelia senegalensis*	Laughing dove		X		

Source: Fieldwork 2022

Plate 4.3: Showing vegetation and data gathering along the ROW

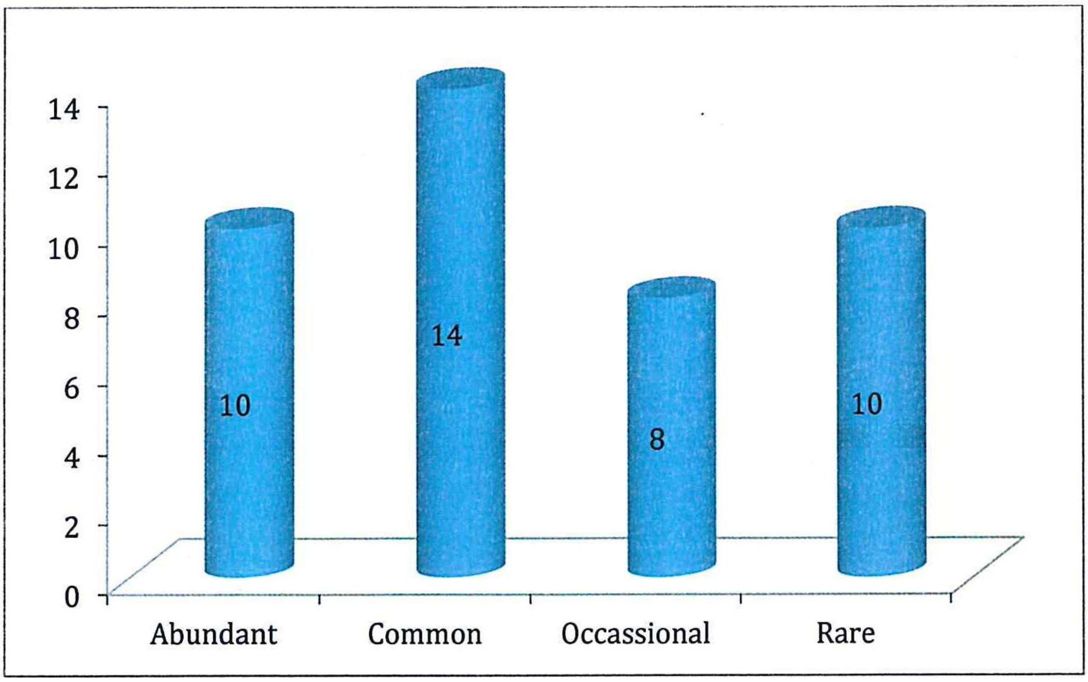

Figure 4.10: Wildlife species composition in the area

4.5.6 Soil

Physico-Chemical characteristics

In the topsoil, soil reaction (pH) in the wet season were generally acidic with values ranging from 4.18 - 8.05 and mean value of 5.85 while the dry season, the pH values ranged from 6.68 - 6.91 with mean value of 6.73 respectively. Similarly, the bottom soil pH values ranged between 3.98 and 8.11 with mean value of 5.76 in the wet season and varied from 6.66 - 6.79 with mean value of 6.73 in the dry season. Soil around the proposed Gas pipeline route after Ogere (SS6) Sagamu, Ogun state were measured to be more acidic with lowest pH value of 3.98 and 4.18 respectively while the highest pH value were recorded around Circular road Badeku, Ibadan, Oyo state (SS52) and (SS44) with values of 8.05 and 8.11 respectively. Soil pH influences the measure of chemicals and nutrients that can be dissolved in soil water, and in this way the measure of nutrients available to crops. Some nutrients are more obtainable in acidic soil while others are more obtainable in the alkaline soil. The increase of strongly acidic soils (that is less than 5 pH units) can result in poor crop productivity as a result of the following factors: manganese toxicity, aluminum toxicity, deficiency in calcium and magnesium, low levels of vital plant nutrients such as molybdenum and phosphorus Though there was significant seasonal variation in the soil reaction along the proposed pipeline route/study area, an insignificant variance was recorded when pH results from the study area are compared with control values. By soil textural classification, the soil around the proposed pipeline route could be classified as sandy-loamy and clay through dark, light brown, brown to reddish-brown in term of colouration. The soil porosities were of the mean values of 0.39 for both top and bottom soil in the wet season respectively. Similarly, the project area soils could be classified as fairly permeable, with values which exceeded not soil permeability critical level of 0.15 cm/s for a farmland (Foth1975).

Plate 4.4: Showing the representatives of Nipco, Diskol, FMEnv and OGSME during data gathering

Soil texture is defined as the potion of sad, silt and clay size particle that make up the mineral fraction. Soil texture distribution in the study area is presented in Figure 3. In Oyo, it is observed the texture sandy clay is of high dominance followed by the sandy loam, it is also observed that the texture of soil northward is mostly loamy sand and the texture of soil southward is clay loam. Considering Ogun, it is observed that the texture of sandy clay is dominating followed by the sandy loam and then the loamy sand. South western Nigeria has soil texture mostly composed of sandy loam, sandy clay, loamy sand and clay loam this indicates that it is composed of both sand and clay but there’s more percentage of sand in the soil, sandy soil have larger particles than clay and very unrestricted draining due to the air space in between particles; they are easy to work on and till but they dry out very fast and usually have poor productivity as the nutrients are basically washed away. Clayey soils are poised of minute mineral particles that shrink the air space in the soil; and cause the soil to absorb water and become easily compacted. Clayey soils are usually very fertile but need some enhancement to reveal some nutrients. Sandy loam is predominated by sand particles but contain sufficient clay and sediment to deliver some structure and fertility, they have the capability of draining water quickly and cannot retain significant amount of water and nutrients. Growing of plants in this soil type would necessitate regular irrigation and fertilization than soils with a greater clay concentration and sediments. Sandy loam soils are often poor in specific nutrients and may require additional fertilization to support healthy crop productivity. Loamy sand comprises of more than 25 percent of medium particles, less than 25 percent of the two coarsest particle types and less than 50 percent of fine or very fine particles. Clay loam is a mixture of soil that contains mostly clay than any other type of rocks or minerals; the particles of clay are very minor, which is one of its most significant characteristics; for this reason, barns that contain excessive clay have a tendency to be heavy, because they are so dense. Usually clay loam contains a good deal of plant nutrients and supports most types of plants and crop.

Drainage Pattern

In the south western Nigeria, the soil drainage varies from well drained to poorly drained soil. One of the major physical properties of soil which is important to crop production is drainage through the rooting zone. This characteristic greatly influences aeration in the rooting zone, and the degree of aeration greatly influences several important biochemical reactions of economic importance to crop production. The soil in Ogun State is observed to vary from well drained to somewhat poorly drained, some areas varies from moderately to poorly drained to very poorly drained. In Oyo state, it is observed that the soil in the east varies from well drained to very poorly drained soil; in the west, the soil is shown to be moderately well drained.

Land Use and Cover

The land cover/land use information obtained from satellite imagery and field survey of the project route is typical of a linear project where the project transverses diverse land use/cover types such as industrial, residential, farmlands, primary forest and secondary forest. The primary forests occupied approximately 1.5%, secondary forest 40%, sparse vegetation and bare soil 48%, built up area (urban/industrial) 10%, water constituted about 0.5% of the land area. Approximately 2,822 square metres representing 98% of the 2,880 square metres total land take of 160km by 18 metres width right of way is government owned. The RoW falls within the road buffer zone, which is kept for future expansion of roads or installation of infrastructures such as water pipelines, telecommunication and electricity cables etc

Chemical, Heavy Metals and Organics Properties

The available phosphate, total nitrogen, sulphates and carbonates levels in the topsoil were of the mean concentrations of 0.56mg/kg, 0.10%, 4.96mg/kg and 11.28mg/kg respectively in the wet season while bottom soil recorded mean concentration of 0.50mg/kg for available phosphate; 0.09% for total nitrogen, 3.54mg/kg for the sulphate and 8.70mg/kg for the carbonates. The cation exchangeable capacities (CEC) of the topsoil varied from 1.592 - 28.949meq/l00g in the wet season and 1.76 - 2.22meq/l00g in the dry seasons. Meanwhile, in the bottom soil, CEC values ranged from 1.335 - 24.706meq/l00g in the wet season and 1.81- 1.96meq/l00g in the dry season. Increase in CEC values recorded in both study area and the control sites confirms the significant leaching effect of soil acidity on soil nutrients (Ca, K, Na, and Mg) mostly occurring in the wet season than the dry season probably due to heavy rainfall in the region.

The summary of results of the heavy metals and organic levels in the topsoil and bottom soil respectively.Iron levels in the topsoil were markedly higher in concentrations with mean values of 4090.98mg/kg and384.28mg/kg in the wet and dry seasons respectively. Also in the bottom soil, a mean concentration of (3992.22mg/kg was recorded for Iron (Fe) in the wet season and 372.99mg/kg in the dry season. Zinc concentration mean levels in the topsoil were 15.67mg/kg and 30.68 mg/kg in the wet and dry season respectively while concentration mean values of 12.65mg/kg and 27.57mg/kg were recorded in the bottom soil. Also, Lead (Pb) levels in the topsoil were of the average values of 11.81mg/kg and 15.83mg/kg in the wet and dry season respectively while bottom soil recorded mean concentrations of 10.56mg/kg in the wet season and 20.61mg/kg in the wet season. There was no definite pattern for metals abundances in soils for both dry and wet season. The total organic carbon contents in the topsoil varied from 0.273- 3.705% with mean value of 1.20% in the wet season and 0.19 - 0.26% with mean value of 0.23%) in the dry season. Also, bottom soil in the project route had organic carbon contents in the range of 0.208 - 2.71% with mean value of 1.03% in the wet season and 0.16- 0.22% with mean value of 0.19%) in the dry season. However, total petroleum hydrocarbon (TPH) and oil and grease levels in soils of both the study area and control were below their respective detection limits (0.031mg/kg for TPH and 0.1mg/kg for oil & grease) of the analytical instruments, and as such the soil of the study area could be described as not polluted by petrogenic substances.

Soil Microbiology

Soil represents a very favourable habitat for microorganisms and is inhabited by a wide range of microorganisms, including bacteria, fungi, algae, viruses and protozoa. Microorganisms are found in large numbers in the soil (usually between one and ten million microorganisms are present per gram of soil) with bacteria and fungi being the most prevalent. The microbial load recorded in the topsoil is expectedly high and this may be due to its relatively organic matter load, which serves as source of energy and nutrients for microbes' growth. The hydrocarbon degraders (HUF and HUB) population densities were relatively low and their HUF and HUB population percentage were far below 10%, indicating very negligible petrogenic hydrocarbon pollution in the soil of the study area. The summary of the microbial loads in the soils of the proposed area are presented in the Tables for top soil and bottom soil respectively.

However, the availability of nutrients is often limiting for microbial growth in soil and may increase soil fertility and plant growth. The Total Heterotrophic Fungi TPH) and Bacterial (THB) load in the topsoil during the wet season ranged from 0.4 x 10 — 2.7 x 106 cfu/g and 2.2 x 10 — 3.1 x 106 cfu/g with an average values of 4.0 x i0 cfu/g and 9.0 x 10 cfu/g for both THF and THB respectively, while THF and THB population densities in the bottom soil ranged from 0.2 x 10 — 0.8 x 106 cfu/g and 1.4 x 105—1.9 x 106 cfu/gwith a mean of 1.6 x 10 cfu/g and 4.0 x 10 cfu/respectively.

Table 4.18.3: Statistical description of soil properties for Wet Season

Physic-Chemical Properties	Top soil (0 – 15 cm)				Bottom soil (15 – 30 cm)			
	Range	Mean	Standard deviation	Mean control	Range	Mean	Standard deviation	Mean control
Sand (%)	67.4 – 85.82	77.66	5.04	79.14	65.51 – 83.63	76.81	4.58	77.71
Silt (%)	1 – 64	3.26	1.24	2.47	2.1 – 6.24	3.78	0.98	3.47
Clay (%)	10.34 – 28.68	18.88	4.62	18.39	12.85 – 29.69	19.41	4.21	18.82
Porosity	0.341 – 0.42	0.39	0.02	0.39	0.368 – 0.416	0.39	0.01	0.39
Permeability (g/cm^3) x 10^{-3}	0.11 – 0.17	0.14	0.02	0.13	0.11 – 0.16	0.14	0.01	0.142
Bulk Density (g/cm^3) x 10^{-3}	1.15 – 1.83	1.48	0.18	1.45	1.14 – 1.87	1.47	0.20	1.55
pH	4.18 – 8.05	5.85	0.87	5.93	3.98 – 8.11	5.76	0.97	6.22
CEC (meq/100g)	1.592 – 28.949	8.59	5.93	10.70	1.335 – 24.706	6.90	4.66	8.21
Moisture Content (%)	11.35 – 18.53	14.28	1.92	11.62	10.07 – 20.75	14.57	2.17	12.41
Total Nitrogen (%)	0.024 – 0.32	0.10	0.05	0.09	0.018 – 0.234	0.09	0.04	0.07
Exchangeable Cations								
Nitrate, NO_3^- (mg/kg)	0.02 – 0.98	0.31	0.23	0.43	0.01 – 1.25	0.29	0.21	0.23
Nitrite, NO_2^- (mg/kg)	0.002 – 0.003	0.003	0.0005	0.002	0.002 – 0.003	0.003	0.0005	0.002
Phosphate, PO_4^{3-} (mg/kg)	0.02 – 1.87	0.56	0.43	1.32	0.03 – 2.16	0.50	0.44	0.77
Carbonate, CO_3^{2-} (mg/kg)	<0.001 – 37	11.28	9.69	16.0	<0.001 – 30	8.70	8.36	7.40
Sulphate, SO_4^{2-} (mg/kg)	<0.001 – 30	4.96	6.71	10.8	<0.001 – 32	3.54	6.30	2.0
Ammonium, NH_4^+ (mg/kg)	0.01 – 0.29	0.09	0.07	0.15	0.01 – 0.36	0.09	0.06	0.08
Anions								
Sodium, Na^+(mg/kg)	55.59 – 144.5	101.13	24.00	107.13	54.89 – 137.9	95.34	24.76	97.94
Potassium, K^+(mg/kg)	24.78 – 743.7	343.78	254.19	489.88	13.36 – 743.7	280.41	232.82	285.75
Calcium, Ca^{2+}(mg/kg)	59.83 – 3261	529.06	694.55	616.90	31.07 – 2598.9	360.21	457.46	450.78
Magnesium, Mg^{2+}(mg/kg)	92.88 – 1231.8	553.06	318.11	704.90	86.38 – 1142.1	476.28	289.50	575.8
Heavy Metals								
Iron, Fe (mg/kg)	578 – 7232.5	4090.98	1598.24	3612.40	1277.7 – 7152.8	3992.22	1747.15	2874.72
Cadmium, Cd (mg/kg)	0.01 – 1.65	0.30	0.35	0.08	0.02 – 0.77	0.23	0.23	0.21
Chromium, Cr (mg/kg)	1.42 – 41.06	10.15	8.26	6.21	0.1 – 45.49	10.03	9.73	3.52
Copper, Cu (mg/kg)	0.28 – 49.03	4.66	8.97	2.58	0.06 – 30.79	3.66	6.25	1.52
Nickel, Ni (mg/kg)	0.51 – 8.15	3.24	1.60	3.99	0.05 – 7.12	2.97	1.53	4.91
Vanadium, V (mg/kg)	0.02 – 0.39	0.15	0.08	0.19	0.04 – 0.34	0.14		
Lead, Pb (mg/kg)	0.43 – 144.1	11.81	19.53	4.83	0.23 – 108.4	10.56	15.31	6.84

Zinc, Zn (mg/kg)	2.69 – 54.11	15.67	11.85	15.16	1.68 – 38.15	12.65	9.30	11.16
Barium, Ba (mg/kg)	0.01 – 1.58	0.15	0.28	0.08	0.01 – 0.99	0.13	0.20	0.09
Mercury, Hg (mg/kg)	NA	<0.001	NA	<0.001	NA	<0.001	NA	<0.001
Arsenc, Hg (mg/kg)	0.01 – 0.45	0.05	0.08	0.028	0.01 – 0.28	0.04	0.06	0.03
Organics								
TOC (%)	0.273 – 3.705	1.20	0.56	1.05	0.208 – 2.71	1.03	0.45	0.84
BTEX (mg/kg)	NA	<0.001	NA	<0.001	NA	<0.001	NA	<0.001
TPH (mg/kg)	0.85 – 465.9	90.96	131.97	27.64	0.83 – 313.1	62.75	82.79	23.05
PAH (mg/kg)	0.003 – 1.864	0.37	0.53	0.11	0.003 – 1.253	0.25	0.33	0.09
OIL & Grease (mg/kg)	1.07 – 585.3	106.78	155.02	34.17	1.03 – 384	73.44	95.68	28.24
Microbiology								97.94
THB (CFU/g)	$2.2 \times 10^5 - 3.1 \times 10^6$	9.0×10^5	7.9×10^5	9.8×10^5	$1.4 \times 10^5 - 1.9 \times 10^6$	4.5×10^5	4.1×10^5	3.9×10^5
THF (CFU/g)	$0.4 \times 10^5 - 2.7 \times 10^6$	4.0×10^5	5.5×10^5	2.3×10^5	$0.2 \times 10^5 - 0.8 \times 10^6$	1.6×10^5	1.5×10^5	1.2×10^5
HUB (CFU/g) $\times 10^3$	0.2 – 1.7	0.86	0.31	0.82	0.1 – 11	0.52	0.24	0.54
HUF (CFU/g) $\times 10^3$	0.1 – 1	0.46	.23	0.48	0.1 – 0.7	0.26	0.15	0.22
SRB (MPN/100g)	<0.001 – 11	3.78	2.88	6.0	<0.001 – 4	1.85	1.56	1.80
Fecal Coliform (MPN/100g)	3 – 93	26.40	16.92	22.6	3 – 64	13.61	12.04	13.60

Source: Fieldwork 2022.

Table 4.19: Statistical description of soils properties for Dry Season

Parameter	Top soil (0 – 15 cm)				Bottom soil (15 – 30 cm)			
	Range	Mean	Standard deviation	Control	Range	Mean	Standard deviation	Mean control
pH (10% Solution)								
Particule Size								
% Sand	85 – 85	85	0	85	85 – 85	85	0	85
% Silt	10 – 10	10	0	10	10 – 10	10	0	10
% Clay	5 – 5	5	0	5	5 – 5	5	0	5
Total Analysis								
Calcium (meq/100g)	0.03 – 0.52	0.28	0.245	0.67	0.08 – 0.29	0.19	0.105	0.66
Magnessium (meq/100g)	0.56 – 0.60	0.58	0.02	0.62	0.56 – 0.61	0.59	0.025	0.52
Sodium (meq/100g)	0.3 – 0.23	0.27	0.035	0.31	0.3 – 0.26	0.28	0.02	0.29
Potassium (meq/100g)	0.84 – 0.87	0.85	0.015	0.82	0.87 – 0.8	0.83	0.035	0.88
Exchangeable Acidity (meq/100g)	0.01 – 0.01	0.01	0	0.01	0.01 – 0.01	0.01	0	0.01
CEC (meq/100g)	1.73 – 2.22	1.97	0.245	2.42	1.81 – 1.96	1.88	0.075	2.35
Base Saturation (%)	98.0 – 98.4	98.2	0.2	97.0	98.5 – 97.6	98.1	0.45	98.0
Organic Carbon (%)	0.19 – 0.26	0.23	0.035	0.19	0.16 – 0.22	0.19	0.03	0.17
Total Nitrogen (%)	0.17 – 0.2	0.19	0.015	0.15	0.15 – 0.19	0.17	0.02	0.16
Phosphorus (mg/kg)	74 – 82	78	4	73.0	76 – 80	78	2	75.0
Micro Nutrients								
Copper (mg/kg)	5.93 – 2.11	4.02	1.91	3.36	5.48 – 1.64	3.56	1.92	4.16
Iron (mg/kg)	412.52 – 356.04	384.28	28.24	350.81	410.36 – 335.6	372.99	37.38	377.65
Zinc (mg/kg)	31.45 – 29.91	30.68	0.77	40.66	32.12 – 23.02	27.57	4.55	24.53
Manganese (mg/kg)	242.19 – 212.84	227.52	14.675	115.12	244.18 – 204.8	224.49	19.69	138.47
Heavy Metals								
Lead (mg/kg)	16.7 – 14.88	15.83	0.91	8.48	24.7 – 16.46	20.61	4.12	16.34
Nickel (mg/kg)	<0.001	<0.001	0	<0.001	<0.001	<0.001	0	<0.001
Cadmium (mg/kg)	<0.001	<0.00	0	<0.001	<0.001	<0.001	0	<0.001
Chromium (mg/kg)	2.23 – 0.97	1.6	0.63	1.40	2.58 – 0.45	1.52	1.06	2.40

Source: JESL Fieldwork 2020

4.5.7 Geology and Hydrology

4.5.7.1 Geomorphology

The project area falls within the Precambrian Basement Complex of Southwesten Nigeria composed of migmatite-gneiss complex; slightly niigmatised to unmigmatised paraschists and metaigneous rocks; charnockitic rocks; older granites and unmetamorphosed dolerite dykes, pegmatites and quartz veins (Rahaman, 1989). Nigeria lies to the rest of the West African Craton in the region of late Precambrian to early Paleozoic orogenesis. The Basement complex is made up of Precambrian rocks and these rocks consist of the schist belt infolded in them. The Precambrian rocks in the study area are part of the Precambrian Basement complex of Nigeria which is made up of the migmatite-gneiss complex, the schist belts and the granitoids. The main lithologic units in the study area include; granite-gneiss, migmaflte-gneiss and bandedgneiss with well delineated geologic boundaries amongst others. These rocks have undergone polycydic deformation thereby causing the deformation of both micro and macro structures as displayed on the field. Geologic structures in rocks that can be used as clues in determining the geologic history of an area include fold, fractures, foliation, dyke etc. Some of them are not deformational but are secondary structures developed during metamorphism of after the emplacement of the rocks. The southwestern Nigeria falls between latitude 70N and I OON and longitude 20E and 70E which is made up of rocks which are mainlyPrecambrian in age. The study area belongs to the Precambrian Basement complex of southwestern Nigeria which lies to the rest of the West African Craton in the region of late Precambrian to early Paleozoic orogenesis. The Nigeria basement complex extends westward and is continuous with the dahomeyan of the Dahomey — Togo - Ghana region to east and the south Mesozoic recent sediments of Dahomey and Niger coastal basins over the basement complex. The west African Craton and the Pan African event, which presents the framework of West Africa in the entire igneous/ metamorphic Structural framework of Africa consist of Precambrian rocks that have been subjected to major supracrustal plutonic events, such as Liberian (3,000 ± 200my) Eburnean (1,850 ± 250my) Kibarian (1,150 ± l00my) Pan African (600my) The Crystalline rocks which forms the basement complex rocks of Nigeria are exposed in about half the surface area of the country. The remaining half is covered by sedimentary rocks of Sokoto, Chad or Bornu basin, Niger valley, Benue trough and Anambra basin. The Basement rocks are also exposed in the North central, southwestern and eastern part of the country and the basement complex are separated by sedimentary rocks except in the north central where they are interwoven for descriptive purposes. The Dahomey sedimentary basin, a basin known to have resulted from events associated with the break-up of Gondwana and subsequent opening of the southern Atlantic.

Plate 4.5: Showing geological formation along ROW

Deposition was in a fault-controlled depression, bounded by faults and other tectonic structures of the Romanche Fault Zone on the west, and by the Benin Hinge line, also a major fault structure, on the east. Sediment thickness in the basin, which extends from Accra/Ghana to the Okitipupa Ridge, where it is separated from the Niger Delta, increases from north to south and from east to west within Nigeria. The mostly continental Oligo-Plieistocene sediments of the Benin Formation also known as "Coastal Plain Sands" overlie the Ilaro Formation. The formation consists of loose, poor to moderately sorted sands, clays, pebbles, sandy clays and clayey sands, and rarely, thin lignite beds. The youngest sedimentation in the area is of Quaternary alluvial deposits of unconsolidated and unsorted sands, clays and silts.

4.5.7.2 Hydrology

The hydrogeology of the project area is a reflection of the interplay between surface waters, geomorphic structures and regional deep groundwater flow (Abam 1999). The groundwater in the project area can beregarded as deep groundwater contained within the topmost 9 -12 m from the ground level based on the hydrogeological characteristics. The weathered basement and the fractured basement columns constitute the main Aquifer unit; in a typical basement complex environment. Groundwater storage and movement occur within connected fractured zones and pore spaces. The major source of Aquifer recharge in the project area is surface precipitation (rainfall). Additional recharge is through base flow. Discharge sources include groundwater abstraction from boreholes located within the project area and evapo-transpiration. Groundwater exploration in crystalline basement complex terrain requires detailed geophysical investigation to effectively characterize the hydro-geologic zones to enhance successful identification of well locations. These zones are largely due to the development of secondary porosity and permeability by fracturing and/or weathering of these rocks. Thus, the search for groundwater in such rocks is aimed at mapping such secondary structures which constitute the basement Aquifers. Higher elevation at the northwestern part of the study area indicates that groundwater generally flows toward the eastern and southwestern parts.

The level indicated in the boreholes is subject to seasonal variation accordingly as rainfall and the nearby body of water influences the groundwater regime. The test may be considered to have being carried out during the height of the raining season and the groundwater level is not expected to rise. The water quality represented by the physico-chemical properties of the shallow groundwater within the project area is presented in Table 4.20. The groundwater quality is naturally dependent on the morphology of the surface water system, interactions between surface water and groundwater along the creek channels, frequency and quantity of rainfall, tidal movement, brackish discharges and the density of the distributaries in the area. The creek is in hydraulic and hydrodynamic connection with the shallow Aquifer. Both the groundwater levels and quality are therefore affected by the tidal movements and salinity. The results of analysis conducted on ground ewater is shown in Table 4.20

Table 4.20: Results of Groundwater Analysis

PARAMETER	BH 01 Trailer Park	BH 02 Int. market Ogere	BH 03 Kyakwama village, ogere	BH 04 Adetohun village RCC	BH 05 Tech U	BH 06 (C) Soka Area
Colour (Pt-Co)	4	6	18	27	14	24
Alkalinity (mg/l)	6	4	6	6	4	6
Elect. Cond. (µs/cm)	199	96.2	101	222	187	103
pH	5.9	8,2	10.1	7.4	7.7	7.8
Temperature (^{0}C)	25.7	26.2	26.6	26.0	28.2	26.4
Total Hardness (mg/l)	55	20	49	30	10	22
COD (mg/l)	1.03	0.65	0.75	1.12	0.96	0.75
BOD (mg/l)	0.67	0.43	0.5	0.75	0.64	0.5
DO (mg/l)	1.5	1.0	1.2	0.8	2.0	1.5
Salinity (mg/l)	113	41	89	60	29	78
TDS (mg/l)	117	162	199	103	087	109
TSS (mg/l)	1	1	2	1	2	2
Turbidity (NTU)	0.6	0.8	1.2	1.0	0.8	1.0
Oil & Grease (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chloride, Cl^- (mg/l)	68	25	54	36	13	25
Sulphate, SO_4^{2-} (mg/l)	3	0	3	1	2	2
Nitrate, NO_3^- (mg/l)	0.8	0.2	0.6	0.3	0.1	0.6
Phosphate, PO_4^{3-} (mg/l)	0.18	0.08	0.15	0.1	0.05	0.16
Carbonate, CO_3^{2-} (mg/l)	3	2	3	3	2	3
TPH (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAH (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BTEX (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
THC (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Redox Potential (mV)	118	122	120	121	118	120

Phenol (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ammonium, NH_4^+ (mg/l)	0.23	0.06	0.17	0.09	0.03	0.18
Calcium, Ca^{2+} (mg/l)	8.538	1.313	3.171	7.982	3.011	3.794
Magnesium, Mg^{2+} (mg/l)	5.936	1.4141	2.892	0.918	1.705	2.742
Potassium, K^+ (mg/l)	3.01	1.141	1.359	0.727	0.99	3.581
Sodium, Na^+ (mg/l)	15.593	9.617	16.102	2.752	9.047	13.397
Manganese, Mn^{2+} (mg/l)	<0.001	0.009	0.033	0.053	<0.001	0.064
Iron, Fe (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc, Zn (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, Cr (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, Cu (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium, V (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, Ni (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, Ba (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
THB (CFU/ml) x 10^2	2.6	3.2	2.5	1.8	2.4	2.7
THF (CFU/ml) x 10^2	1.5	2.1	1.8	1.4	1.3	1.8
HUB (CFU/ml) x 10^2	1.2	1	0.8	1.3	0.6	0.6
HUF (CFU/ml) x 10^2	1	0.6	0.4	0.9	0.4	0.3
SRB (MPN/100ml)	3	0	4	0	3	0
Fecal Coliform (MPN/100ml)	1,100	240	75	93	9	27

Table 4.20.1: Summary of Groundwater Results

PARAMETER	RANGE	AVERAGE	STANDARD DEVIATION	BH CONTROL	FEMnv Limit (Drinking Water)	WHO Limit (Drinking Water)
Colour (Pt-Co)	4 – 30	18.5	9.11	22	NA	NA
Alkalinity (mg/l)	4 – 8	6	1.41	8	NA	NA
Elect. Cond. (µs/cm)	134 – 752	354.8	161.49	467	NA	1200
pH	5.9 – 8.7	6.9	0.29	6.8	6.5 – 8.5	6.5 – 8.5
Temperature (^{0}C)	25.7 – 28.2	26.5	0.05	26.2	NA	NA
Total Hardness (mg/l)	10 – 125	53.9	42.00	114	NA	NA
COD (mg/l)	0.45 – 1.12	0.79	0.21	0.80	0.05	NA
BOD (mg/l)	0.3 – 0.75	0.53	0.14	0.53	NA	NA
DO (mg/l)	0.8 – 2.0	1.4	0.13	2.1	NA	4.0 – 6.0
Salinity (mg/l)	29 – 278	116.8	87.79	202	NA	NA
TDS (mg/l)	89 – 502	236.3	107.10	312	500	1000
TSS (mg/l)	1 – 4	1.8	0.97	3	<10	NA
Turbidity (NTU)	0.6 – 1.2	0.9	0.43	0.8	1	5
Oil & Grease (mg/l)	0.00-1.20	0.02	0.05	<0.01	`10	NA
Chloride, Cl^- (mg/l)	13 – 168	67.3	55.34	123	NA	NA
Sulphate, SO_4^{2-} (mg/l)	0 – 17	4.12	5.06	10	500	250
Nitrate, NO_3^- (mg/l)	0.1 – 1.5	0.68	0.47	1.2	10	10
Phosphate, PO_4^{3-} (mg/l)	0.05 – 0.37	0.18	0.11	0.27	<5	0.5
Carbonate, CO_3^{2-} (mg/l)	2 – 4	3	0.71	4	NA	NA
TPH (mg/l)	<0.01-1.00	0.005	0.003	<0.001	10	NA
PAH (mg/l)	NA	<0.001	NA	<0.001	NA	NA
BTEX (mg/l)	NA	<0.001	NA	<0.001	NA	NA
THC (mg/l)	<0.001-1.200	0.04	0.1200	<0.01	0	4.0 – 6.0
Redox Potential (mV)	112 – 123	119.3	3.19	115	NA	NA
Phenol (mg/l)	<0.001-0.001	0.001	0.001	<0.001	NA	NA
Ammonium, NH_4^+ (mg/l)	0.03–0.44	0.20	0.14	0.35	NA	NA
Calcium, Ca^{2+} (mg/l)	1.313-30.78	9.65	9.49	10.268	NA	200
Magnesium, Mg^{2+} (mg/l)	0.918 – 15.057	5.09	4.71	7.051	NA	150
Potassium, K^+ (mg/l)	0.727-13.71	4.23	4.45	6.469	NA	10
Sodium, Na^+ (mg/l)	2.752 – 24.847	14.47	7.09	21.167	200	200
Manganese, Mn^{2+} (mg/l)	0.009 – 0.064	0.040	0.02	<0.001	0.05	0.1
Iron, Fe (mg/l)	NA	<0.001	NA	<0.001	1.0	0.3
Zinc, Zn (mg/l)	NA	<0.001	NA	<0.001	5.0	5

Chromium, Cr (mg/l)	NA	<0.001	NA	<0.001	0.05	0.05
Lead, Pb (mg/l)	NA	<0.001	NA	<0.001	0.05	0.01
Copper, Cu (mg/l)	NA	<0.001	NA	<0.001	NA	NA
Cadmium, Cd (mg/l)	NA	<0.001	NA	<0.001	0.01	0.003
Mercury, Hg (mg/l)	NA	<0.001	NA	<0.001	0.001	0.001
Vanadium, V (mg/l)	NA	<0.001	NA	<0.001	0.01	NA
Nickel, Ni (mg/l)	NA	<0.001	NA	<0.001	0.05	NA
Arsenic, As (mg/l)	NA	<0.001	NA	<0.001	NA	NA
Barium, Ba (mg/l)	NA	<0.01	NA	<0.01	NA	NA
THB (CFU/ml) x 10^2	1.6 – 3.2	2.48	0.51	2.3	NA	NA
THF (CFU/ml) x 10^2	1 – 21	1.50	0.35	1.3	NA	NA
HUB (CFU/ml) x 10^2	0.6 – 1.3	0.91	0.24	1.0	NA	NA
HUF (CFU/ml) x 10^2	0.3 – 1	0.54	0.25	0.2	NA	NA
SRB (MPN/100ml)	0 – 4	2	1.69	3	NA	NA
Fecal Coliform (MPN/100ml)	9 - 1100	224.9	342.05	43	NA	NA

Source: Fieldwork 2022

Groundwater chemistry is controlled by the chemistry of the infiltrating water, the chemistry of the porous media including the interstitial cement or matrix of the Aquifer, the rate of groundwater flow and the permeability of the Aquifer (Offodile, 2002). More than 85% of public water for consumption is sourced from groundwater (Ufoegbune et al, 2009), and this is used for domestic, industrial and agricultural purposes. Groundwater pollution is one of the environmental problems facing many coastal regions as a result of high population, urbanization and industrialization. The quality of groundwater in the study area was investigated in this study using multivariate geo-statistical techniques. The groundwater in the project area was conducted based on collection of groundwater from hand dug wells and geotechnical survey drilled boreholes.

Physical and Chemical Properties

The statistical summary of the physico-chemical properties of the groundwater in both seasons is presented in Table above. The pH levels of the groundwater were found acidic with values varying from 5.6 — 7.7 and 6.56 — 6.91 in wet and dry seasons with average of 6.8 and 6.67 respectively. Total Dissolved Solids (TDS), salinity, nitrate, and sulphate were within their respective NURC/ WHO limits. The groundwater was free of both petrogenic and biogenic hydrocarbon pollutants as oil & grease and THC levels were detected at Yaali Foods sampling point while others were below the analytical instruments' detectable limit of 0.00lmg/l. Heavy metal enrichment index revealed low concentrations, no indication of salt intrusion and the recorded values could be termed to be a baseline data or the 23 constituents of the bedrock materials. The values recorded for both season were relatively lower probably due to dilution from availability of rainwater. The total heterotrophic bacteria and fungi were moderate in population densities. The presence of coliform bacteria, particularly faecal coliform, in both wet and dry seasons is indicative of groundwater pollution.

4.5.8 Surface water quality

4.5.8.1 Physicochemical conditions

The topography of the area is rugged with undulating terrain with some outcrops in several places. The drainage system in the area is usually marked with the proliferation of many smaller streams which are dry for many months, especially from November — May. There are major rivers in the study area called river Olomo and Ogunmakin in Ogun State stretch, river Ona in Oyo State stretch. The drainage pattern typical of the study area is trellis which is controlled by the structures. The baseline characteristics of the rivers transvered and associated surface waters contiguous to the project area is recorded and analyzed. Such information is necessary as basis for understanding the characteristics of the existing environment and as benchmark for the subsequent evaluation of project impacts. The summary of the physic-chemical characteristics of surface waters are presented in Table 4.21.

Table 4.21: Physicochemical parameters of surface waters

PARAMETER	SW 01 Olomo River	SW02 Ogun River	SW 03 Ona River	SW C Ogunpa River
Colour (Pt-Co)	256	121	190	378
Alkalinity (mg/l)	6	6	8	6
Elect. Cond. (µs/cm)	803	708	926	201
pH	7.1	9.0	9.1	8.3
Temperature (^{0}C)	28.1	26.5	27.2	26
Total Hardness (mg/l)	27	60	90	29
COD (mg/l)	1	1.44	0.25	1.75
BOD (mg/l)	0.67	0.96	0.14	1.17
DO (mg/l)	1.9	2.2	2.3	2.4
Salinity (mg/l)	59	139	182	65

TDS (mg/l)	119	111	202	219
TSS (mg/l)	21	7	24	32
Turbidity (NTU)	21.7	18.2	53.8	31.1
Oil & Grease (mg/l)	<0.01	<0.01	<0.01	<0.01
Chloride, Cl^- (mg/l)	36	78	110	39
Sulphate, SO_4^{2-} (mg/l)	1	2	3	2
Nitrate, NO_3^- (mg/l)	0.3	1	1.1	0.5
Phosphate, PO_4^{3-} (mg/l)	0.1	0.2	0.25	0.14
Carbonate, CO_3^{2-} (mg/l)	3	3	4	3
TPH (mg/l)	<0.001	<0.001	<0.001	<0.001
PAH (mg/l)	<0.001	<0.001	<0.001	<0.001
BTEX (mg/l)	<0.001	<0.001	<0.001	<0.001
THC (mg/l)	<0.01	<0.01	<0.01	<0.01
Redox Potential (mV)	116	116	123	125
Phenol (mg/l)	<0.001	<0.001	<0.001	<0.001
Ammonium, NH_4^+ (mg/l)	0.09	0.3	0.32	0.14
Calcium, Ca^{2+} (mg/l)	5.176	10.695	20.876	3.383
Magnesium, Mg^{2+} (mg/l)	1.859	5.265	7.873	2.544
Potassium, K^+ (mg/l)	4.313	4.617	9.355	4.117
Sodium, Na^+ (mg/l)	5.025	14.373	18.255	8.145
Manganese, Mn^{2+} (mg/l)	<0.001	0.151	<0.001	<0.001
Iron, Fe (mg/l)	1.647	0.401	0.434	3.022
Zinc, Zn (mg/l)	<0.001	<0.001	<0.001	<0.001
Chromium, Cr (mg/l)	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/l)	<0.001	<0.001	<0.001	<0.001
Copper, Cu (mg/l)	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	<0.001
Vanadium, V (mg/l)	<0.001	<0.001	<0.001	<0.001
Nickel, Ni (mg/l)	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	<0.001	<0.001	<0.001	<0.001
Barium, Ba (mg/l)	<0.01	<0.01	<0.01	<0.01

THB (CFU/ml) x 10^2	2.9	3.6	2.1	3.6
THF (CFU/ml) x 10^2	1.5	2.3	1.2	2.5
HUB (CFU/ml) x 10^2	1.1	0.5	0.8	0.3
HUF (CFU/ml) x 10^2	0.7	0.3	0.6	0.2
SRB (MPN/100ml)	0	3	4	3
Fecal Coliform (MPN/100ml)	93	28	11	20

Table 4.21.1: Physicochemical parameters of surface waters

PARAMETER	RANGE	AVERAGE	STANDARD DEVIATION	SWC1 CONTROL Ogunpa	FMEnv Limit (Aquatic Life)
Colour (Pt-Co)	121 – 389	266.8	104.47	384	NA
Alkalinity (mg/l)	6 – 8	6.4	0.8	6	NA
Elect. Cond. (µs/cm)	186 – 926	564.8	310.98	118	NA
pH	7.1 – 9.1	7.8	0.29	7.63	6.0 – 9.0
Temperature (^{0}C)	26.0–28.1	27.0	0.72	26.9	20 - 33
Total Hardness (mg/l)	24 – 90	46	25.56	25	NA
COD (mg/l)	0.25–1.88	1.26	0.59	1.50	NA
BOD (mg/l)	0.14 – 1.25	0.84	0.40	1.04	4.0
DO (mg/l)	1.9 – 2.8	2.30	0.29	6.3	6.8
Salinity (mg/l)	59 - 182	101.8	49.86	65	NA
TDS (mg/l)	111 – 219	171.8	210.03	219	NA
TSS (mg/l)	7 – 32	23	9.01	26	NS
Turbidity (NTU)	18.2 – 53.8	29.64	12.80	25	NA
Oil & Grease (mg/l)	NA	<0.001	NA	<0.01	NS
Chloride, Cl^- (mg/l)	36 – 110	60.4	29.26	39	NA
Sulphate, SO_4^{2-} (mg/l)	1 – 3	2	0.63	2	NA
Nitrate, NO_3^- (mg/l)	0.3 – 1.1	0.68	0.31	0.5	NS
Phosphate, PO_4^{3-} (mg/l)	0.1 – 0.25	0.16	0.05	0.13	NA
Carbonate, CO_3^{2-} (mg/l)	3 – 4	3.2	0.4	3	NA
TPH (mg/l)	NA	<0.001	NA	<0.001	NA
PAH (mg/l)	NA	<0.001	NA	<0.001	NA
BTEX (mg/l)	NA	<0.001	NA	<0.001	NA
THC (mg/l)	NA	<0.001	NA	<0.01	1.0
Redox Potential (mV)	116 – 130	122	5.40	125	NA
Phenol (mg/l)	NA	<0.001	NA	<0.001	NA
Ammonium, NH_4^+ (mg/l)	0.09 – 0.32	0.2	0.09	0.15	NA
Calcium, Ca^{2+} (mg/l)	3.383 – 20.876	8.71	6.65	3.469	NA
Magnesium, Mg^{2+} (mg/l)	1.859 – 7.873	4.03	2.25	1.768	NA
Potassium, K^+ (mg/l)	3,864-9,355	5.25	2.07	4.001	NA
Sodium, Na^+ (mg/l)	5.025 – 18.255	10.58	4.94	5.605	NA
Manganese, Mn^{2+} (mg/l)	<0.001 – 0.151	0.10	0.05	<0.001	NA
Iron, Fe (mg/l)	0.401-3.022	1.64	1.09	2.404	NA
Zinc, Zn (mg/l)	NA	<0.001	NA	<0.001	0.03
Chromium, Cr (mg/l)	NA	<0.001	NA	<0.001	0.00002 – .002

Lead, Pb (mg/l)	NA	<0.001	NA	<0.001	0.0017
Copper, Cu (mg/l)	NA	<0.001	NA	<0.001	NA
Cadmium, Cd (mg/l)	NA	<0.001	NA	<0.001	0.0002 – 0.0018
Mercury, Hg (mg/l)	NA	<0.001	NA	<0.001	0.001
Vanadium, V (mg/l)	NA	<0.001	NA	<0.001	NA
Nickel, Ni (mg/l)	NA	<0.001	NA	<0.001	0.025 – 0.15
Arsenic, As (mg/l)	NA	<0.001	NA	<0.001	NA
Barium, Ba (mg/l)	NA	<0.001	NA	<0.01	NA
THB (CFU/ml) x 10^2	2.1 – 3.6	3.1	0.56	2.8	NA
THF (CFU/ml) x 10^2	1.2 – 2.5	1.9	0.49	1.7	NA
HUB (CFU/ml) x 10^2	0.3 – 1.1	0.7	0.29	1.2	NA
HUF (CFU/ml) x 10^2	0.2 – 0.7	0.5	0.19	0.8	NA
SRB (MPN/100ml)	0 – 4	2.6	1.36	0	NA
Fecal Coliform MPN/100ml)	11 - 93	39	28.98	23	NA

Source: Fieldwork 2022

4.5.8.2 Surface water microbiology

In the wet season, Total Heterotrophic Bacteria (THB) population densities varied from 2.1 to 3.6 x 102 cfu/ml (Mean 3.1 x 102 cfu/ml) while Total Heterotrophic Fungi (THF) loads ranged from 1.2 to 2.5 x 102 cfu/ml with mean value of 1.9 x 102 cfu/ml. Hydrocarbon degraders were low in population which confirms the fact that petroleum hydrocarbon may be present in mean quantities of 0.7 x 102 cfu/ml in HUB and 0.5 x 102 cfu/ml. Presence of petroleum hydrocarbon degraders suggest effective degradation of petrogenic hydrocarbon if spilled into the waterbodies during activities in proposed project site. However, faecal coliform population ranging from 11 - 93 MPN/100ml was obtained in the wet season. Presence of the faecal coliform reveals direct human defaecation into the two waterbodies.

Plate 4.6: Surface water sampling point at Ogunmakin

4.5.8.2 Surface water microbiology

In the wet season, Total Heterotrophic Bacteria (THB) population densities varied from 2.1 to 3.6 x 102 cfu/ml (Mean 3.1 x 102 cfu/ml) while Total Heterotrophic Fungi (THF) loads ranged from 1.2 to 2.5 x 102 cfu/ml with mean value of 1.9 x 102 cfu/ml. Hydrocarbon degraders were low in population which confirms the fact that petroleum hydrocarbon may be present in mean quantities of 0.7 x 102 cfu/ml in HUB and 0.5 x 102 cfu/ml. Presence of petroleum hydrocarbon degraders suggest effective degradation of petrogenic hydrocarbon if spilled into the waterbodies during activities in proposed project site. However, faecal coliform population ranging from 11 - 93 MPN/100ml was obtained in the wet season. Presence of the faecal coliform reveals direct human defaecation into the two waterbodies.

Plate 4.7: Surface water sampling and analysis at Odo Ona River

4.5.8.3 Sediments Physico-chemical Characteristics

In Aquatic ecosystem, the sediments act as sink and therefore preserve or retain the quality of the environment. The summary of physicochemical state of the bottom sediments in project area is presented in Table 4.22.

Table 4.22: Physicochemical Results of Sediment

	Wet Season 2022			
PARAMETER	**RANGE**	**AVERAGE**	**STANDARD DEVIATION**	**SED C1 CONTROL Ogunpa**
pH	5.3 – 5.82	5.52	0.20	0.20
Redox Potential (mV)	122 – 138	138.2	17.21	17.20
TOC (%)	0.624 – 3.588	1.76	1.01	1.01
Sand (%)	75.14 – 81.27	78.7	2.30	2.31
Silt (%)	2.68 – 6.98	4.1	1.51	2.75
Clay (%)	15.78 – 21.46	17.2	2.16	15.57
Particle Size Distribution	NA	NA	NA	SL
Temperature (^{0}C)	26.9 – 27.1	26.98	0.08	27.0

Chloride, Cl^- (mg/kg)	10 – 167	56.8	57.18	25
Sulphate, SO_4^{2-} (mg/kg)	1 – 25	11	8.88	8
Nitrate, NO_3^- (mg/kg)	0.2 – 2.3	1.26	0.79	0.8
Phosphate, PO_4^{3-} (mg/kg)	0.1 – 1.25	0.64	0.44	0.25
Carbonate, CO_3^{2-} (mg/kg)	4 – 38	18.8	12.86	20
TPH (mg/kg)	39.2 – 202.6	104.61	56.66	109.7
THC (mg/kg)	52.27 – 270.2	139.49	75.56	146.3
Oil & Grease (mg/kg)	45.3 – 248.5	125.5	69.73	128.4
BTEX (mg/kg)	NA	<0.001	NA	<0.001
PAH (mg/kg)	0.157 – 0.810	0.42	0.23	0.439
Sodium, Na^+ (mg/kg)	91.84 – 137.8	119.29	15.98	134.8
Potassium, K^+ (mg/kg)	149.6 – 690.7	475.24	245.92	250.2
Magnesium, Mg^{2+} (mg/kg)	337 – 1,010.3	735.56	257.17	552.1
Calcium, Ca^{2+} (mg/kg)	299.3 – 405.5	347.88	45.38	229.5
Cadmium, Cd (mg/kg)	<0.001 – 0.03	0.03	NA	<0.001
Zinc, Zn (mg/kg)	8.67 – 28.21	20.996	6.56	15.42
Iron, Fe (mg/kg)	1596.8 – 4,994.5	3274.92	1152.62	2,595.9
Cobalt, Co (mg/kg)	NA	<0.001	NA	<0.001
Copper, Cu (mg/kg)	<0.001 – 1.36	1.15	0.23	<0.001
Chromium, Cr (mg/kg)	<0.001 – 4.86	4.62	0.29	<0.001
Vanadium, V (mg/kg)	0.04 – 0.19	0.12	0.05	0.09
Nickel, Ni (mg/kg)	0.81 – 3.95	2.46	1.03	1.99
Lead, Pb (mg/kg)	11.05 – 17.61	14.74	2.48	9.54
Manganese, Mn (mg/kg)	55.7 – 199.6	127.92	46.23	123.9
Barium, Ba (mg/kg)	<0.01 – 0.04	0.037	NA	<0.01
Arsenic, As (mg/kg)	<0.01 – 0.01	0.01	NA	<0.01
Mercury, Hg (mg/kg)	NA	<0.001	NA	<0.001
Silver, Ag (mg/kg)	NA	<0.001	NA	<0.001
THB (CFU/g)	3.5×10^5 – 2.6×10^6	1.25×10^6	8.62×10^5	2.3×10^6
THF (CFU/g)	2.3×10^5 – 2.0×10^6	7.58×10^5	6.47×10^5	2.1×10^5
HUB (CFU/g) x 10^3	0.4 – 1.0	0.68	0.2	1.4
HUF (CFU/g) x 10^3	0.2 – 0.6	0.34	0.14	0.8
SRB (MPN/100g)	3 – 15	8.2	4.67	4

Source: Fieldwork 2022

Physico-chemical Properties

The pH value of the sediment was generally acidic with values which varied from 5.3 -5.82 in the wet season with mean pH value of 5. Redox potential (mV) with average values of 138.2mV wet season value ranges from 122-171 mV. The nutrients were moderate in concentration, with mean values of 0.64mg/kg for available phosphate, 56.8mg/kg for chloride, 11.0mg/kg for the sulphate, 18.8mg/kg for Carbonate and 1.26mg/kg for nitrate in the wet season. The particle size distribution is SL in all the waterbodies except in SD2 Ogunmakin River which is SCL.

Organics and Heavy Metals

As presented in above, iron recorded the highest concentrations, amongst other metals determined insediment as its values ranged from 1596.8 - 4994.5mg/kg (mean value of 3274.92mg/kg) in the wet season.The high iron content recorded in this area is a characteristic of sediment rich in iron than other metals (Anderson 1967). Next in abundance is Zinc with a mean value of 20.99mg/kg wet seasons. Also, Nickellevels were found in the range of 0.81 -3.95mg/kg in wet season. Also, Copper was measured to be of the average concentrations of 1.15mg/kg in the wet season. Chromium was measured to be of the average concentrations of 4.62mg/kg in the wet season. Lead was measured to be of the average concentrations of 14.74mg/kg in the wet season. Total organic carbon (TOC) varied from 0.624 -3.588% wet season. Also, Total Petroleum Hydrocarbon (I'PH) levels varied from 39.2 - 202.6mg/kg with mean value of 104.61mg/kg in the wet season. The bottom sediment of the river systems in the proposed project area contains negligible levels of petroleum hydrocarbon.

Plate 4.8: Showing surface water sampling point

Sediment Microbiology

Table above presents the population densities of the heterophic and hydrocarbonoclastics bacteria and fungi present in bottom sediment collected from the waterbodies in the area. Total heterotrophic bacteria (THB) loads ranged from 3.5 x 10 - 2.6 x l06cfu/g in the wet season. Also, Total heterotrophic-Fungi (THF) populations varied between 2.3 x i0 - 2.0 x l06cfu/g during the wet season respectively. Hydrocarbon Utilising Bacteria (HUB) ranged from 0.4 - 1.0 x 10 cfu/g in the wet season. The population densities of the hydrocarbon utilising fungi (HUF) ranged from 0.2 — 0.6 x 10 cfu/g in the wet season. The high population density of the microbes recorded in this environment is an indication of a viable community with capacity to mineralise organic matter. Thus, low levels of mineral petroleum hydrocarbon recorded in the environment may be linked to degrading capacity of the hydrocarbonoclastics bacteria and fungi.

4.5.8.4 Hydrobiology

4.5.8.4.1 Phytoplankton

A total of 46 species of phytoplankton belonging to Bacillariophyta (10 species), Cyanophyta (20 species), Chlorophyta (13 species) and Euglenophyta (3 species). The Bacillariophyta were generally dominant constituting 49.1% and 55.4% of the phytoplankton assemblages in the study area and control stations respectively. A total of 2338 cells/L were enumerated within the study area and 957 cells/L in the control station. A test of significance showed a 2-fold increase in the Bacillariophyta population within the study area compared to the control ($p<0.05$. The variance maybe attributed to high influx of allochthonous inputs into the study area compared to the control. The introduction of cosmopolitan and exotic species of phytoplankton assemblages (Rhizosolenia, Skeletonema sp., Coscinodiscineae ip and Thalassiothrix sp.) resulting from high precipitation further lends credence to the high inputs into the study area. The dominance of Bacillariophyceae is characteristic of the phytoplankton community structure within lotic and lentic water systems South West of Nigeria and consistent with the findings of Nwankwo, 1996, Onyema, 2008 and Yakub et al, 2011. The second most dominant taxonomic group were the Cyanophyta representing 34.0% and 33.6% of the phytoplankton assemblages within the study area and the control. The total number of individual taxa enumerated were 794 cells/L and 322 cells/L and differed significantly ($p<0.05$). The dissimilarity in the relative abundance and distribution of the Cyanophyta assemblages is suggestive of allochthonous influx. Cosmopolitan species comprising Microcystis .p, Anabaena ipiroides, Planletothrix and Spiridina p dominated the Cyanophyta community and were well represented in 90% of the sampling stations including the controls. Furthermore, the Chlorophyta comprised of 15.4% and 11.0% of the phytoplankton, assemblages within the study area and the control. The total number of individual taxa enumerated was 361 cells/L and differed significantly from the controls (1.05cells/L). Chiorella .b, Cosmarium .t, and Oocystis ip were well represented in 100% of the sampling stations including the controls.

In corresponding order of increasing dominance in the phytoplankton assemblages within the Study area and controls were Bacillariophyta (49.1%, 55.4%) >> Cyanophyta (34.0%, 33.6%)>> Chiorophyta (15.4%, 11.0%) >> Euglenophyta (1.45%, 2.0%). The low composition of the flagellates (Euglenophyta) compared to other taxonomic groupings maybe attributed to competitive advantage in stratified environment, where motility and mixotrophy facilitates the acquisition of nutrients for growth (Casas et al., 1999 and Nogueira et al., 2000). Broadly, the species density was generally high and showed consistent trend in taxa number in all the sampling stations including the controls. This was necessitated by high nutrient inputs from high precipitation and heavy runoffs resulting to high amounts of phytoplankton biomass and cell numbers (Bode *et al,* 2015).

Table 4.23: Summary of the Relative Abundance and Diversity of Phytoplankton Community

	Study Area		Control	
Major Taxonomic Groups	**Number of individuals percentage (%) in parenthesis**	**Number of species**	**Number of individuals percentage (%) in parenthesis**	**Number of species**
Bacillariophyta	1149 (49.1%)	10	530 (55.45)	10
Cyanophyta	794 (34.0%)	20	322 (33.6%)	20
Chlorophyta	361 (15.4%)	13	105 (11.0%)	13
Euglenophyta	34 (1.45%)	3	19 (2.0%)	3
TOTAL				
Number of sampling points	5		2	
Volume of water sampled (L)	1000		1000	
Total number of individuals enumerated/L	2338		957	
Total number of species	46		46	

Source: Fieldwork 2022

Diversity Indices

The Shannon—Wiener (H) diversity index (H′) and Margalef Richness index (D) were used to characterize the phytoplankton assemblages. The Shannon diversity index ranged from 2.807 in SW02 to 3.485 in SW03. The indexes were within the moderate water quality (3 - 2) index as described by Mishra et al 2010 and suggestive of low environmental stressor burdens within the recipient water. The allocthonous influx as a result of heavy runoffs from precipitation may be responsible for the organic matter inputs in the recipient environment. In addition, the low levels of organics, heavy metals and organic matter in the surface water lends credence to the organic burdens in the surface water.

Table 4.24: Ecological indices of phytoplankton assemblages

	SW01 Olomo River	SW02 Ogunmakin	SW03 Ona River	SW Control 1
Taxa_S	40	30	42	32
Individuals	556	354	530	448
Dominance_D	0.04761	0.08079	0.03689	0.05775
Shannon_H	3.304	2.807	3.485	3.032
Simpson_1-D	0.99524	0.9192	0.9631	0.9423
Evenness_e^H/S	0.6803	0.5519	0.7769	0.648
Menhinick	1.966	1.594	1.824	1.512
Margalef	6.17	4.941	6.536	5.078
Equitability_J	0.8956	0.8252	0.9325	0.8748
Fisher_alpha	9.882	7.825	10.71	7.888
Berger-Parker	0.1079	0.1441	0.09434	0.1138

Source: Fieldwork 2022

4.5.8.4.2 Zooplankton

A total of 28 species of zooplankton belonging to Arthropoda (21 species), Rotifera (6 species) and Pisces (1 species). The Arthropoda were generally dominant constituting 70.5% and 70.0% of the zooplankton assemblages in the study area and control station. A total of 313 cells/L were enumerated within the study area and 145 cells/L in the control station. A test of significance showed a 2-fold increase in the Arthropoda population within the study area compared to the control ($p<0.05$). The Arthropods population provided a clear insight of the ecosystem, stability within the study area and rates of predation by organisms (metazoans) in the higher trophic levels. In addition, the high abundance of arthropoda compared to other taxononiic groups may be attributed to low predation rates within the study area compared to the controls. Well represented taxa include: Bosmina obtusirostris, Daphnia culcullata, and Holopedium gibberum. Findings are consistent with Olaniyan, 1975 and Onyema et al., 2007 which established the dominance of Arthropods (Crustaceans) in lentic and lotic river systems in South West Nigeria. The second most dominant taxonomic group were the Rotifera representing 18.5% and 30.0% of the zooplankton assemblages within the Study area and the control. The total number of individual taxa enumerated were 82 cells/L and 62 cells/L withinthe Study area and the control and differed significantly ($p<0.05$). The variance maybe attributed to the abundance of unicellular algae (feeding behaviours) within the Study area compared to the controls. Most species were found in low numbers and only 2 species (*Keratellastipidata* and *Chriochilas unicornus)* had average densities >30cells/L. In corresponding order of increasing dominance in the zooplankton assemblages within study area and controls were Arthropoda (70.5%, 70.0%) >> Rotifera (18.50%, 30.0%) >> Pisces (11.0%, 12.1%). Broadly, the species density was generally high and showed consistent trend in taxa number in all the sampling stations.

Table 4.25: Summary of the Relative Abundance and Diversity of Zooplankton community

	Study Area		Control	
Major Taxonomic Groups	**Number of individuals percentage (%) in parenthesis**	**Number of species**	**Number of individuals percentage (%) in parenthesis**	**Number of species**
ARTHROPODA	313 (70.5%)	21	142 (70.0%)	22
ROTIFER	83 (18.5%)	6	60 (30.0%)	5
Pisces	48 (11.0%)	1	27 (12.1%)	1
TOTAL				
Number of sampling points	5		1	
Volume of water sampled (L)	1000		1000	
Total number of species (S)	22		20	

Source: Fieldwork 2022

Diversity Indices

The Shannon—Wiener (H) diversity index (*H′*) and Margalef Richness index (D) were used to characterize the zooplankton assemblages. The Shannon diversity index ranged from 2.315 in SW2 to 2.797 in SW3. The indexes were within the moderate water quality (3 -2) index as described by Mishra et al, 2010 and suggestive of low predation and environmental stressors within the Study area.

Table 4.26: Ecological indices of Zooplankton assemblages

	SW01 Olomo River	SW02 Ogunmakin	SW03 Ona River	SW Control
Taxa_S	19	16	21	19
Individuals	99	77	91	132
Dominance_D	0.07724	0.1408	007064	0.0699
Shannon_H	2.7	2.315	2.797	2.767
Simpson_1-D	0.9228	0.8592	0.9294	0.9301
Evenness_e^H/S	0.7833	0.6327	0.7807	0.8376
Menhinick	1.91	1.823	2.201	1.654
Margalef	3.917	3.453	4.434	2.686
Equitability_J	0.9171	0.8349	0.9187	0.9398
Fisher_alpha	6.987	6.141	8.558	6.086
Berger-Parker	0.1212	0.2987	0.1099	0.1136

Source: Fieldwork 2022

4.5.8.4.3 Benthic Fauna

A total of 20 species of Benthic fauna within the study area were represented by Arthropoda (18 species) and Oligochaeta (2 species). The Arthropoda were generally dominant constituting 80.7% of the Epifaunal and Infaunal assemblages in the study area and 79.3% in the control station. The variance in the taxa number maybe attributed to the environmental conditions prevailing in the study area (high calcium contents and the presence of macrophytic vegetation). A total of 142 individuals/m^2 were enumerated within the study area and 69 indlividuals/m^2 in the control station. A test of significance showed a 2-fold increase in the Arthropoda population within the study area compared to the control ($p<0.05$). Three species (Dolomedes fimbriatus, Chironomous transyalensis , Naucoris cimicoides and Cordulia sp) represented by the Crustacean, Insecta and Arachnida community recorded average relative abundance of >10 individuals/m^2. Broadly, the general dominance of the Arthropoda assemblages maybe attributed to the rich organic substrates in the bottom sediments and abundance of macrophytic vegetation. In corresponding order of increasing dominance in the Epifaunal and Infaunal assemblages within the study area were Mollusca (80.7%, 79.3%) >> Oligochaeta (23.9%, 20.7%). Broadly, the species density was generally high and showed consistent trend in taxa number in all the sampling stations.

Table 4.27: Summary of the Relative Abundance and Diversity of Benthic fauna community

	Study Area		Control	
Major Taxonomic Groups	**Number of individuals percentage (%) in parenthesis**	**Number of species**	**Number of individuals percentage (%) in parenthesis**	**Number of species**
Arthropoda	142 (80.7%)	18	69 (79.3%)	18
OLIGOCHAETA	34 (23.9%)	2	18 (20.7%)	2
TOTAL				
Number of sampling points	5		2	
Volume of SEDIMENT sampled (m2)				
Total number of individuals enumerated/m2	176		87	
Total number of species (S)	20			**20**

Source: Fieldwork 2022

Diversity Indices

The Shannon—Wiener (H) diversity index (*H′*) and Margalef Richness index (D) were used to characteri2e the Infaunal and Epifaunla Benthic assemblages. The Shannon diversity index ranged from 1.836 in SD3 to 2.475 in SD4. The indexes were within the moderate water quality (3 - 2) index as described by Mishra et al, 2010 and suggestive of low environmental stressors within study area and control. The relative abundances of the Oligochaeta (*Dero obtuse* and *Dugesiapolychroa*) lends credence to the resilience and high carrying capacity of the bottom sediments within the study area.

Table 4.28: Ecological indices of Benthic fauna assemblages

	SW01 Olomo River	**SW02 Ogunmakin**	**SW03 Ona River**	**SW04 Odo Oba River**	**SW05 Odo Osun River**	**SW Control 1**	**SW Control 2**
Taxa_S	14	13	9	15	13	15	16
Individuals	44	33	28	27	44	50	43
Dominance_D	0.126	0.1203	0.2066	0.1056	0.1333	0.0984	0.113
Shannon_H	2.285	2.312	1.836	2.475	2.215	2.469	2.425
Simpson_1-D	0.874	0.8797	0.7934	0.8944	0.8667	0.9016	0.887
Evenness_e^H/S	0.7018	0.7767	0.6968	0.7921	0.7048	0.7874	0.7067
Menhinick	2.111	2.263	1.701	2.887	1.96	2.121	2.44
Margalef	3.435	3.432	2.401	4.248	3.171	3.579	3.988
Equitability_J	0.8658	0.9015	0.8356	0.9139	0.8636	0.9118	0.8748
Fisher_alpha	7.088	7.912	4.592	13.9	6.227	7.265	9.233
Berger-Parker	0.2273	02121	0.3571	0.1852	0.2273	0.18	0.2093

Source: Fieldwork 2022

Plate4.9:A dragon fly resting on atwig at site

Plate 4.10:A Black pansy butterfly resting on dry leaf in the proposed project

Plate4.11:Cotton Steiner on the forest floor of the proposed project site

Plate4.12: Red imported fireant (*Solenopsisinvicta*) crawling on tree stem at site

Plate4.13: Leaves eaten by grasshoppers and beetles at site

Plate4.14: Termite habitat observed at the project site

Plate4.15:ABird'snest on a tree at the section of proposed project site

Plate4.16:Rodent burrows at the secton of proposed project site

Plate 4.17: Most sections of the study site dominated by Panicum maximum

Plate 4.18: Stands of Musa sapientum growing within the project site.

4.5.9 Socio-economics

4.5.9.1 Approach

Primary data collection was through the use of structured questionnaire which was pre-tested to ensure reliability, Focus Group Discussions (FGDs) guide, In-Depth Interviews (IDIs) guide, Questionnaires (Appendix 4.5), Health Index measurement, Ethnographic field research and participatory observation techniques (Crewell, 2003; WHO, 2010; Bernard, 2011; Ritchie and Lewis, 2012; Akpabio, 2013). Secondary data from relevant literatures was also consulted to complement the result of the study. All these techniques were complemented by visual photography sessions. At least ten (10) focus group discussion sessions were held in the various communities. An estimated three hundred (200) people made up of indigenes, residents, women, men and youths were randomly interviewed. A total of two hundred (200) questionnaires using the simple random method were distributed filled and 170 were retrieved. This was done to validate and/or complement the information given by the general respondents.

4.5.9.2 Project affected Communities

Socio-economic and Health studies were carried out in the project affected communities of the two states of Ogun and Oyo states. Some of these communities included but not limited to Ogere Community, Ijebu Ishara community in Remo North LGA, Alakuko in Owode Obafemi LGA all in Ogun State, Ajagba, Fidiwo, Omi Adio, Omi Fatokun and Adetokun in Oyo State. Majority of communities are the people of Yoruba extraction There are, however, other residents from different parts of Nigeria including Igbos from states in South Eastern Nigeria; Hausa from different states in Northern Nigeria and other Nationals from Benin Republic, Togo, Ghana among others. Notable facilities around the proposed pipeline project include among others;

- Yaali Foods Limited
- Ramona Trailer Park
- NGL Africa PVT Limited
- Technical University
- Dominion University
- Aramed Medical Centre
- Reynolds Construction Company
- Chinese Farm

- Triton Farms Limited
- Davotech Quarry
- Diamond Foods Limited
- Agritted Hatchery Farm
- Rolled Steeel Product Limited
- PML Quary
- Aramed Memorial Hospital
- ITB Nigeria Limited
- Rom Oil Mills Limited
- General Hospital, Orile Odo, Idi Ayunre
- Oluyole Local Government Secretariat

4.5.9.3 Community History/Ethnography, Structure and Settlement Pattern

The Yoruba are the second largest ethnic group in Nigeria, comprising approximately 21 percent of the nation's population (CIA World Factbook, 2002) and traditionally residing in the western region. The proposed project is located in Ogun and Oyo State, two of the six constituents of south western States, where the Yoruba's are the major ethnic group. Sub-ethnic groups however, also exist. The project-affected community and population belong to the Ijebu and Ibadan sub-group. The language of the Yoruba ethnic groups is also predominant. Not only are most of the households Yoruba, the Yoruba language is the most widely spoken language in the community, even among some minority ethnic groups. Expectedly, the ethnic background of majority of respondents indicated they were from Ogun and Oyo State and neighbouring Yoruba speaking states, Ondo, Ekiti, and Lagos while few are from Delta, Ebonyi, Cross River, Rivers and Benue States.

The oral history shows that the people speak Ijebu as the most popular dialect. The aworis constitutes almost 80% of the population while other existing tribes include Egun, Egede, Ibo and Hausa. The people have a well define hierarchical social structure with traditional leadership through kings, Obas, chiefs and Elders. The traditional authority structures hardly vary from one community to another with the traditional head (king or baale) and chief jointly administering their political, economic and social affairs. Authority in the communities is at two levels. The first is the traditional ruling council authority composed of the village chiefs and headed by an Oba or Baale, The second is the Community Development Association, comprising of an elected chairman and some executive members. The Community Development

Association (CDA) mobilizes the different sections and interest in the community for development purposes. The CDA reports to the council of Elders. There is also a youth council with elected chairman and members.

Generally, speaking three broad groups are identifiable in the communities, male elders, youth and women. The role of male elders is traditional governance of the community. They dominate the political arena and the decision making positions, while the youth leader are usually at the bottom rungs of the ladder of authority. The traditional role of the youth includes constituting a labour force in the development projects, security of the community and to enforce law and order. Traditionally, there is a limit to the involvement of women in the political governance of theses local settlements. Generally, women play a subdued role in the community usually placed at the background. The community has a patriarchal family arrangement.

In terms of settlement pattern, they all conform to two basic settlement patterns: linear and nucleated. Formerly rural villages, settlements were linearly situated along the many roads and transportation routes that traverse the area, establishing housing on the basis of lineage and kinship.

Religion: Ogere and Toll gate area of Ibadan communitkies represents mini Nigeria with all tribes in Nigeria represented, including the Benenois and Togolese. Almost all the Hausas in the community profess Muslim faith, only very few are Christians. There is a Mosque in the place and other worship places in the area. The Igbos are mainly Christians with few traditional worshippers. The Yorubas have both Christians and Muslims almost in equal proportions. Each group worships without any interference; there is freedom of worship and of associations.

Occupation: At Ogere, most of the community members are traders. It is the commercial nerve centre of the area with all types of commodities being sold in the market, a cow market, yam market, fruit market, onion market etc. The Igbo traders sell all manner of goods ranging from electrical parts, motor parts, patent medicine stores, restaurants etc. There are artisans like carpenters, brick layers, welders, electricians. Farming/agriculture is practiced in Ogere community and its environs a little removed from Ogere community/Toll gate. The farming is of subsistence level, producing food crops like, maize, yam, cassava, plantain, banana, cocoa yam and cash crops like palm oil, cocoa and coffee.

Infrastructural Facilities: There is a death of infrastructural facilities, the roads in most communities are not paved, no potable water, and water is sourced from open wells, private boreholes. No municipal water scheme in the entire community. Water vendors are seen selling sachet water everywhere in the area. Electricity is both poor and epileptic and the people were seen using generators especially restaurants, beer parlours. Some people even use hurricane lamp to light their shops to ensure they make some sells.

4.5.9.3 Settlement Pattern

Settlement pattern in the study area is linear and scattered. The entire settlement layout are densely built and occupied with short and unpaved roads. It is likely that they all began as linear settlements along the road but the evidence now is of settlements with internal structures that spread deep from the main road. The internal structures of the settlements have not developed to a point where they acquire distinct functional properties like commercial, residential and public uses. These settlements are all struggling to integrate with the sprawl at the fringe of the town; therefore they may take some time to develop unique identities.

4.5.9.4 Education

In general, the Southwest region is doing better than the national average as regards access, retention, and learning. However, even here many challenges remain. Educational attainment is higher in urban areas than in rural areas within the study area. The primary attendance rates show that about 20 percent of children aged 6—11 years are not in school. The last 20 percent to enroll in school are typically the most disadvantaged and a disproportionate number of them are from poor rural households and sick or disabled. Many children in this age group are not in school because their parents consider them to be too young to attend school.

The educational status of the project area is satisfactory considering the population figures and the number of children of school age in school and the low dropout rate. In the study area there are nursery, primary and secondary schools (Government community and privately) in almost every community. School enrolment ratio is fairly increasing with very good improvements in the last few years. English is the official language in government and to some extent in business transactions while Yoruba is the predominant language spoken by both indigenes and non-indigenes in the project affected communities in all forms of businesses and social interactions. However, it was observed that communicating in English language was quite challenging in the core rural areas despite 85% of sampled population (allegedly) claiming to be able to read and write.

4.5.9.5 Demography

The split between the males and the females in Nigeria are quite even. Men take the edge in numbers, but not by much. There are according to estimates, about 1.04 males to every 1 female in the country. It should be noted, though, that while women are slightly outnumbered by men, after the age of 65, women outnumber the number of men. Life expectancy is 51 years for males and 52.2 years for females. There are 140 persons living per square mile on the average in terms of density of the population. Life expectancy is 51 years for males and 52.2 years for females with a total fertility rate of about 6.2 children per woman of childbearing age (a little above the national average). Although population of the study area is predominantly rural (90%), the distribution in terms of sex is almost equal between male (50.8%) and female (49.2%). This pattern of population distribution is same across various constituencies, between urban and rural areas in the project states. In terms of age distribution, the observation during the survey indicates that 45.2% of the population was made up of young people below the age of 15 years, 49.0% between the ages of 15 and 59 while 5.8% were people aged 60 and above. The age distribution of the project area is similar with that of Nigeria as shown in Table 4.29. The proportion of persons in the younger age groups is substantially larger than the proportion in the older age groups for each sex in both urban and rural areas, which reflects the young age structure of the Nigerian population and is an indication of a population with high fertility. Approximately forty-four percent of the population is below 15 years of age and 4 percent is age 65 or older.

Table 4.29: Age Distribution of Nigeria

Age	Percentage	Male	Female
0-14 years	42.5%	41,506,288	39,595,720
15-24 years	19.6%	19,094,899	18,289,513
25-54 years	30.7%	30,066,196	28,537,846
55-64 years	3.9%	3,699,947	3,870,080
65 years and over	3%	2,825,134	3,146,638

Source: 2017 population estimate

The average household size in Nigeria is 5.0 persons while 3.3 and 3.9 for Ogun and Oyo almost all of which were headed by males. The household size is slightly higher in rural areas than in urban areas. Based on the 2006 census the average population growth rate over the period 2006 - 2022 was 3.4%. Using this population growth rate the projected population in 2018 that could potentially be affected by the proposed gas pipeline is given in Table 4.30 to 4. 31.

Table 4.30: Ogun State Population Projection

LGA	Land Mass (km²)	Population			Average	2022 Projected Population		
		Total	Male	Female	HH Size	Total	Male	Female
Sagamu	614	253412	123801	129611	3.3	424465	207367	217098
Ikenne	144	118735	68729	50006		198881	115121	83760
Remo North	1991	90722	59911	30811		151959	100350	51608
Obafemi Owole	104	228851	115369	113482		383325	193243	190082
Odeda	1560	109449	54263	55186		183327	90891	92437

Table 4.31: Oyo State Population Projection

LGA	Land Mass (km²)	Population			Average	2022 Projected Population		
		Total	Male	Female	HH Size	Total	Male	Female
Oluyole	629	202725	102220	100505	3.9	339564	171219	168346
Ono Ara	290	265059	131471	133588		443974	220224	223760
Egbeda	191	281573	138298	143275		471634	231649	239986
Lagelu	338	147957	74315	73642		247828	124478	123350

4.5.9.6 Occupation and Employment

Agriculture is the mainstay of the economy involving at least 70% of the rural population. The major source of occupation and income in the study area is agriculture. Agriculture provides income and employment for about 75% of the populace and they produce both food and cash crops. The food crops are rice, yam, cassava, maize and cowpea while the cash crops are cocoa, oil palm, kola nut, plantain, banana, cashew and citrus. A sizeable percentage of the people of the study area are also involved in business because the settlements are along the highway. The study area has quite a number of private SMEs, which produce diverse products. Income levels of respondents Income is an important variable that influences socioeconomic status of individuals and its distribution pattern has the potential of influencing other demographic variables. Some who may have information about their earnings are also not willing to divulge such sensitive data, considering the effects of taxation. Incomes in the communities range from N5, 000 to more than N20, 000. The modal income bracket is between N15, 000 and N20, 000. Given that the midpoint of the modal bracket is N17, 500 and assuming 31 days per month; a poverty analysis based on the World Bank standard of a minimum of 1.9 United States Dollars ((USD) per person, per day (poverty line) will indicate that the average resident earns about N564.5 per day. Assuming a currency conversion rate of N360 to 1USD, the average daily earnings would translate to about 1.6USD. The average daily income is lower than the

World Bank extreme poverty income of 1.9USD. The National Bureau of Statistics (NBS) calculated the poverty profile of Nigeria (NBS, 2010), and using the then extreme poverty income of 1.25USD per day concluded that 50.6% of the population of Rivers State, 56.1% of the South-South geo-political zone and 61.2% of Nigeria lived in poverty. However, the World Bank in its Nigeria Economic Report (NER), cited in This Day Newspaper, 23 July 2014, estimated a lower poverty rate of 33.1% in Nigeria.

4.5.9.7 Marital Status of Population

Marriages in the study area are contracted between adult males and adult females. There were no indications that same sex and juvenile marriages were practiced in the communities. The marriage process involves stages that bring the couple, their parents and relations, friends and other community members together. Parents and relations, however, play more prominent roles in the process. Drinks and gifts are usually presented by the groom's family to the bride's family in the process. Marriage ceremonies are usually accompanied with feasting and merry making. There are no known marriage restrictions on the basis of religion or culture in the study area. Generally, societies accept and raver the marriage institution. They accord the married some socio-cultural privileges and respect. Monogamy is the common practice but polygamy is also practised and accepted and some keep concubines. Polygamous marriages are estimated at about 30% in the study area except in Ogere that houses many uses who practice polygamy. Married residents are about 53.0% in the Ogere communities and 40.0% in Sagamu. A significant proportion of residents (22.2% in Sagamu communities and 25.0% in Ogere) are single. This could be as a result of the communities acquiring' urban status and Sagamu being in the Hub of industrial belt where a lot of unmarried young men migrate to seek for greener pastures.

4.5.9.8 Religious Practices

Most residents across the study area profess the Christian faith. Christians account for 53.6% of the population, traditional worshippers I l.3%, Muslims 34.4%, etheists 3.8% and others l.9%. Apart from worship and strict adherence, most residents irrespective of their religious faith, revere places of worship and traditions of the communities. Christian denominations with worship places in the communities include Anglican, Assemblies of God, Deeper Life Bible Church and Redeemed Christian Church of God, Catholic Church among others. The main Christian festivals of Christmas and Easter are celebrated by residents while Muslims in the community also celebrate their festivals of Eid el-Malud, Eid el-Fitre and Eid el-Kabir. There are no known communal restrictions on religious beliefs and worship in the communities.

4.5.9.9 Traditional Administration and Socio-Cultural Institutions

The Yoruba ethnic nationality is traditionally made up of clans and each of them has an autonomous administrative set up. Each of the communities studied is administered by a traditional ruler/chief called Baale who is the head and custodian of the traditions and customs of the people. He is assisted directly by a Council of Chiefs. Each one of them also has a Land Priest who is the traditional spiritual leader. The land priest in conjunction with the Council of Chiefs, support the office of the traditional ruler. Each of the communities under study has a traditional ruler. The traditional ruler oversees the three groups of four villages that make up the community. Communities in the study area also celebrate during the course of the year with activities which include masquerade and Oro festivals around July the mid of the year, parties and sport competitions are held. Participation in these is open to both indigenous and non-indigenous residents. Communities in the study area prohibit some practices perceived to be harmful with a view to ensuring security of life and property and fostering harmonious co-existence and habitation. These include committing suicide, incest, having sexual intercourse with a married woman who is not one’s wife, having sexual intercourse in the bush and stealing. Residents abide by these prohibitions and those who do not are punished, if caught, by severe fines and traditional penalties depending on the gravity of the offence, sometimes by ostracism.

4.5.9.10 Land Use Management

Land Ownership/Access and Tenure System, land is Nigeria’s most important long-term resource base and in areas where this finite resource is in short supply can be very contentious. Practically everywhere therefore, Nigerians share land as a common denominator wherein lie most of their hopes and most of their problem. Before rights can be exercised over land, it has to be acquired in one of six principal methods of land acquisition, namely, inheritance, purchase, lease, pledge, exchange, and gift. Land in Nigeria falls under four broad ownership classes, regardless of who the law says holds the land in trust for whom. They are individually-owned, family-owned, communally-owned, and government-owned land. Across the project communities, as it is inmost parts of Nigeria, the constituent founding families of each of the communities own land, and authority over its’ use is vested in the hands of the eldest man in the family. Non-indigenes living amongst the native population also acquire land for cultivation from owners of the land on an individual basis, paying only a nominal fee as may be demanded.

4.5.9.11 Waste Management

The waste management practices were very poor. Waste streams were not segregated but lumped together and disposed of into water courses, farms, and gutters. The wastes consist of commercial wastes like papers, cartons, plastic bottles, cans. Others include food wastes, vegetables, cow dungs etc. In most parts of the community, there is no water cistern or closet or VIP (ventilated improved toilets) People defaecate in open places, some in nylon bags and disposed around human surroundings. Indiscriminate and unsanitary disposal of faeces is inimical to human health.

4.5.9.12 Road Traffic Study

4.5.9.12.1 Traffic Volumetric Survey

A survey of baseline traffic volume and traffic flow on the Ibadan — Lagos express way was conducted for the Nipco Gas Limited 60km Gas Pipeline Project EIA Study. The survey will serve as a reference document in future evaluation of traffic impact assessment and general traffic management. Traffic volumetric survey was undertaken by trained assistants at points along hypothetical cordons traversed by motorised traffic on the road of interest. Routine Survey was carried out for seven days at regular time interval. Road survey was conducted during the Day from 7:O0hrs to 18:00hrs which represent the period of significantly active road usage. Actual count was taken for vehicles corning to Ibadan from Iwo as incoming while those leaving as outgoing vehicles. In order to properly account for all types of traffic of interest as deemed necessary and to be able to carry out basic arithmetic and statistical operations, vehicle types were delineated into categories as shown in Table 4.32.

Table 4.32: Delineated Vehicles types

S/No.	Vehicle	Description
1	Buses	A transport vehicle design to carry more people than a car or van (≤ 30)
2	Luxurious Buses	A Long luxury transport vehicle design to carry large number of people ≥ 56)
3	Cars	Four-wheeled road vehicle that is powered by an engine and able to carry a small number of people (≤ 6)
4	Motorcycles	A two-wheeled vehicle that is powered by a motor and has no pedals
5	Trucks	A large, heavy road vehicle used for carrying goods, materials, or troops; a lorry

4.5.9.12.2 Traffic Volumetric Survey Results.

Table 4.33: Daily Road Traffic Volume along Ibadan to Lagos (27/10/2022 - 02/11/2022)

Vehicle Type	Wednesday (27/10/22)	Thursday (28/10/22)	Friday (29/10/22)	Saturday (30/10/22)	Sunday (31/10/22)	Monday (01/11/22)	Tuesday (02/11/22)	Total
Buses	162	140	218	268	143	147	148	1226
Luxury Buses	31	39	29	76	41	58	44	318
Cars	291	285	305	463	370	346	406	2466
Motorcycles	11	15	13	19	20	30	22	130
Trucks	129	130	134	171	137	157	146	1104
Total	624	609	699	997	711	738	766	5144

The results of the roadway traffic survey are shown in Tables 4.33 which reveals that over the 7-day survey period, the highest volume of traffic was recorded on Saturday with a total of 997 vehicular units with cars as the highest. The lowest was on Thursday with a total of 609 units. The weekly average time interval volume of traffic was highest between I 5:00hr — 1 8:00hr with an average vehicular count of 349 units. This reveals that there is more activity within the evening hours of the day. In terms of vehicular composition to total traffic volume, cars constitute the highest of 55% of the total roadway traffic surveyed. Buses had 28% while the lowest was motorcycle with only 3%.

4.5.9.13 Conflict Resolution

Conflicts and contentious issues are resolved in the area by collaboration among the various organs. In the event that a community member runs fowl of the law, the issue is handled family heads/chiefs, youth or women group, and the resolution terminates at the feet of the community head the bale depending upon the nature and gravity of the offence. The deviant is punished according to the gravity of the offence, smaller crimes could lead to monetary fines, while serious offenses could involve meting out serious punishment, including being given up to the police.

4.5.9.14 People's Perceptions Fears and Expectations

The general populace in the area is pleased and excited with the proposal for the construction of gas pipeline because the project will help to create employment opportunities, improve electricity, generate revenue and increase incomes. Community consultation, FGD and responses from the administered questionnaires indicated that the resident population is not opposed to the industrialization drive of the Federal and state Government particularly gas utilization. The worry is that communities must always be carried along, consulted and benefits accruing from such project implementation be given to them to have a sense of belonging. The level of awareness in the communities about the proposed project was high. Focus group discussions and key informant interviews revealed so much enthusiasm and are very supportive of the proposed project. All affirmed their readiness to work towards the realization of the project. Communities agreed that the project development activities have the potential to impact them negatively in some ways, but they are also hopeful that increased employment opportunities, social infrastructural development accruable from the development activities if properly executed shall more than compensate for the negative externalities. Their suggestions therefore, were tailored towards the improvement of their socioeconomic conditions and lessening of the negative impacts on their livelihoods and health. Very high expectations regarding the project and its positive effects were expressed; overall social issues, health centers and increased access to both potable water and health care services and resources were mentioned as necessary ingredients for a crisis-free operating environment. Expectations, Priority Needs/Demands of Project Communities are;

- Project implementation acceptable to community
- Employment opportunities for the indigenes are topmost priority.
- Community wants employment opportunities, training of youth in skills and other manpower development programmes, scholarship awards, sustainable rural development projects-healthcare and other facilities, and compensation for any resource losses (land, crops, trees and fishing ponds) as well as get the pipeline surveillance/security contract.
- Commensurable compensation for resource losses, employment opportunities, scholarship awards, provision of potable water, etc.
- Above all, community should be carried along during operations; when complaints are made, these should be looked into properly and promptly

4.5.10 Health Assessment

4.5.10.1 Health Care Facilities

The importance of adequate health care facilities in providing sustainable rural development can therefore not be over-emphasized. Convergence of opinions agreed that lack of basic health care facilities have led to inefficiency in production, declining productivity, reduced life expectance and increased infant mortality rate. The findings for the study indicate that the available healthcare facilities are grossly inadequate and their distribution depicts serious inequality. There is an urgent need for serious intervention on the part of the government in the provision of health care facilities in the study area especially in the rural communities focused on equitable distribution and accessibility to enhance sustainable rural development.

In the project communities of Ogun and Oyo state assessed, there were many primary health centres which are NHIS accredited, well equipped and fully functional while some are completely dilapidated and abandoned especially in the remote villages are state hospitals, General hospitals, primary health centres, health clinics, maternities, health posts. The state is in charge of General hospitals, Local Government councils in charge of primary health centres, Teaching/tertiary hospitals are run by the federal government. They serve as referrals to provide excellent services. Major cases are referred to Teaching or specialists' hospitals like University of Ibadan teaching hospital. The General Hospital handles more difficult cases than the primary health centres. The Model Health centres handle cases like, delivery, health education, health promotion, immunization, treatment of minor injuries, and provision of drugs. Others render skeletal services. The community members agree that they are satisfied with the services. Doctor patient/contact time is short but some people live further than 1.5km to the hospital, the recommended distance. The services rendered by the centre included the following:

- Delivery services
- Maternal and child care
- Family planning services
- Immunization and minor ailments
- Health Education.
- Health Promotion

Problem of logistics, poverty, ignorance, drug revolving scheme, financial constrain limit health care delivery in the health centres in some cases, some essential drugs are not available, and electricity is epileptic. There are however, a few private hospitals that complement the effort of the public health sector. Traditional Medical practitioners are many and readily come to aid orthodox medical practice.

At these communities there were traditional medicine practitioners, traditional birth attendants and trado-orthopaedic/Bone setting practitioners who in their limited capacity assist and compliment orthodox healthcare delivery. These traditional healers lack adequate training in Hygienic procedure. Although some TBA have been trained by NGOS, while the others were trained by government agencies. Few of them are resident in the communities. There is urgent need to train other people in the area of hygiene to make their contributions more meaningful. There are many patent medicine stores that complement orthodox medicine. Facilities for prompt/emergency responses were available in the General Hospital. As already stated Poor economic and financial resources, problem of trained personnel, lack of infrastructural facilities limited the quality and type of Healthcare delivery in some of the public Health institutions.

Traditional healers confirm that they are usually the first point of treatment for many people in the community and while some report health cases early, others come late. According to healers, those who delay do so because of high costs of treatment, shame or ignorance. Traditional health care providers also claim that they refer patients to the nearest orthodox medical facilities such as the General Hospital, which are in most cases above the recommended travel time. The healers do not only refer the patients but they also assist in getting the patients to the facility as reported by a group of key informants. Traditional healers also indicate that transportation is one of the major challenges to the practice of their trade. It limits access to places where they can purchase herbs for prompt treatment of their patients. Also some patients cannot afford their services.

The earlier health survey indicates that majority (93.3%) of the respondents in the surveyed community manage their health problems through herbal remedy and/or self-medication, while not less than 20% of the respondents reported that they have never visited a health facility before. This was attributed largely to the absence of such facilities around their community. Many of the residents in the project area are quick to point out that there are no health facilities in their communities. According to them, "People in the community depend on the herbal healers for their health care needs". The nearest primary health care or general hospital is farther than the recommended distance and travel time. Lack of drugs and lack of medical personnel especially doctors were also identified as part of the pressing needs of the community. The choice of a health facility was also surveyed and convenient access was the most common reason for the respondents' choice. The reasons for the choice of place of last treatment ranged from 8.2% for considerate/courteous services to 35.7% for convenient access.

The assessment of health conditions of the community members was based on survey and hospital records. From the survey, majority of the respondents in all the communities surveyed (93.3.6.5%) reported that their perceived health condition was good, 2.8% reported a bad health status while the remaining 0.7% said that their health status is undecided as they cannot give an affirmative response as to whether or not their perceived health status is good or bad.

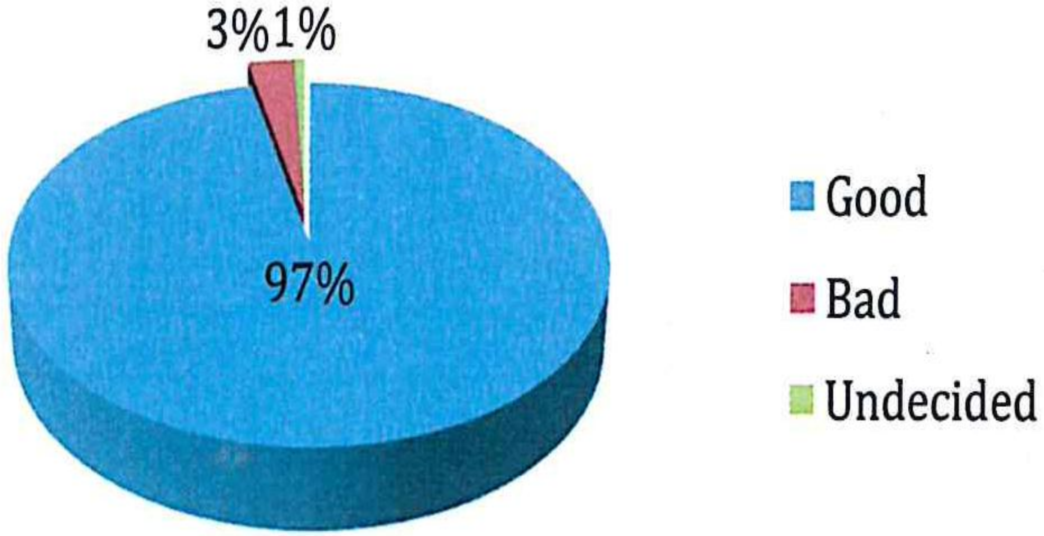

Figure 4.11: Perceived Health Condition in Surveyed Communities

4.5.10.2 Social Issues affecting Health

The WHO (2011) reports that the harmful use of alcohol is a worldwide problem resulting in millions of deaths, including hundreds of thousands of young lives lost. It is not only a causal factor in many diseases, but also a precursor to injury and violence. Furthermore, its negative impacts can spread throughout a community or a country, and beyond, by influencing levels and patterns of alcohol consumption across borders. Indeed, people who drink alcohol excessively (over two drinks per day) have a one and a half to two times increase in the prevalence of hypertension. The association between alcohol and high blood pressure is particularly noticeable when the alcohol intake exceeds 5 drinks per day. Moreover, the connection is a dose-related phenomenon (WHO, 2010). Smoking on the other hand increases the risk of vascular complications (for example, heart disease and stroke) in people who already have hypertension, it is not associated with an increase in the development of hypertension. The health surveys of the communities in the project area show that more than a tenth (12%) of the households have someone who smokes, while more than a quarter (29.8%) of the households have one or more persons who drinks alcohol or palm wine. Palm wine is the most commonly consumed, followed bybeer then gin. Other forms of alcohol reported to be consumed are spirits and other wines.

4.5.10.3 Disease Prevalence

In an attempt to estimate the level of morbidity in the project-affected communities, respondents were asked about the illness episodes suffered by household members in the last 12 months to the study. The responses were validated by asking a series of other questions related to the reported illness. The disease trend in the host community based on household members who have or have had a disease in the past twelve months indicated that the most predominant disease conditions among children in order of importance were malaria, diarrhea, eye problems and acute respiratory tract infections. Others were worm infestation and skin infections *(sarcoptei, scabei, fungal dermatitis)*, Diseases among the adult population were malaria, typhoid fever, diarrhea, pneumonia, hypertension, diabetes, sexually transmissible infections and tuberculosis. The table below shows the commonest diseases and conditions in the studied area and the proportional morbidity.

Table 4.34: Distribution of illness episodes among Respondents

DISEASES	NUMBER OF CASES	PROPORTIONAL %
Malaria	343	28.1
RTI	132	10.8
Diarrhea	139	11.4
Skin disease	100	8.2
Typhoid	32	2.6
Fever/convulsion	40	3.3
Eye problems	60	4.9
Arthritis	30	2.5
Hypertension	40	3.3
Peptic ulcer	9	0.7
Measles	13	1.1
STI	7	0.6
Pregnancy Related Complications	34	2.8
Tuberculosis	9	0.7
Anaemia	49	4.0
Accident/injury	32	2.6
Hernia	16	1.3
Toothache	5	0.4
Headache	119	9.8
Asthma	9	0.7
Diabetes	2	0.2
Total	120	100

Source: Field Survey 2022

Malaria is reportedly the leading cause of illness in the project-affected area even though there is abnormally slightly higher proportion of deaths from diarrheal disease. Malaria however contributes to anaemia in children in the study communities and this undermines their growth and development. The field survey also revealed that apart from the direct effect on the child survival, malaria exacerbates poverty in the communities through diminishing productivity and mortgaged household income. All these have negative consequences on the standard of living and by implication health. Women of reproductive age bracket who make up 23% of the total population are vulnerable to complications of pregnancy and childbirth this is mostly due to low access by this group to quality reproductive health services including antenatal and postnatal programs. This can result in high maternal mortality ratio.

4.5.10.4 Health care Practice

The knowledge of the practice of malaria control was good, as much as 40% households were in possession of insecticide treated bed nets for the control while 60% had none. Other methods of malaria control assessed included cleaning of the environment and the use of insecticide aerosol sprays (pyrethroids). Bed net prevalence was quite impressive as it far exceeded South-West zonal prevalence of 10% and the National prevalence of 8% (NDHS 2008), but yet to attain the revised National target of 80% set by the National Strategic Plan of action 2009, 2013 (FMoH 20090). The use of insecticide treated bed nets has been designated as the main method employed for malaria prevention in Nigeria. This is because insecticide treated bed nets have proved successful in the prevention of malaria as a result of both personal protection which they provide the users and also the mass effect on the local mosquito population when they are used on a community wide basis (Soremekun et al 2004) (Langeler and Snow 1996) Knowledge of control of malaria graph). Knowledge of respondents on the management of diarrhea is presented; Use anti-diarrhoeals (62%), use of herbs (20%), use of oral rehydration solution (15.5%), others are (3%). The correct knowledge of the causes of the prevention of sexually transmitted infections (STIs) including HTV/AIDS was low.

Knowledge of abstinence was 8.9%, condom use was 45.4% and mutual fidelity was 15.3%. It was obvious that most community members lacked the correct knowledge of STI and HIV prevention. This could result from poor information or misconceptions about the diseases even as some respondents were insinuating that HIV could be prevented by taking drugs and prayer.

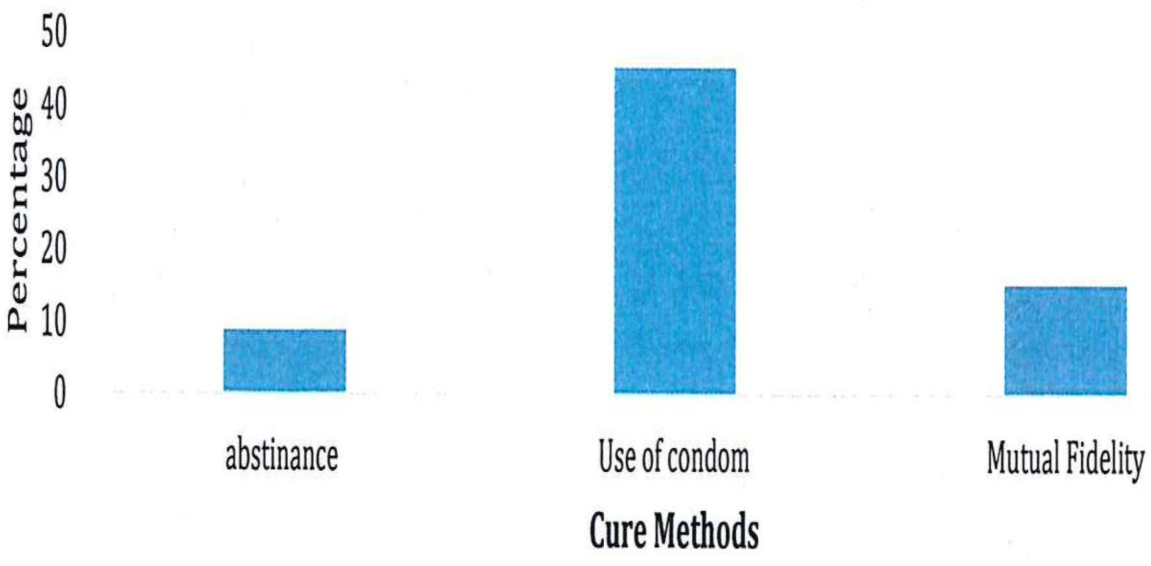

Figure 4.16: Knowledge of Prevention of HI V/AIDS by Respondents.

The use of modern family planning methods was 48.9%, traditional methods (21.80%) and those eligible but did not use them were 29.3%. This result however, exceeds the national and south-West regional prevalence rates of 14.6% and 16% respectively (USAID 2009), (NDHS 2008). The use of modern family planning methods was l8%, traditional methods 5l% and those eligible but did not use them were 3l%. This result however exceeds the national and South-West regional prevalence rates of 14.6% and l6% respectively ((USAID 2009), NDHS 2008). Three major reasons for non-use of family planning were given as fear of adverse reaction (53%), -fear that it could cause damage to the reproductive system and compromise future fertility potentials (33.6%), religion forbids (4.2%%), spouse not in support (7.6%) and sex of child (1.8%). Family planning allows individuals and couples anticipate and attain their desired number of children. This is usually unmet as there have always been discrepancies between individual contraceptive behaviours and their stated fertility preferences (Bhandari et al 2006).

4.5.10.5 Environmental health

Refuse is mostly disposed of in the project communities by open dumping around the surroundings, near the houses or along the road, so that the people are virtually surrounded by their wastes. Access to acceptable means of faecal disposal in the form of ideal sanitary latrines is another important determinant of health. Many households in the project communities lacked sanitary latrines and therefore practice open defecation in nearby bushes, along the road and rivers. Standard houses in the project area had water-closet system or pit latrines. Refuse is mostly disposed of in the project communities by open dumping, along the roads, into the rivers, pen-domestic farmlands and in most cases into water courses and drainage channel, open burning of refuse and burying. These methods are very poor refuse disposal methods with serious health implications especially as they promote the multiplication of disease vectors such as rodents/vermins, cockroaches. Access to acceptable means of faecal disposal in the form of ideal sanitary latrines is another important determinant of health. Here in the project-affected communities, sewage disposal is a major challenge. Many households in the project communities lacked sanitary latrines and therefore practice open defecation in nearby bushes and along the road as already stated. Most community members who do not have toilets have no alternative than to defecate in nearby water courses or defecate into a nylon bag and thrown into water courses. Unhygienic handling and disposal of faeces also contributes to the spread of communicable diseases especially those transmitted by water and food like diarrhea, cholera, typhoid cholera, typhoid and intestinal helminthiasis as a result of water pollutions.

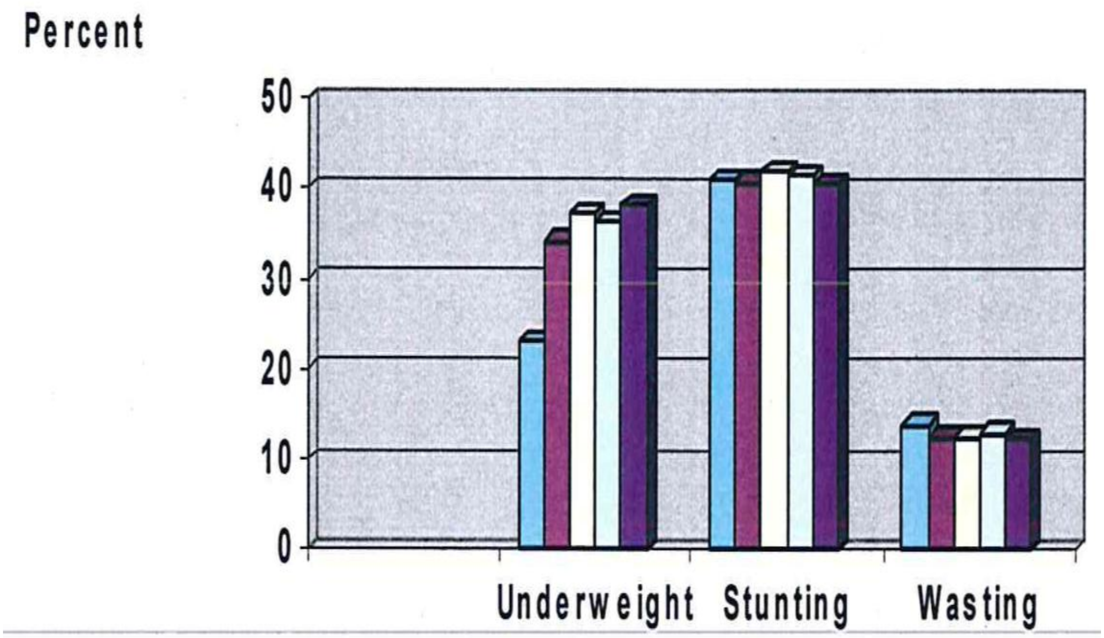

Figure 4.17: Nutritional Status of Under-Fives in the project areas.

4.5.10.6 Nutritional Status.

Pregnant and lactating women and children below the age of three years are the most susceptible to the effects of malnutrition on health and well-being. Malnutrition is known to be an associated risk factor in 6 out of every 10 deaths in children below the age of five years. Malnutrition among children less than five years was used as the proxy for assessing malnutrition in the project communities. Nutritional status of these children was assessed by determining the prevalence of underweight (low weight for age), stunting (low height for age) and wasting (low weight for height). The results showed that compared with the 2008 national estimates (NDHS 2008), a much higher proportion of children were underweight in the project communities compared to the national estimate (Figure 4.17). For stunting and wasting, the figures are comparable to the national estimates (2008 NDHS). The high rates of malnutrition observed in the project communities are probably related to the level of poverty, illiteracy, ignorance and perhaps to mal-absorption syndrome. It is anticipated that the projects might impact positively in this respect through industrialization, compensation, social responsibility, and opportunities for employment.

CHAPTER FIVE

POTENTIAL AND ASSOCIATED IMPACT ASSESSMENT

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POTENTIAL AND ASSOCIATED IMPACT ASSESSMENT

5.1 Impact Assessment Methodology

Project activities and environmental interfaces generally encompass a broad range of issues including air pollution, land pollution, effects on employment and community structure. There are several approaches and techniques developed for evaluating potential impacts of any project on the environment. The ISO 14001 method is simple to apply, provides a high level of detail and also relies on limited data. The ISO 14001, therefore is selected for the identification and evaluation of impacts for the proposed gas pipeline project. The Nipco Gas Limited pipeline project could have impacts on the biophysical, social and health components of the environment. The impact assessment process is used to identify and qualify these potential impacts, evaluate their likelihood of occurrence, magnitude and significance. This is essentially a qualitative model that relies on the following:

- The professional judgment of the EIA Consultants
- Knowledge of the gas pipeline process and procedures to be used
- the baseline environmental status of the gas pipeline works area
- Experiences from similar gas pipeline project in the region and elsewhere
- The terms of reference for the ETA as generated from the scoping workshop
- Issues raised during consultation with stakeholders

Step 1 — Establishing the Basis for Impact Assessment

- **Baseline development**
  - Collection of environmental (biophysical, social and health) baseline data in the project area.
  - Integration of environmental (biophysical, social and health) baseline data to develop an integrated understanding of the existing natural and social environment, baseline data have been described in Chapter 3 and 4.

- **Determination of sensitivities**

Determination of sensitivities that characterize the natural and social environment by the expert environmental teams (biophysical, social and health) using their knowledge of the integrated baseline data.

- **Determination of project activities**

Determination of individual project activities undertaken in the respective project phases: pre-construction; construction; operation and maintenance; and decommissioning, restoration and abandonment.

Step 2 — Interaction Matrix Assessment of interaction

Assessment of interactions between project activities and sensitivities (describing the biophysical, social and health environment) in a workshop setting with the environmental, social and health expert teams.

- **Description of interaction**

Brief description of anticipated interaction between the project and the sensitivities on the biophysical, social and health environment of the project is highlighted. These interactions and the sensitivities were developed into a matrix.

- **Identification of primary impacts based on interaction matrix**

Identification of impacts based on the interactions between project activities and sensitivities as identified in the interaction matrix. The identification of the impacts was phase-sensitive. The relevant project phases include pre-construction; construction; commissioning; operation and maintenance; and decommissioning, restoration and abandonment. This approach helped in identifying impacts that cut across most of the project phases.

Step 3 — Integrated Impact Assessment

- **Integration of Identified Impacts**

Identification of the significant impacts of the project taking a high level, integrated perspective while using information from the previous steps and expert opinions in the process, including the identification of residual impacts.

- **Description of Impacts**

Development of a brief description of the impacts including a description of the impacts of different project activities on a single sensitivity, using the integrated impact list and expert judgment of the specifics of the project and its natural and social environment.

- **Impact Classification**

From these exercises, a list of impacts was developed. These impacts were classified as either

- adverse or beneficial
- short term or long term
- reversible) or irreversible
- short term < 3 months; long term> 3 months

• **Impact Evaluation**

Mind the interaction and/or connections between the project activities and the biophysical, social and health issues so that accurate predictions about what may happen can be made. This exercise identified the significant positive and significant negative impacts arising from the project.

• **Mitigation Measures**

- Development of mitigation measures based on the integrated list of significant impacts, clearly connecting impacts and mitigation measures.
- Assessment of residual impact after implementation of mitigation measures and a demonstration that any residual impact is as low as reasonably practicable (ALARP).
- Enhancement of significant positive impacts.

5.2 Development of Interaction Matrix

5.2.1 Sensitivities

Based on the baseline, as described in Chapter 3, a list of sensitivities that characterize the biophysical, social and health environment of the proposed gas pipeline project was examined. The aim of impact identification is to ensure that both significant and insignificant potential and associated bio-physical, social and health impacts are accounted for. The anticipated impacts were determined based on the interaction between project activities and environmental sensitivities. Environmental sensitive components likely to be affected by the activities of the proposed project are presented in Table 5.1.

Table 5.1: Impact Indicators

Component		Impact Indicators
Biophysical	Soil	Changes to soil quality indices (physicochemical properties, hydrocarbons, heavy metals, Microbiology
	Air	Emissions of NO_2, SO_2, $PM_{2.5}$, PM_{10}, CO, VOC, greenhouse (CO_2, CH_4)
	Noise	Change in noise levels at sensitive receptors
Social	Population	Changes in population indices, total population, gender ratio

	Infrastructure	Improvement or pressure on existing urban/rural infrastructure including waste handling facilities
	Macro and micro economy	Change in macro and micro economy, employment, standard of living, occupation
	Social and Cultural Structure	Disruption in local authority and governance structure; change in social behaviour, intra- and inter-ethnic classes
	Transportation	Alteration in means of transportation or ability to move efficiently
	Education	Change in primary, secondary and tertiary education school enrolment and attendance
Health	Pollution Related Health Effects	Increase in concentration of air pollutants of concern (NO_2, SO_2, $PM_{2.5}$, PM_{10}, CO, VOC) and contamination of surface waters and potable ground water, increased noise beyond regulatory limits, increased night time beyond acceptable.
	Communicable and Non-Communicable disease	Change in incidence of communicable and non-communicable diseases or disease – causing factors
	Morbidity and mortality	Change in health of workers and general public, change in security of the area
	Health care/ recreational facilities	Changes in availability of and access to health care and recreational facilities
	Psychosocial factors	Drug use/abuse, communal violence, crime, suicide, depression and prostitution; changing expectations of quality of life.
	Accidents/Fires/ Explosions	Changes in rate of occurrence and severity of accidents/fires/explosions

5.2.2 Project Activities

A list of activities which interact with the social and natural environment in a distinct way either due to their nature or due to timing was compiled. The full list of project activities used in the interaction matrix has been summarized in four (4) phases of pre-construction, construction, operation and decommissioning. Based on these interactions, the identified negative impacts were rated as High, Medium and Low. Positive impacts arising from the project were not further classified.

The purpose of scoping is to identify those aspects of the proposed activities, which could have significant impacts on the environment. This is usually based on past experience, literature reviews and findings of previous EIA studies on similar projects. The scoping process attempts to find answers to the questions below:

- What impacts will occur as a result of the execution and operation of the Gas Pipeline Project?
- What will be the extent, magnitude, and duration of the impacts?
- Which of these impacts will be important within local and national contexts?
- What can be done to mitigate, reduce/avoid altogether the adverse impact or to enhance positive impacts?

Scoping is thus an important part of the impact assessment process and involved identification of potential environmental impacts to ensure that the assessment focuses on the key issues for decision making. Therefore, scoping is an activity aimed at identifying those components (biophysical, social and health) of the environment, which may be impacted by the project and for which there are common concerns by stakeholders. The anticipated impacts were determined based on the interaction between project activities and environmental sensitivities as listed in Table 5.2. Based on the interaction between the different project activities and the environmental sensitivities/components (as shown in Table 5.2), a checklist of associated impacts were produced, as depicted in Table 5.3.

Table 5.2: Sources of Environmental Impacts (Impacts Associated with Project Activities)

Environmental Components	Pre-Construction Phase				Construction Phase									Post Construction Phase				
	Site Survey	Land acquisition	Mobilization	ROW Clearing	Trenching/Escavation	Stringing and welding	NDT	Coating/Holiday Detection	Pip Lowering-in	Cathodic Protection	Back Filling	Thrust boring (road cross	HDD (river crossing)	Hydro-testing	Demobilizaion	Pigging	Maintenance	Abandonment
BIOLOGICAL ENVIRONS																		
*Vegetation	X	X		X	X												X	
*Biodiversity	X			X														
*Wildlife	X			X	X			X			X			X		X	X	
*Aquatic Life				X	X												X	
PHYSICAL ENVIRONS																		
*Land Use		X						X			X			X		X	X	X
*Soil Quality				X	X			X			X			X		X	X	
*Surface Water				X	X												X	
*Ground Water			X	X	X												X	
*Air Quality		X	X	X	X													
SOCIAL ENVIRONS																		
*Demography			X										X					
*Employment	X		X	X	X	X							X					X
*Income	X	X	X	X	X	X							X					X
*Community Issues	X	X	X	X	X	X							X					X
*Public Disturbance	X	X	X	X	X	X							X					X
*Public Health			X		X	X	X											

5.3 Identified Impacts

Based on the information from the discussions, the impacts from the gas pipeline Project were identified and categorized as presented below.

Table 5.3: Checklist of Identified Associated and Potential Impacts

Project Phase	Project Activity	Environment Component	Potential/Associated Impacts
Pre-Construction	Site Survey	Vegetation, Wildlife	
	Land acquisition	Vegetation, Social aspect	
	Mobilization of workforce and equipment to site	Social	
		Social & Health	
		Air Quality	
	ROW Clearing	Vegetation	
		Soil	
		Surface Water Quality	
		Wildlife	
		Air Quality	
Construction Phase	Pipe Stringing & Welding	Environmental, Social and Health	
	NDT (examination of welding joints)	Social and Health	
	Coating and Holiday detection	Soil and Surface and Ground Water	
	Trenching	Soil	Removal of top soil, damage to roads, likely spillage of crude oil (if there is an existing crude oil pipe) if existing pipes are ruptured
		Surface Water	Surface water contamination
		System	
		Air Quality/Noise	Changes in noise and exhaust gases from excavators. Increase in dust during the dry season.
		Soil	Alteration of soil profile
		Soil and Ground Water	Contamination of soil and water (ground) from chemicals used for cathodic protection.
		Surface Water	Increase in surface water turbidity
		Soil	Soil contamination
		Surface water	Alteration in water quality status
		Ground water	Groundwater contamination
		Social Issues	Contamination on farm land and crops
		Soil	Soil contamination
		Social Issues	Community agitation
		Surface Water System	Discharged hydrotest water can contaminate surface water and also can increase surface water temperature.

		Soil	Contamination of soil by discharged hydrotest water
		Soil, Vegetation, Water (surface and round) & Air Quality	Release of gases through isolation valves. Severe damage to vegetation, wildlife and soil in the event of fire/explosion and may lead to groundwater pollution; Contamination of soil and water system with condensate
		Soil & Vegetation	Corrosion of abandoned structure, causing increase in ambient concentration of iron in the soil, Pollution of soil & water by waste disposal
		Social Environment	Temporal job creation for locals, Loss of job (local vigilante, ROW maintenance crew), agitation & youth restiveness

5.4 Interaction Matrix

With the background knowledge of the project and its biophysical, social and health environment, the Project Team determined the interactions between project activities and sensitivities. Each interaction was discussed followed by an assessment as to whether the effect of the interaction was expected to be positive, minor or negative. Many of the project activities, as well as their interactions with the environment, are similar and overlap during the various phases of the project. This overlap has been taken into account in assessing the impacts arising from the gas pipeline project. In the interaction matrix (Table 5.4), an (X) is used to indicate where a project activity interacts with components of the environment.

5.4.1 Impact Assessment

Two stages were involved in assessing the impacts. The first stage classified the impacts as either adverse beneficial, short term or long reversible or irreversible. An (X) was used to indicate these classifications. Adverse impacts are those which impact negatively on the biophysical, health, and social environments while beneficial impacts are those which enhance the quality of the environment. For this study, short term means a period of time less than three months while any period greater than three months is considered long term. Reversible/irreversible meant whether the environment can either revert to previous conditions or remain permanent once the activity causing the impact is terminated.

Stage one: Classification

The first stage involved in the assessment of impact is impact classification. Impacts are classified as follows:

- Adverse (-) or Beneficial (+) in nature,
- Short term < 3 months (S) or Long term> 3 months EL), and
- Reversible (R) or Irreversible (I). Stage two: Significance

The second stage involves evaluation to determine whether or not the impact is significant. The criteria and weighting scale employed in evaluation are as follows:

- Legal/regulatory requirements (L);
- Risk factor (R);
- Frequency of occurrence of impact (F);
- Importance of impact on an affected environmental component (I); and
- Public perception/interest (P).

The quantification scale of 0, 1, 3 and 5 was used. This is a modification of the arbitrary scale proposed by Vesilind, et al. (1994). The ratings are as described below and are adapted from the International Organization for Standardization ISO 14001 – Environmental Management System Approach.

- **Legal/Regulatory Requirements (L) – Is there a legal/regulatory requirement or a permit required?**

0 = There is no legal/regulatory requirement
3 = There is legal/regulatory requirement
5 There is a legal/regulatory requirement and permit required

- **Risk Factor (R) – What is the risk/hazard rating based on the Risk Assessment Matrix?**

1 = Low risk
3 = Intermediate risk
5 = High risk

- **Frequency of Impact (F) — What is the frequency rating of impact based on the Risk Assessment Matrix?**

1 = Low frequency (rare)
3 = Intermediate frequency (likely)
5 = High frequency (very likely)

- **Public interest/perception (P) — What is the rating of public perception and interest in proposed project and impacts based on consultation with stakeholders?**

1 = Low interest/perception
3 = Intermediate interest/perception
5 = High interest/perception

- **Importance of affected environmental components and impacts (I) — What is the rating of importance based on consensus of opinions?**

1 Low
3 Medium
5 High

This approach combines the following factors in assessing the overall impact rating of the project on the environment:

- The sensitivity/vulnerability of the ecosystem components;
- The productivity evaluation/rating of the ecosystem components;
- Knowledge of the possible interactions between the proposed project and the environment;
- Envisaged sustainability of the project environment; V
- The economic value of the proposed project activities; and
- Projected duration of the impact of each project activity on various environmental components.

The frequency of occurrence of each impact was determined from site-specific research while the importance of affected enviromnental component was determined through consultation and consensus of opinions. The perception of the communities and the general public on the potential impacts and their effects were determined through consultation with the communities and consensus of opinions of environmental professionals. The overall impact rating is determined as shown in Table 5.1. The potential and associated impacts of the project are presented in Table 5.4.

Table 5.4: Impact Value and Rating

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 5.5: Risk Assessment Matrix

Consequence		Increasing Probability				
		A	**B**	**C**	**D**	**E**
Severity	Environment	Never heard of incident in the sector	Incident has occurred in sector	Incident has occurred in Nipco Gas Projects	Happens several times per year in Nipco Gas Projects	Happens several times per year in gas pipeline projects
0	No effect					
1	Slight effect					
2	Minor effect		Risk			
3	Localized effect			Medium		
4	Major effect			Risk	High Risk	

Table 5.6: Further Definition of Consequence – Severity Rating for Risk Matrix

Severity	Potential Impact	Definition
0	Zero effect	No environmental damage. No change in the environment. No financial consequences.
1	Slight effect	Local environmental damage within the fence and within systems. Negligible financial consequences.
2	Minor effect	Contamination, damage sufficiently large to effect the environment. Single instance of statutory or prescribed criteria being exceeded, single compliant. No permanent effect on the environment.
3	Localized effect	Limited loss of discharges of known toxicity. Repeated examples of statutory or prescribed limit being exceeded. Affected neighborhood.
4	Major effect	Severe environmental damage. The company is required to take extensive measures to restore the contaminated environment to its original state. extensive range of statutory or prescribed limits exceeded.
5	Massive effect	Persistent severe environmental damage or severe nuisance extending over a large area. In terms of commercial or recreational use or nature conservancy, a major economic loss for the company. Constant and high level of statutory or prescribed limits being exceeded.

Source: SIEP (1996)

Table 5.7: Severity Factor Code

Likelihood (Severity Factory	Code	Definition
High		**The threat-source is highly motivated and sufficiently capable and controls to prevent the vulnerability from being exercised are ineffective**
Medium		**The threat source is motivated and capable, but controls are in place that may impede successful exercise of the vulnerability.**
Low		**The threat source lacks motivation or capability, or controls are in place to prevent, or at least significantly impede, the vulnerability from being exercised.**
Positive		**Increase in economy, employment and welfare**

Table 5.8: Potential Impacts Identification, Ranking and Quantification

Project Phase	Project Activity	Description of Impact	Impact Quantification						Impact Quantification						
			Adverse	Beneficial	Short term < 3moths	Long term > 3months	Reversible	Irreversible	L	R	F	I	P	F+I+P +R+L	Overall Ranking (High/ Medium/ Low)
Pre-construction	Land acquisition for Flowlines	Loss of farmland	X			X		X	3	5	5	5	5	15	H
		Community unrest	X		X	X	X		0	5	3	5	5	13	H
		Loss of habitat	X			X		X	0	1	5	1	1	7	M
		Loss of biodiversity	X			X		X	0	1	1	3	1	5	L
		Loss of income	X		X		X		0	3	5	5	5	15	H
		Changes in traditional occupation	X			X	X		0	1	3	3	5	11	H
		Generation of capital from land compensation		X	X			X	3	3	5	5	5	15	H
Mobilization	Movement of goods, equipment and personnel	Increase in potential for road traffic volume	X		X				3	5	5	5	5	15	H
		Increase in potential for road traffic incidents	X		X				3	5	3	3	3	9	M
		Increase in noise	X		X				3	3	5	3	3	11	H
		Stress on existing security structures	X					X	0	3	1	3	5	9	M
		Reduction in air quality (dust, exhaust)	X		X				0	1	3	3	3	9	M
		Damage to existing roads	X		X		X		0	3	3	3	50	1	H
		Increase in economic activities			X	X			0	1	5	5	5	15	H
Construction	Site preparation (Land clearing, Excavation)	Loss of flora and fauna	X					X	0	1	3	3	3	9	M
		Community unrest	X		X		X		0	5	3	5	5	13	H
		Stress on existing security structures	X					X	0	3	1	3	5	9	M
		Increase in employment		X	X		X		3	5	5	5	5	15	H
		Increase in dust and noise	X		X		X		3	3	3	3	3	9	M
		Increase in economic activities		X	X		X		0	1	5	5	5	15	H
		Changes in landscape	X			X		X	3	1	3	1	1	5	L

		Increase in erosion potential	X			X	X	X	0	5	5	5	3	13	H
		Threat to health of workers (snake bites) insect bites and stings, injuries etc)	X		X	X		X	3	5	3	5	5	13	H
	Influx of labour and followers	Changes in local population	X	X	X	X		X	0	3	5	5	5	15	H
		Increase in mortality, morbidity and STIs	X					X	0	5	5	5	5	15	H
		Increase in social vices	X					X	0	3	3	3	3	9	M
		Pressure on existing infrastructure and utilities	X					X	0	1	5	5	5	15	H
		Increase in inflation level	X					X	0	3	5	5	5	15	H
		Changes in culture, lifestyle and habits	X	X		X		X	0	1	3	3	1	7	M
		Increase in economic activities	X	X				X	0	1	5	5	5	15	H
		Reduction in air quality	X				X		0	1	3	1	3	7	M
	Waste Generation and disposal	Increase in breeding grounds for disease vectors and other agents of diseases	X			X	X		3	5	3	5	3	11	H
		Increase in nuisance	X		X		X		0	1	3	3	3	9	M
		Blockage of natural drainage	X		X		X		0	1	3	3	1	7	M
		Pressure on existing waste management system	X			X	X		0	3	3	3	3	9	M
Pre-Construction	Land acquisition for flowlines	Loss of farmland	X			X		X	3	5	5	5	5	15	H
		Community unrest	X		X	X	X		0	5	3	5	5	13	H
		Loss of habitat	X			X		X	0	1	5	1	1	7	M
		Loss of biodiversity	X			X		X	0	1	1	3	1	5	L
		Loss of income	X		X		X		0	3	5	5	5	15	H
		Changes in traditional occupation	X			X	X		0	1	3	3	5	11	H
		Generation of capital from land compensation		X	X		X	X	3	3	5	5	5	15	H
Mobilization	**Movement of goods, equipment and personnel**	**Increase in potential for road traffic volume**	**X**		**X**		**X**		**3**	**5**	**5**	**5**	**5**	**15**	**H**
		Increase in potential for road traffic incidents	**X**		**X**		**X**		**3**	**5**	**5**	**3**	**3**	**9**	**M**
		Increase in noise	**X**		**X**		**X**		**3**	**3**	**5**	**3**	**3**	**11**	**H**
		Stress on existing security structures	**X**		**X**			**X**	**0**	**3**	**1**	**3**	**5**	**9**	**M**
		Reduction in air quality (dust, exhaust)	**X**			**X**		**X**	**0**	**1**	**3**	**3**	**3**	**9**	**M**
		Damage to existing roads	**X**		**X**	**X**		**X**	**0**	**3**	**3**	**3**	**5**	**9**	**11**
		Increase in economic activities			X	X		X	0	1	5	5	5	15	H
Construction	Site preparation (Land	Loss of flora and fauna	X			X		X	0	1	3	3	3	9	M
		Community unrest	X		X		X		0	5	3	5	5	13	H
		Stress on existing	X			X		X	0	3	1	3	3	9	M

	clearling, Excavation	Increase in employment		X	X		X		3	5	5	5	5	15	H
		Increase in dust and noise	X		X		X		3	3	3	3	3	9	M
		Increase in economic activities		X	X		X		0	1	5	5	5	15	H
		Changes in landscape	X			X		X	3	1	3	1	1	5	L
		Increase in erosion potential	X			X		X	0	5	5	5	3	13	H
		Threat to health of workers (snake bites, insect bites and stings, injuries, etc)	X		X	X	X	X	3	5	3	5	5	13	H
	Influx of labour and followers	Changes in local population	X	X	X	X		X	0	3	5	5	5	15	H
		Increase in mortality, morbidity and STIs	X			X	X	X	0	5	5	5	5	15	H
		Incrse in social vices	X			X		X	0	3	3	3	3	9	M
		Pressure on existing infrastructure and utilities	X			X		X	0	1	5	5	5	15	H
		Increase in inflation lelvel	X			X		X	0	3	5	5	5	15	H
		Changes in culture, lifestyle and habits	X	X		X		X	0	1	3	3	1	7	M
		Increase in economic activities		X		X		X	0	1	5	5	5	15	H
		Reduction in air quality	X			X	X		0	1	3	1	3	7	M
	Laying of flowlines and pipeline networks (ROW bush Clearing, Trenching, stringing, Welding, radiography, Field joint coating, Lowering, backfilling, Hydrotesting)	Reduction of flora and fauna population													
		Reincrease in employment opportunities	X			X	X		0	3	3	3	3	9	M
		Threat to health of workers (snake bites, insect bites and stings, injuries, etc)		X		X	X		3	3	3	3	3	9	M
		Reduction in air quality (dust levels)	X		X	X	X	X	3	5	3	5	5	13	H
		Increase in noise level	X		X		X		3	3	3	3	3	9	M
		Increase in erosion potential	X		X		X		0	3	3	3	3	9	M
		Contamination of surface waterbodies	X		X		X		3	5	3	5	5	13	H
		Pressure on existing waste management systems	X		X		X		0	1	3	1	1	5	L
		Habitat fragmentation	X		X		X		0	1	3	1	1	5	L
		Loss of Habitat	X		X		X		0	1	3	1	1	5	L
		Potential for falls into exposed trenches (animals, unsuspecting passers-by)	X		X		X		0	3	3	3	3	9	M
		Soil degradation from spills and leaks	X		X		X		3	3	3	3	5	11	H
		Degradation from soil compaction	X		X		X		0	1	3	1	1	5	L
		Change in topography of the soil	X		X		X		0	3	3	3	1	7	M
		Exposure to radiation materials	X		X	X	X	X	3	5	1	5	3	9	M
		Potential for inhalation of welding fumes	X		X		X		3	3	3	3	1	7	M
		Potential for conflicts arising from labour issues (welders)	X		X		X		0	3	3	3	3	9	M
		Stress on existing security structures	X			X		X	0	3	1	3	5	9	M

		Erosion from release of hydrotest water	X			X		X	0	3	5	5	3	13	H
		Contamination of surface and underground water and soil from inhibited hydrotest water	X		X			X	3	5	3	5	3	11	H
		Increase in potential for incidents (high pressure of pipes during hydrotesting)	X		X	X	X	X	3	5	1	5	5	11	H
Operations and Maintenance	Operation and Maintenance of Gas Plant	Increase in employment opportunities		X		X	X		3	5	5	5	5	15	H
		Increase in noise levels	X			X	X		3	1	3	3	3	9	M
		Reduction in gas flaring	X			X		X	5	3	3	5	5	13	H
		Reduction in air quality	X			X	X		3	1	1	3	3	7	H
		Degradation of soil and surface water from spills and leaks	X			X	X		3	1	3	3	3	9	M
		Relaive drop in economic activities	X			X		X	0	1	3	3	3	9	M
		Decrease in commercial waste generation		X		X	X		0	1	3	1	1	5	L
		Increase in industrial waste generation (rags, filters, lubricating oil, etc)	X			X	X		3	1	1	3	1	5	L
		Increase in employment opportunities		X		X	X		3	3	3	3	3	11	H
		Degradation of soil and surface water from spills and leaks	X			X	X		3	1	3	3	3	9	M
		Stress on exiting security structures	X			X		X	0	3	1	3	5	9	M
		Threat to health of workers (snake bites, insect bites and stings, injuries, etc)	X		X	X	X	X	0	5	3	5	5	13	H

5.5 Impact Discussion

The impacts associated with the proposed gas pipeline project have been identified and evaluated visa-vis the recipient environment. They have also been subjected to the impact severity evaluation. All potential impacts to the environment as summarised are intended to provide an insight into the nature and level of significance of the identified impacts as well as a description of mitigation measures outlined in the various phases of the development.

5.5.1 Potential Negative impacts of the project activities

Impact on Air Quality

Short-term air emissions that could degrade air quality may result fromconstruction related operations. All diesel-powered facilities such as power generators, bull-dozers, trucks and heavy machineries would emit SOx, CO_2, CO, NOx, VOCs and other hazardous gases. These combustiongases can cause air pollution problems and health related hazards for people in the vicinity. Dust generated during construction especially during clearing and trenching, could also alter air quality of the environment. The impact is significant; short term, reversible and local.

Impact on Vegetation/Biodiversity

A wide variety of plant species in the primary swamp forest, secondaryrainforest regrowth vegetation and bush fallows will be cleared to make way for ROW and access roads. ‘This would have local disruptive effects on the vegetation structure and function. The impact is significant in the short term and reversible.

Impact on Land Use

The entire length of the pipeline route shall be freshly acquired. Landacquisition entails loss of farmland by the indigenous farmers who usethe land to cultivate various crops. The negative impact is significant,reversible and of long-term effect.

Impact on Soil

Clearing of the vegetation would expose the soil to direct sunshine, which would elicit chains of significant negative impacts. The direct exposure would lead to increase in soil temperature, fluctuating moisture regimes,erosion and topographic changes. Dramatic increases in soil temperature would result in high mortality of soil organisms and drying of the soil to theextent that regeneration is hindered. These impactswould be both direct and indirect, long term, reversible and local. Approximately 8,640m^3 of soil will be excavated and backfilled. This would render the soil loose and unstable and may trigger soil erosion.

Impact on Surface and Ground waters

The Ogun River and their tributaries in the project area may be polluted by runoff and sedimentation as well as trenching and excavation. Incidental discharges comprising petrol, diesel and lubricants may degrade both surface and ground waters. Surface runoff of chemicals, metals and solid wastes frequently stored in piles on the facility site can pollute surface waters andpercolate to groundwater. The impact is short term, reversible and local.

Impacts on Socio-economics

The settlement types within the project area are predominantly semi- urban. Therefore their population sizes are averagely large. Given population size, the influx of workers during the construction phase will significantly affect the demographic pattern of the host communities. Construction activities will no doubt affect the sex ratio of communities' for the period the activity is taking place in particular communities. Farming is by far the dominant occupation in the host communities, and as a result, personal incomes are generally on the low side. The project will potentially impact occupation and income, among others. This is so because employment will attract higher income, there would be some redirection of labour from farming, fishing, etc to the project. In addition, the higher personal incomes associated with employment could cause some inflation in the local economy. Therefore, price increases and redirection of labour are likely to be among the major impacts of the project on the local economy. Large concentrations of construction workers around the town could bring about increased demands on services and facilities. This may result in significant increases in prices, which would be a burden on the local populace. At the end of construction activities, there may be local economic depression in the host communities and neighbouring settlements following withdrawal of labour force, i.e. a “boom and burst” scenario. Conflicts may also arise between non-native construction crew and localpeople as a result of the former’s disregard or lack of respect for nativeculture, local norms (traditions), religious practices and lifestyles. A common impact on lifestyles concerns sexual and other forms of behaviour, as well as modes of dressing. Sexual laxity/prostitution andalcoholism are the most common and are associated with migrant workers living alone, away from their families. In some cases, youth militancy develops as youths organize in order to extract money from project owners or contractor either for themselves or for their communities.

Impacts on Social Infrastructure

The most common social infrastructures in the host communities are primary and secondary schools, healthcare facilities and water supply systems. The project will bring about population growth due to the influx of workers. The capacity of local infrastructures in some of the communities is very limited and so cannot cope with the increased demand that will result from population growth during the project, especially the construction phase.

Pressure on existing infrastructure and utilities

The study area has limited physical, social and economic institutional infrastructure. Potable water, recreational facilities, electricity, clinics, banks and post offices were inadequate. With the influx of labour and followers, there will be pressure on the already grossly inadequate infrastructure of the area, such as recreational facilities, schools, clinics, water supply, communication facilities, markets, housing, hotels, drinking parlours, etc. An influx of people into the area could cause an increase in levels of crime and other social vices. Also the project may increase risks for community unrest,sabotage actions and violent protests. It is unlikely that the existing security forces will be able to cope with such situation based on their current strength.

Increase in morbidity (including STIs and HIV) and mortality

Currently morbidity (and mortality) from communicable diseases such as malaria, respiratory tract infections and diarrhoea diseases is very high. Health services are few with low capabilities. Based on baseline health survey, the current knowledge, attitude and practice with regards to sexually transmitted infections is low. There are practices of multiple sexual partners and condom use is low. The expatriates and other migrant workforce from outside the area may import some communicable diseases such as Tuberculosis, HIV/AIDS, SARS etc. Contact with the communities could lead to transmission of these diseases among the locals. Influx of labour could also act indirectly to cause an increase in the levels of other communicable diseases such as diarrhoea/gastroenteritis, respiratory tract infections and malaria through poor housing and overcrowding. This is likely to occur as the present living standard of the people is low with poor housing, inadequate sanitation and water supply occasioned by pressure on an already deficient and inadequate community infrastructure. The influx of people including commercial sex workers and migrant workmen, many of whom are likely to be young, sexually active and either single or without their families could therefore increase the potential for casual sex and the transmission of STI including HIV/AIDS. Given the current low level of knowledge of STI, low availability and use of protective mechanisms in the local communities and the public health importance of STI/HIV/AIDS in the nation, this impact cannot be over emphasized.

Impacts on Health Status

During construction activities, the health of local people may be negatively impacted when non-native labourers from outside the locality import diseases, which the local medical facilities are inadequate to handle. The labourers can also contact diseases, most especially, sexually transmitted infections such as gonorrhea, syphi1i herpes, H1V/AIDS, etc. Increased commercial sexual activities among construction workers could lead to a sharp increase in the influx of commercial sex workers neighbouring metropolis with the attendant health risks.

Environmental Sanitation and Waste Management

A number of waste types shall be generated during the construction, operation and abandonment phases of the project. These include metal scraps, spent lubricant, domestic waste (including sewage) etc. Improperwaste disposal would lead to loss ofaesthetics, increase of disease vectors, risk of accidents by sharp objects/scrap piles, and contamination of soil and water bodies (through run-offs). The impacts of waste generation are significant, short term and reversible.

Risk of Fire and/or Explosion

Fire and explosion can occur in any section of the pipeline in varying degrees of magnitude. This could be as a result of gas leaks from the pipes, operational errors, or activities of vandals. The most vulnerable targets of fire/explosion are vegetation, wildlife and people.

Increase in potential for road traffic incidents

It is anticipated that road traffic will increase during mobilization of personnel and equipment to site over the period. During the construction phase which is expected to last about six months, intensive movement of personnel and equipment will also take place as well as during operation and maintenance. During the period, an added number of 5 - 10 tonnes truck per day will be added to traffic volume. Given the present condition of the road, there is the potential for increased road traffic accidents/injuries during these phases.

Exposure to Dangerous Animals, Insects and harmful Plants

The species of reptiles found in the area include crocodiles, snakes, bees, tsetse flies. Contact with harmful plants (*Mimosa sp*) in the area could lead to allergic reactions. The healthcare centres in the area do not have a record of any human injury from these plants. The clearing of the vegetation could expose the workforce to these animals/insects thereby triggering attack. The impact is direct, negative, short/long term, reversible/ irreversible and was rated minor.

Increase in the cost of living

Average monthly income in the study area is about 20,000, which is below the national minimum wage of N30,000. An injection of workers with significantly higher incomes into the project area could create a local inflationary pressure. This impact is described as direct, negative, short term, local, reversible, and the rating is minor.

Emission of exhaust fumes/noxious gases to the atmosphere

Emission of exhaust fumes/noxious gases to the atmosphere from the crafts will result in the temporary deterioration of ambient air quality. The sources of emissions of noxious gases into the atmosphere related to transportation include; the increased number of boat movements into the area. These are expected to generate an undetermined quantity of gases which are released into the atmosphere. The gases from machinery include SOx, NOx, CO, CO_2 suspended particulate matter (SPM) etc. The inhalation of these gases could trigger respiratory tract diseases and worsen existing ones like asthma, chronic bronchitis. The concentration of these emissions will depend on wind speed and direction. The impact was rated as minor due to the anticipated minimal quantity of emissions. The impact is direct, negative, short term, local and reversible.

Potential impacts on air quality

Emissions from construction equipment, work equipment, trucks and other vehicles used in construction work could be a source of air pollution. Dust from construction activities is also a possible source of air pollution.

Noise and vibration

Construction activities may create a problem of noise and vibration generated by construction equipment, truck traffic, work vessels and other similar sources.

Construction Waste management

Wastes from construction activities are mainly spoils generated. Disposal of dredged material on land may cause destruction of plants, loss of vegetation, leakage of contaminated materials and salt, odour, an unsightly view and other nuisances to the local community. Disposal in water may cause problems.

Third party agitation

The community agitation could arise from: reduction in the surface water quality of the water bodies in the area, disturbances of fishing activities, discontent from business/employment issues. The impact is qualified as direct, negative, short/long term, local and reversible. It is rated major.

General Waste Management

As in most other industrial terminals, the wastes generated in this study area included both degradable and non-degradable types. Most of the degradable wastes were mainly kitchen wastes that included food wastes or remnants (garbage), papers etc. The non-degradable wastes were mainly metals, plastics, polythene bags, cans/tins etc. For human waste disposal, vacuum trucks were the most commonly used method of disposal, followed by defecation in the bush and then water cistern. There is deliberate private modern waste management practice in the project area predominant waste disposal method in the area is disposal in burrow pits. The activities planned for the gas pipeline project will not alter the waste generation and disposal pattern in the study area. These wastes will consist of domestic wastes (hazardous and non-hazardous, sanitary wastes (grey and black water), construction waste, used lubricating oils, rags and filters as well as vegetation and paper. As a result of anticipated increased activities of service providers and followers associated with this project, it can be anticipated that the total quantity of waste generation apart from industrial wastes will not in any dimension adversely increase over and above the capabilities of the existing waste management facilities in the project area.

Contamination of surface water from fuel and oils

Power generation requires the use of refined petroleum products and lubricating oils. Accidental discharges and leakages from generator and storage tanks are a potential source of hydrocarbons in the water. Inorganic additives in fuel and oil can add to heavy metal contents in the environment. This impact is rated minor and is direct, negative, local, short term and reversible.

5.5.2 Potential Positive impacts of the project activities

In this instance the cumulative impacts may arise from the parallel running of the proposed gas pipeline project. The construction and operation of gas pipeline can also create cumulative impacts in-terms fixed point project. These impacts have been assessed to pose beneficial to medium significant adverse impacts.

Cumulative impacts relating to the construction of the proposed gas pipeline include:

- Pollution (Air, soil & Water)
- Incidents (Road accidents)
- Population (migrants, Workers, followers)
- Aesthetic value of area where there are existing industries
- Pressure on existing infrastructure

Based on the individual impact assessment for the projects, majority of the cumulative impacts would occur during the early phases of these projects: mobilization and construction, while a small number would occur during operation of the various facilities.

The cumulative positive impacts identified are

- Business Opportunity/Economic enhancement
- Skills acquisition
- Increase in revenue

The cumulative negative impacts identified are:

- Increase in potential for road traffic volume
- Increase in noise nuisance
- Reduction in air quality (dust, exhaust)
- Stress on existing security structures
- Changes in local population
- Increase in social vices
- Pressure on existing infrastructure and utilities
- Increase in communicable diseases (including STIs)
- Pollution of surface water sources
- Loss of biodiversity

The significance rating of each of these impacts has been obtained through the process of impact identification, ranking and quantification, in each of the projects.

Project Table. 5.9 Cumulative Impact Analysis

Impacts	Gas Pipeline
Reduction in biodiversity/Loss of flora and fauna	Low
Increase in cost of living/inflation	Low
Increase in potential for road traffic volume	High
Increase in noise nuisance	Medium
Reduction in air quality (dust, exhaust)	Medium
Community unrest	Low
Stress on existing security structures	Medium
Business opportunity/Economic enhancement	Positive
Changes in local population	Low
Increase in social vices	Medium
Pressure on existing infrastructure and utilities	Medium
Skills acquisition	Positive
Injury to workers	Low
Increase in communicable diseases	Low
Pollution of surface water sources	High
Soil degradation from spills and leaks	Low

5.6.1 Cumulative Positive Impacts

Business Opportunities/Economic Enhancement

A percentage of the various project costs would be reserved for local contracting. These projects would therefore, create various opportunities for local contractors to take advantage for the supply of goods and services. This would ultimately enhance the economy of the area and improve the economic well-being of the contractors.

Employment & Skills Acquisition

The project would require skills of various types and there is the potential for the acquisition of new skills by qualified community indigenes in various areas during construction only. Acquisition of these skills would improve the chances of such individuals within the labour market of getting similar jobs based on the new skills acquired. Also skills that would be of indirect service to these projects would also be of benefit to the communities. Within the service industry, barbing, tailoring, repairs, waste management, etc would expand to cater for the influx of personnel and waste they would generate, while the supply industry (foodstuff, office consumables, provisions etc) would also expand.

Increase in Revenue to the Government

With the commissioning of the gas pipeline revenue for the company will increase based on the increase activities and objects of the pipeline project.

5.6.2 Cumulative Negative Impacts

Most of these impacts were individually rated as medium or high for the various projects. Their cumulative effects would most likely be high or medium.

Reduction in air quality (dust & exhaust emissions)

During the dry season, harmattan dust, construction dust and exhaust fumes would be deposited on vegetation, pedestrians, and structures close to the road in higher concentrations due to the increase in traffic volume.

Stress on existing infrastructure & Utilities

Though contractors would provide accommodation, feeding, transport etc for their workers, the camp followers would utilize those services and infrastructure available within the communities. Thus, there would be cumulative stress on the poor infrastructure and utilities with each influx of camp followers.

Increase in communicable diseases

With each influx of construction workers & camp followers, the frequency of STIs would increase as well as the chances of individuals contacting different types of infections. The cumulative effects of different infections in individuals would compromise their health status leading to absence from work, loss of income and, in the extreme case, death.

Water and soil contamination

With simultaneous construction activities at the various locations there is the increased potential for accidental spills and leaks that could cause water and soil contamination. With an increase in the frequency of contamination there is the potential for some of the contaminants to accumulate especially in soil and sediments.

Potential for community unrest

With simultaneous construction activities, the host communities of the project area would experience an increase in population due to the influx of workers, camp followers, contractors, job seekers etc. This could lead to negative stress within the communities of several types. These could be cumulative with the influx of persons for each project and lead to community unrest. Other extraneous factors not related to the projects such as border dispute; inter-communal disputes & politics could also heighten the situation.

CHAPTER SIX

MITIGATION MEASURES & ALTERNATIVES

CHAPTER SIX
MITIGATION MEASURES/ALTERNATIVES

6.1 Introduction
The actions and measures that Nipco Gas Limited intends to take to reduce (or eliminate) negative impacts and promote positive impacts of the proposed Project are presented in this chapter. In this mitigation measures, emphases are placed on those negative impacts rated as significant (medium and high impacts). The measures are aimed at reducing these impacts to As Low As Reasonably Practicable (ALARP). The residual impacts that could arise despite these mitigation measures were also noted. None significant impacts are expected to be mitigated through effective implementation of Nipco Gas Limited Safety and Environment policies that will be put in place during the different phases of the project.

The mitigation measures proposed for the predicted medium and high-ranking impacts arising from this Project recognized the following:
- Environmental laws in Nigeria, with emphasis on permissible limits for waste streams FMEnv (formerly FEPA, 1991)
- Best Available Technology for Sustainable Development
- Feasibility of application of the measures in Nigeria
- Concerns of stakeholders during consultation meetings, scoping workshops and the socio economic/health status of the host communities.

Mitigation measures are recommended for the potential negatives impacts identified in the impact assessment.

Prevention: Exclude significant potential impacts and risks by design and management measures.

Reduction: Minimize the effects or consequences of those significant associated and potential impacts that cannot be prevented, to a level as low as reasonably practicable by implementing operational and management measures.

Control: Implement operational and management measures to ensure that residual associated impacts are reduced to a level as low as reasonably practicable.

Factors for determining implementation of mitigation measures are:
- Avoiding the impacts altogether by not making a certain action or parts of an action

- Minimizing impacts by monitoring the degree or magnitude of the action and its implementation.
- Rectifying the impacts by repairing, rehabilitating or restoring the affected environment.
- Compensation for the impact by replacing or providing substitute resources
- Feasibility
- Ease of implementation
- Local suitability
- Institutional requirements
- Monitoring requirements
- Training requirement
- Cost (Capital and operating) and
- Cost effectiveness

The mitigation measures are categorized by relevant impact category, potential impact, and affected specific area. The Required General and Specific Mitigation measures are divided into three sections, labelled Environmental, Socioeconomic, and Health and Safety, and subsequently into seven categories of potential impacts. These categories of impacts by section are:

Environmental

- Land Use;
- Topography, Geology, and Soils;
- Habitats, Biological Resources and
- Air Quality (including Noise and Vibration).

Socioeconomic

- Cultural (and Archaeological) Conditions; and
- Socioeconomic Conditions (Means of Livelihood, and Transportation and Infrastructure). Health and Safety
- Public and Worker Health and Safety.

Table 6.1: Proposed Mitigation Measures

Project Phase	Project Activity	Description of Impact	Significance Rating Before Mitigation	Mitigation	Significance Rating After Mitigation (Residual Impact Rating)
Pre-Construction	Land acquisition for Manifold and flow lines	Loss of farmland and associated income	High	• Nipco Gas Limited shall pay adequate compensation to affected land owners • Nipco Gas Limited shall increase productivity o remaining farmers through provision of farming support facilities such as improved varieties of seedlings and other extension services.	Low
		Community unrest	High	• Nipco Gas Limited shall identify all bona-fide land owners prior to land acquisition and payment of compensation. • Nipco Gas Limited shall ensure adequate consultations and enlightenment of host communities using established channels of communication to ensure transparency of the land acquisition and compensation payment process.	Low
Mobilization	Movement of goods, equipment and personnel	Potential increase in road traffic volume	High	• Large and slow moving vehicles should be scheduled during off peak periods • Ensure maintenance of all roads of any damage caused by project • Raise community awareness of unusual activity through the HSE/SD team	Low
		Potential increase in road traffic incidents	Medium	• Pre-mobilization of all vehicles • Visible warning signs on roads and vehicles • Speed breakers at sections traversing communities • Defensive driving course for Nipco Gas and contractor drivers	Low

				• Vehicle monitoring device/Nipco Gas journey management policy/nigh driving and alcohol policy shall be enforced • First aid training of workforce and provision of first aid boxes in operational vehicles.	
		Increase in noise levels	High	• Enforce night driving policy (no night driving except when unavoidable) • Nipco Gas Limited shall ensure that all vehicles and equipment conform to World Bank limits for noise	Low
		Reduction in air quality (dust, exhaust fumes)	Medium	• Nipco Gas Limited shall ensure that only vehicles with pre-mobilization certificates are used to reduce emissions from vehicle exhaust.	Low
		Damage to the existing Road	High	• Nipco Gas Limited shall ensure repair of road when damage is caused by the project	Low
Construction	Site preparation (land clearing, excavation)	Loss of flora and fauna	Medium	• Site clearing shall commence from developed (e.g. roads) to undeveloped areas to provide escape routes for wildlife. • Hunting by employees of contractors shall be prohibited • Nipco Gas Limited shall educate construction workers on the sensitive nature of the biodiversity of the area and the need for conservation	Low
		Loss of habitat	Medium	• Nipco Gas Limited shall limit cleared area to what is required • Nipco Gas Limited shall encourage the re-vegetation of land cleared for temporary use where feasible.	Low
		Community unrest	High	• Nipco Gas Limited shall ensure that all host communities are represented in the employment of locals during land clearing	Medium

				and excavation to avert any conflict that could arise from perceptions of unfairness • Nipco Gas shall ensure that land clearing and excavation jobs are reserved exclusively for the host communities. • Nipco Gas shall abide by all MOUs signed with the host communities	
		Stress on existing security structures	High	• Nipco Gas shall ensure that both contractor and Nipco Gas personnel develops a high level of security consciousness both within and outside the work area. • Daily security reports shall have reviewed by the Nipco Gas Project Manager • Special security force shall be established and deployed for the project. This shall include deploying some of Nipco Gas security system to strengthen security in the area. • Nipco Gas shall ensure that a liaison to foster partnership with the community so as to guarantee security for the project is established and substained. • In order to beef up security for the project, Nipco Gas shall contact government authorities to improve the strength of the police force and shall consider providing assistance with equipment e.g. patrol vehicles, to ensure improved security. • Nipco Gas shall ensure that safety workshops to identify, security risks are regularly organized.	Medium
		Increase in dust and noise	Medium	• Nipco Gas shall ensure that nose masks and ear muffs are worn by site workers during excavation.	Low

				• Water shall be sprayed on construction sites to reduce dust levels especially during dry season	
		Potential increase in erosion	High	• Nipco Gas shall re-vegetate areas not needed for construction as soon as possible following excavation.	Low
		Threat to health of workers (snakes bites, insect stings, injuries, etc)	High	• Nipco Gas shall ensure usage of PPE by field workers • Nipco Gas will ensure there are adequately trained and sufficient numbers of first aiders at each site • Nipco Gas shall ensure that anti-venon/anti-histamine is provided on site to mitigate snake bites and insect stings. • Nipco Gas shall ensure that awareness is created among site workers and nearby communities on the likelihood of exposure to poisonous wildlife and plants	Low
Construction		Changes in local population	High	• Prior to commencement of the construction phase, Nipco Gas shall advertise construction jobs that will be available. This will hopefully discourage unqualified personnel from moving into the project area, thus reducing the rate at which the local population will grow. • Nipco Gas will look into the development of off-site job recruitment based on the training provided for local community personnel. • Movement of unauthorized persons into camps shall be strictly restricted	Medium
Construction		Increased in morbidity (including STIs) and mortality	High	• Health awareness lectures shall be given to workers on the mode of transmission of STIs (including HIV/AIDS)	Low

				• As much as possible provide psychological support to persons living with the HIV virus • Nipco Gas shall insure immunization of workforce against as appropriate. • Provision of insecticide treated nets to field workers to reduce 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. • Alcohol and drug policy shall be implemented to encourage healthy lifestyle for workers. • Nipco Gas shall assist the activities of the state action committee on STIs/HIV/AIDS within the local communities. • Nipco Gas shall ensure site clinic is provided to take care of minor illnesses for all construction workers • Nipco Gas shall ensure the provision of condoms for construction workers	
		Increase in social vices	Medium	• Nipco Gas shall conduct enlightenment campaign and health education for the abatement of abuse of drugs, alcohol among workers throughout the life of the project • Nipco Gas shall ensure that contractor enforces the alcohol and drug policy for staff	Low

				• Nipco Gas shall encourage contractor to support sporting activities • Nipco Gas shall support public health lectures with emphasis on common communicable diseases such as malaria, TB, STIs including HIV/AIDS. • Nipco Gas shall engage and support local security systems • Nipco Gas shall provide condoms for construction workers • Nipco Gas shall ensure that contractor implements social and health awareness programs for all workers at induction and on a continuous basis throughout the life of the project	
		Pressure on existing infrastructures and utilities	High	• Nipco Gas shall make adequate accommodation arrangement prior to mobilization on workforce to reduce pressure on local housing. • As appropriate, Nipco Gas shall support the development of the health facility • Nipco Gas shall provide bascic recreational facilities for workers within their camps • Nipco Gas shall extend water supply from camps/worksites to communities at strategic points	medium
		Increase in inflation level	High	• Nipco Gas shall support skill development and enhancement of the local communities through training and complemented by cooperatives and micro-credit schemes.	Medium
		Changes in culture, lifestyle and habits	Medium	• Nipco Gas shall carry out enlightenment complains to encourage positive influence on cultural values and healthy	Low

				lifestyles (e.g. breast feeding habits, alcohol and drug use, exercise, monogamy, high moral values with regard to sexuality etc) and discourage adverse influences (e.g. prostitution, drug abuse, alcoholism etc).	
		Increase in potential for erosion	High	• Nipco Gas shall re-vegetate areas not needed for construction as soon as possible.	Low
		Soil degradation	Medium	• Nipco Gas shall provide containment for chemcials and liquid discharges. • Nipco Gas waste management policy shall be enforced in cases of domestic waste, scrap metals, non-plastic combustible packaging materials, plastic packaging materials, drums and containers as well as medical wastes. • Nipco Gas shall ensure that a controlled fuelling, maintenance and servicing protocol for construction machinery at worksite is established and followed to minimize leaks and spills.	Low
		Injury to workers	High	• Nipco Gas will ensure there are adequately trained numbers of first aiders at each site. • Nipco Gas shall provide and enforce appropriate use of PPEs (e.g. coveralls, hard hats, eye goggles) • Nipco Gas shall ensure that health talks awareness lectures and job hazard analysis are conducted prior to work activities.	Medium
		Loss of biodiversity	Medium	• Nipco Gas shall limit cleared area to what is required	Low

				• Nipco Gas shall ensure that site clearing is commenced from developed (e.g. roads) to undeveloped areas to provide escape routes for wildlife • Nipco Gas shall undertake to educate construction workers and locals on the sensitive nature of the biodiversity of the area and the need for conservation • Nipco Gas shall ensure that hunting by employees of the contractors shall be prohibited • Nipco Gas shall encourage the contractor to re-vegetate land cleared for temporary use where feasible	
		Reduction in air quality	Medium	• Nipco Gas shall ensue that all mobile and stationary internal combustion engines are properly maintained	low
		Increase in breeding ground for disease vectors and other agents of diseases	High	• Nipco Gas waste management policy shall be enforced	Low
		Increase in nuisance	Medium	• Nipco Gas CLOs will ensure there is continuous communication with the communities	Low
		Blockage of natural drainage	Medium	• Nipco Gas shall ensure that wastes are disposed of at appropriate locations provided for waste disposal and collected as quickly as possible.	Low
		Contamination of the environment by domestic wastes	Medium	• Nipco Gas shall ensure regular collection and disposal of wastes in accordance with the project waste management plan	Low
		Threat to health of workers	High	• Enntec shall ensure that fully equipped first aid boxes, and trained first aiders are	Medium

				available on site at all times in addition to a functional site clinic • Nipco Gas shall enforce appropriate use of personal protection equipment (PPE) • Nipco Gas shall ensure the training of first aiders (at least 1:50) • Nipco Gas shall ensure that anti-venom/anti-histamine is be provided on site to mitigate snake bites and insect stings.	
		Pollution of surface water sources	High	• Nipco Gas shall ensure that bund walls used for storage of drilling materials are not cracked • Nipco Gas shall ensure regular collection and disposal of wastes in accordance with the Nipco Gas 's waste management plan • Nipco Gas shall ensure that disposal of drilling wastes is in line with regulatory standards	Low
Laying of flow lines and pipe line network	ROW bush clearing, Trenching Stringing Welding Radiography Field joint coating Lowering Backfilling Hydro-testing	Reduction in flora and fauna population	Medium	• Nipco Gas shall ensure that only the minimum required land for the ROW shall be cleared • Nipco Gas shall re-vegetate areas not utilized during operation of the pipeline	Low
		Threat to health of workers (snake bites, insect stings, injuries, etc)	High	• Nipco Gas shall ensure that fully equipped first aid boxes are available on site at all times in addition to a functional site clinic • Nipco Gas shall enforce appropriate use of PPE's • Nipco Gas shall ensure the training of first aiders (at least 1:50)	Medium

				• Nipco Gas shall ensure that anti-venom/anti-histamine is provided on site to mitigate snake bites and insect stings.	
		Increase in noise levels	Medium	• Nipco Gas shall inform communities in advance of likely increase in noise level during trenching • Nipco Gas shall ensure that workers in high noise areas wear ear protecting equipment	Low
		Reduction in air quality (dust, exhaust fumes)	Medium	• Nipco Gas shall ensure that appropriate maintenance programs are in place for all equipment • Nipco Gas shall ensure that water is sprayed regularly to reduce dust levels in dry season	Low
		Potential increase in erosion	Medium	• Nipco Gas shall ensure that trenches are back-filled as quickly as possible.	Low
	Laying of flow lines and pipe line networks (ROW bush clearing, Trenching, Stinging, Welding, Radiography, Field joint coating, Lowering, Backfilling, Hydro-testing)	Contamination of surface water bodies	High	• Nipco Gas shall ensure that trenches are back-filled as quickly as possible.	Low
		Potential for falls into exposed trenches (by animals, unsuspecting passers-by)	Medium	• Nipco Gas shall put barriers and warning signs close to open trenches.	Low
		Soil degradation from spills and leaks	High	• Nipco Gas shall ensure that all maintenance and repair of equipment and vehicles are done in a secure location with clean-up materials (e.g. drip pans, containers, absorbent materials etc) readily available.	Low
		Change in the topography of the soil	Medium	• Nipco Gas shall ensure that the original topography is maintained as far as practically possible.	Low

		Exposure to radiation materials	Medium	• Nipco Gas shall ensure that adequate safety measures (appropriate PPR and engineering techniques) are put in place to avoid exposure to radioactive materials.	Low
		Potential for inhalation of welding fumes	Medium	• Nipco Gas shall ensure that adequate safety measures (appropriate PPE) are put in place or avoid inhalation of welding fumes	Low
		Potential for conflicts arising from labour issues (welders)	Medium	• Nipco Gas shall ensure that she abides by agreements reached with the welders union before their engagement	Low
		Erosion from release of Hydro-test water	High	• As far as is practicable Nipco Gas shall control the rate, flow and location of the release of hydro-test water.	Low
		Contamination of surface and underground water and soil from inhibited hydro-test water	High	• If required, Nipco Gas shall treat inhibited hydro-test water before discharging to the environemnt	Low
		Decrease in communities water source due to collection of hydro-test water	Medium	• Nipco Gas shall ensure that hydro-test water is not collected from community borehole/water sources	Low
		Potential increase in incidents (arising, for example from high pressure of pipes during hydrotest)	High	• Nipco Gas shall place warning signs near the high pressure pipes during hydro-testing • As far as is practicable, Nipco Gas shall ensure the enginnering integrity of the hydro-test process	Low

	Pipeline Operations	Degradation of soil and surface water from spills and leaks	Medium	• Nipco Gas shall ensure the provision of containment for chemicals and liquid discharges • Nipco Gas waste management policy shall be enforced • Nipco Gas shall ensure that a controlled fuelling, maintenance and servicing protocol for machinery is established and followed to minimize leaks and spills.	Low
		Threat to health of workers (snake bites, insect stings, injuries, etc)	High	• Nipco Gas shall ensure that fully equipped first aid bozes, and trained first aiders are available on site at all times in addition to a functional site clinic • Nipco Gas shall enforce appropriate use PPE • Nipco Gas shall ensure that anti-venom/anti-histamine is provided on site to mitigate snake bites and insect stings • Nipco Gas shall ensure the training of first aiders (at least 1:50)	Low
Decommissioning Restoration and Abandonment	Surface equipment dismantling, Excavation, Removal and Disposal of concrete works and pipes	Increase in dust generation	Medium	• Nipco Gas shall ensure proper use of PPEs • Nipco Gas shall ensure that water is sprayed to reduce dust levels	Low
		Increase in noise levels	Medium	• Nipco Gas shall inform communities in advance of likely increase in noise level during decommissioning • Nipco Gas shall ensure proper use of PPE (ear muffs)	Low

		Increase in respiratory tract diseases	Medium	• Nipco Gas shall ensure that all personnel are medically certified for the operation prior to engagement • Nipco Gas shall enforce appropriate use of PPE (nose mask) • Nipco Gas shall use barriers to separate dusty activities from non dusty ones	Low
		Increase in waste generation	High	• Nipco Gas shall ensure that wastes are disposed of in accordance with her waste management plan for this project	Low
		Potential for community unrest (from employment, pollution and resistance to dismantling of equipment)	High	• Nipco Gas shall ensure fair community representation in the employment of local labour • Nipco Gas shall ensure that the waste management plan for this project is implemented • Nipco Gas shall abide by the MOUs signed with the communities for this project.	Medium

6.2 Mitigation of Impacts

6.2.1 Community Unrest

The presence of a large number of vehicles and unusual movements is likely to create unease among the communities given the present state of the roads. As a mitigation measure, Nipco Gas Limited shall maintain established channels of communication and inform communities in advance of this important phase of the project. Community unrest stems, amongst others, from (a) intra- and inter-community chieftaincy tussles; (b) perceptions of Nipco Gas Limited 's failure to deal even-handedily with all strata of community stakeholders; and (c) claims of infrastructural deprivation. This situation may continue during the project. In order to deal with this, Nipco Gas Limited shall establish channels of communication with the communities during all phases of the project

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Furthermore, Nipco Gas Limited shall require contractors to hire local labour where feasible, and to honour all MOU requirements with the local communities. Following the foregoing, the impact rating should drop from high to medium, rather than low because many causes of community unrest are outside the ambit of the project and therefore cannot be addressed at this stage. In the communities' youth restiveness is synonymous with community unrest. This is currently high because of joblessness, high expectations, complaints of broken promises, infrastructural deprivation, lack of contract awards etc. This condition could be exacerbated by the project especially during construction, operation and maintenance as well as during decommissioning, restoration and abandonment of facilities. During construction because of the pressure of employment; during operation and maintenance because of apparent drop in business activities; during decommissioning, restoration and abandonment because of perceived finality of project activities. As mitigation, Nipco Gas Limited shall abide by all agreements reached with the communities; unskilled labour shall be drawn from the community; preference shall be given to qualified skilled labour from the project area; Nipco Gas Limited shall encourage recreational activities; and maintain regular dialogue with the communities. Nipco Gas Limited shall not play favouritism in the communities. It is important that Nipco Gas Limited ensures that the contractors adopt transparent approaches in matters of employment even for the unskilled labour. The impact rating is expected to drop from high to medium significance, but not too low.

6.2.2 Stress on Existing Security Structures

Nipco Gas Limited shall ensure that a high level of security consciousness is maintained by both contractor and Nipco Gas Limited personnel. To enhance security in the area, it may be necessary to establish and deploy a special security force while fostering a closer working relationship between the Nigerian Police in the area and the community.

6.2.3 Pressure on Existing Infrastructure and Utilities

Baseline information indicated that there was scarcity of decent accommodation in the project area to house construction workers. Temporary accommodation is likely to be provided outside of the host communities' housing. This is therefore expected to minimize the stress on existing housing within the communities during the operations phase of the project. Labour influx is anticipated to increase the requirements for health services. There is at present a general paucity of health facilities and health services in the project area. The capabilities of the existing health facilities are limited to the management of minor ailments at the primary health centres. In order to facilitate improved access to healthcare, Nipco Gas Limited shall investigate collaboration with Government and other stakeholders to provide support to the existing health infrastructures at the primary health centres and improve the capabilities of the health services. Emergency rescue and Medevac/ Medrescue procedures shall also be put in place at all worksites.

In view of the current poor housing in the project area, which in itself is a major factor contributing to poor sanitation and the transmission of communicable diseases; it is recommended that all Contractors shall put in place housing plans that will cater for their workforce so as to reduce the pressure on housing in the communities. Such plans shall be in keeping with public health standards for housing. As the influx of service providers (camp followers) may be noticed in the area even prior to mobilization, all mitigation measures shall be implemented as early as feasible. The impact is considered to be of *high* significance, but following mitigation, it should drop to medium. It will not drop to low because even at the end of the construction phase and demobilisation of construction workers, a substantial proportion of the latter will linger and continue to apply pressure on local infrastructure.

6.2.4 Injuries to Workers

Experience of other major projects such as pipeline construction suggests that during construction, operation and maintenance as well as during decommissioning, restoration and abandonment, activities could lead to increased work related injuries/fatalities. Additionally, major plant upsets and work related accidents occurring off-site might also lead to injuries for some community members. With health talks, safety awareness campaigns and job hazard analysis prior to work activities, accidents do occur. However, it is that likely that this impact can be mitigated to low.

6.2.5 Threat to Health of Workers (snake bites, insect stings, injuries, etc.)

Several sources of potential threat to the health of workers exist during different phases of the project life. These potential threats include insect bites (such as mosquitoes), bee stings, and attack by wild animals and snakes etc. Other sources of threat include contact with dangerous plants and injuries to workers, particularly locals. The potential for transmission of communicable diseases, such as tuberculosis (due to overcrowding or close proximity to cases), gastroenteritis (contaminated foods and drinks) and malaria are also high during this phase of the project. The use of machetes, cutlasses and other sharp objects in site clearing, and the use of machinery particularly during construction and demolition, could lead to increased work related injuries. There is also the potential for injuries from falling objects during construction and demolition. Welders also stand additional risk of injury from oxyacetylene flame and welding sparks.

This impact, especially during laying of pipeline networks is of high significance. Although mitigation measures such as usage of PPE by field workers and ensuring that anti-venom and anti-histamines, which shall be administered by trained first-aiders is provided on site have been proposed, it is not likely that these threats to health of workers can be reduced to low.

6.2.6 Increase in Noise Level (during decommissioning and restoration)

Equipment for dismantling will always produce noise as long as the activities last. During these periods, therefore, it is not likely that noise levels can be mitigated to the level of low significance.

6.2.7 Potential for Community Unrest (from employment, pollution and resistance to dismantling of equipment)

As has been observed in other project locations there is always the potential for conflict between communities and companies before companies depart a project location. This is especially so,

- If communities believe that there is unfairness in employing skilled and unskilled workers as well as contractors from the communities;
- If communities perceive that attendant pollution has not been satisfactorily dealt with; and
- Because communities may want to use the opportunity to demand funds from Nipco Gas Limited for any perceived unmet claims or broken promises, before the company's departure.

For these reasons, it is likely that this impact will remain of medium significance even after mitigation measures have been implemented.

6.3 Enhancing Positive Impacts

6.3.1 Increase in Economic Activities

This project is expected to increase economic activities during different phases. During mobilization, and construction, the bulk of the jobs will be created that locals and nationals will be expected to take advantage of. This will improve purchasing power and enhance economic activities. During the decommissioning, restoration and abandonment phase, jobs are expected to be available for locals and nationals even if at a lower rate than during the construction phase. This will also improve purchasing power and enhance economic activities. So as to ensure enhanced economic activities throughout the life of the project, Nipco Gas Limited shall ensure that all subcontracts for supplies and minor repairs are reserved for qualified contractors from the project area in the first instance. The surveys of the communities revealed many workers with some skills, which may not meet the required standards for the project. Nipco Gas Limited shall suggest to the contractors that such persons and local contractors from these communities could formally register with a skills' registration centre, which could be established for the project so that initial considerations shall be given to them for employment and contracts. With employment and contracts given to the local communities, economic activities through availability of capital are likely to be enhanced.

6.3.2 Increase in Employment and Business Opportunities

As part of sustainable approach to community interaction, Nipco Gas Limited under its community development programme (CDP) shall embark on necessary support to the communities so that they can take advantage of the business opportunities which shall be available at the study area as a result of this project.

6.3.3 Skills Acquisition

Technically, for this project, proven technologies shall be applied in the design, construction and operation of the facilities. Training of qualified Nigerians other than Nipco Gas staff in acquiring new skills for the operation and maintenance of the gas pipeline, given the novel technology being introduced, shall be done. Also, some qualified community indigenes that would work on this project would also gain experience during construction, operation and maintenance of the project. Consideration to extending training programme opportunities for gas plant related-technology training may be extended to some locals and nationals who would not be hired for the project but could put their newly acquired training and experience to good use in appropriate locations elsewhere in the country given the attention gas utilization projects are enjoying in the country at the moment.

6.4 Land Use Conflict

Careful selection of survey lines shall be made to avoid important social and agricultural resources impacts. No community shall be displaced and no compensation made because only setback shall be used for the project.

Mitigation of Vegetation impacts and soil conservation

Vegetation clearing shall be restricted to the Work and camp sites, acquired right of way and additional areas essentially needed for the development and safety of operations. On completion of pipe laying, cleared areas that are not part of the immediate ROW shall be re- vegetated and restored to its original state as much as possible. The exposed land area and duration of exposure will be minimized. Temporary (during construction) and permanent, erosion control measures shall be installed. After the commissioning, all excavated areas and camp bases shall be properly backfilled and exposed areas re-vegetated with native plant species.

Proposed erosioncontrol measures shall adopt the following techniques:

- Silt fencing;
- Temporary silttrap basin/construction;
- Short term seeding or mulching of exposed soil areas, particularly on slopes;
- Limitations on access for heavy machinery and the storage ofpipes to avoid soil compaction.

Control of vegetation in Right-of-Way

Control of vegetation will employ selective clearing using mechanical means. Broadcast aerial spraying of herbicides shall be avoided because it affords no selectivity and may release unnecessarily large amounts of chemicals into the environment.

Control of Noise and Vibration

Major construction activities such as, excavation, crane work and backfilling, will be limited to daylight hours to minimize construction noise. Mufflers will be used on diesel equipment and power generators. Appropriate PPE such as ear muffs shall be provided for the workforce and their usage enforced with sound policies like:

- Effective staff awareness campaign on the implications of non- compliance with PPE policy shall be embarked upon. It is the employer's responsibility to make proper use of the protection equipment provided by management;
- Records of noise-exposure measurement of workers shall be kept
- Individual worker's exposure to excessive no se shall therefore be controlled by shift arrangement; and
- Acoustic enclosures and silencers shall be used for high-capacity diesel generators.

Wildlife Displacement and loss

Displaced animals such as antelopes, monkeys, birds and reptiles would migrate and find refuge in undisturbed adjacent vegetation, which is similar in structure, physiognomy and floristic composition to the one in the proposed locations.

- Hunting, fishing, trapping and gathering of food resources by workers, when on- and off-duty, shall be strictly prohibited;
- Poaching shall be prohibited during all phases of project; and
- Roosting, breeding and feeding sites shall be avoided by careful routing.

Control of surface and ground water pollution

Proposed location shall be selected to avoid impacts to water bodies and floodplains. Sediments traps shall be installed to control runoff and sedimentation. Drainage dishes shall also be designed to avoid affecting nearby lands. Wastewater (hydrotesting) shall be properly treated to meet water quality standards before discharge.

Solid Waste Management

Plans are made for adequate on-site disposal areas. Provisions would be made, in the design, for appropriate ultimate disposal facilities for the various categories of solid waste that may be generated. These wastes will fall under two categories viz biodegradable and non- biodegradable. Efficient sorting shall be done on site and these would be disposed off-site according to Nipco Gas as well as regulatory solid waste disposal guidelines.

Socio-Economic and Cultural Issues

Most of the unskilled and semi-skilled labour force will be recruited from the neighboring communities. This will reduce largely some socio- cultural impacts. All employees will be properly briefed to ensure awareness of, and sensitivity to, the local culture, traditions and lifestyles. Consultations with all stakeholders at all levels shall continue throughout the life of the project.

Health and Safety Precautions

Medical facilities shall be provided for all workers. All personnel shall be educated on the risk of unprotected sex and exposure to STT's, HIV/AIDS etc. Periodic training and continual safety reminders shall be provided for all personnel on site. Appropriate safety and rescue equipment shall be made available and employees trained in its use.

Road capacity and usage

Road signs shall be used in all roads connected with the project area. Load and speed limits shall be imposed All drivers involved with the project shall be trained and made safety-conscious.

6.5 Mitigating/Enhancing Cumulative Impacts

Mitigation measures and proposals for enhancing the negative/positive impacts have been presented for each of the impacts which have been considered as cumulative impacts arising from the other projects in the project area. In order to ensure the effectiveness of these measures and proposals, the frequency of monitoring of the appropriate (environmental) parameters will necessarily have to be increased.

6.6 Stakeholder Perceptions

Public interest in this project is expected to be high because of the perceived socioeconomic transformation capital which this project is likely to engender coupled with its impacts on the surrounding communities especially during construction and operation (e.g. noise, traffic, dust, emissions etc) and from the influx of workforce. As the preceding discussions on mitigation and enhancement measures have shown, effective and realistic measures to mitigate/enhance these impacts have been proposed. Nevertheless, stakeholder perceptions such as damage to structures due to vibration and increase in hearing impairment due to increase in noise are likely to persist. In executing the Gas pipeline project, Nipco Gas Limited shall employ and sustain dialogue as well as involve the communities and other stakeholders in all phases of the project in the spirit of securing the social license to operate. In particular, Nipco Gas Limited shall ensure that the contractor fully involves stakeholder communities in the environmental monitoring and management plan for this project.

CHAPTER SEVEN

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

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ENVIRONMENTAL MANAGEMENT PLAN (EMP)

7.1 General

An Environmental Management Plan (EMP) is the essential and stand-alone component of an EIA that provides the assurance that the mitigation measures developed for reducing the effects of adverse associated and potential impacts to as low as reasonably practicable (ALARP) as well as those proposed for enhancing beneficial impacts are implemented and maintained throughout the project life cycle. The EMP for the proposed gas pipeline project, which outlines the strategies for managing hazards, associated and potential impacts and their effects on the environment, is presented in this chapter. This EMP is developed to ensure that mitigation measures and monitoring requirements are provided for environmental impacts described in chapter six of this report. It is also providing the basis for the environmental compliance review that shall be carried out in subsequent stages of the project. EMP is an important management tool which sets out conditions and targets to be met during project implementation. This EMP contains among others the following key items:

- Summary of potential impacts
- Planned mitigation measures
- Planned environmental monitoring
- Planned public consultation process
- Responsibilities and authorities for implementation of mitigation measures and monitoring requirements
- Mechanisms for feedback and adjustment

7.2 EMP Objective

The EMP is designed to:

- ensure progressive reduction of the impacts of the project activities on the biophysical, socioeconomic and health environment with the ultimate aim of eliminating them;
- ensure that all mitigation and enhancement measures prescribed during the impact assessment process for eliminating or minimising the adverse project impacts as well as optimally enhancing the beneficial impacts are fully implemented; and

- provide part of the basis and standards needed for overall planning, monitoring, auditing and review of environmental and socio-economic performance throughout the project life cycle.
- Demonstrate that a systematic procedure ensuring that all project activities are executed in compliance with applicable legislations and policies on Health, Safety, Environment, Security and Community Relations have been established for the project;
- Show that mitigation measures for all impacts and effects have been established and shall be maintained throughout the project's life cycle, so that impact risk levels will remain ALARP;

Demonstrate that emergency response measures will be in place. This will ensure that adequate responses in case of emergency have been established for the project; and

These objectives shall be achieved by:

- ensuring compliance with all stipulated legislation on protection of health, safety and environment policies;
- integrating environmental issues fully into the project development and operational philosophies;
- promoting environmental management awareness among workers;
- rationalising and streamlining existing environmental activities to add value to efficiency and effectiveness; and
- ensuring that only environmentally sound procedures should be employed during the project.

The EMP includes the following plans/programs:

- Environmental Capacity Building Program;
- Environmental Monitoring Program;
- Audit Program;
- Traffic Management Plan;
- Risk Management Plan for polluted Waterway
- Hazardous Materials Management Plan;
- Decommissioning and Closure Plan

7.3 Management Organization

(a) Nipco Gas Limited Establishment

Nipco Gas Limited shall retain the primary responsibility of ensuring that environmental commitments are met through-out the life cycle of this project The company shall establish a schedule for responsibility and training on matters relating to the environment. Environmental issues shall be a line responsibility for which all levels of personnel are accountable. Top management shall ensure that all environmental considerations are integrated into project execution. The Works and Environment Department of Nipco Gas Limited shall offer expert advice on protection measures and shall assist to monitor performance. Nipco Gas Limited shall appoint an Environmental Monitoring Team (EMT) to ensure effective implementation of the recommendations of the EIA and its management plan. The EM Team shall verify the effectiveness of the EMP implementation in liaison with Regulators and other stakeholders as appropriate. Nipco Gas Limited shall take responsibility for all environmental matters and ensure that contractors comply with all applicable environmental laws, regulations and policies as they apply to this proposed gas pipeline project. In principle, the Contractor responsible for construction of the transmission line and associated facility project shall be responsible for implementing those aspects of the EIA recommendations that pertain to the engineering, procurement and construction phase. The Contractors for this project shall be required to submit, for approval, their proposal to manage HSE inherent in their contract execution. The Environmental Management Team will operate in an advisory capacity in all matters.

(b) HSE Coordinator

The HSE coordinator shall report directly to the transmission line Project Manager (PM). The coordinator shall have the authority to stop work or any activity which poses danger to the environment, workers, or the general public during the project construction phase, until measures are instituted to eliminate the dangers or threats. The responsibilities shall include:

- ensure that mitigation measures outlined in the EIA are implemented;
- liaise with the project manager, contractors and other supervisors to ensure as far as reasonably practical, environmental protection, safe and healthy conditions at all work sites;
- coordinate environmental and safety activities between Nipco Gas Limited and all contractors/organisations providing services at the project site;
- ensure clear communication of safety, health and environmental and socio-cultural information to all categories of workers;

- liaise with management in deciding which environmental and safety concerns could be handled in-house and which matters shall require external assistance; and
- co-ordinate, investigate and review environmental and safety incidents and complaints and maintain separate site incident and complaint records

7.4 Use and Maintenance of the EMP

The EMP shall remain a dynamic working tool and will be owned by the proposed gas pipeline project. Nipco Gas Limited supervisor is, however, the custodian of the document and may exercise auditing role to verify compliance by the project. The EMP shall be updated and revised periodically throughout the project's life span to incorporate improved technologies, better environmental regulations, management systems, guidelines and policies. Constructive suggestions by users (contractors, management, line and operating personnel) shall be assessed by the Environmental Management Team and integrated into the EMP.

7.5 Regulatory Compliance

The EMP implementation shall be closely FMEnv and this shall involve a two-way information flow between Nipco Gas Limited and the regulatory body. The FMEnv has the responsibility of enforcing national environmental laws including international environmental laws which Nigeria has subscribed to;

- The FMEnv will serve as a regulatory oversight to the EMP implementation of this project;
- The FMEnv and NURC shall ensure that Nipco Gas Limited periodically make available documentations in form of monthly/quarterly reports or as may be required showing evidences of caring out monitoring requirements, etc. Environment-related regulations as they apply to the Project has been be documented and described in this EIA. Nipco Gas Limited management shall ensure compliance with these regulations throughout the project's lifecycle in line with measures inherent in the Engineering Project Management Guide (EPMG).

7.6 Detailed Design Guidelines

Health, Safety and Environmental (HSE) premises that cover the minimum performance standards for HSE critical elements to be applied to the design of the facilities for this gas pipeline project have been established as part of the Engineering Development phase of this project. These standards and criteria are meant to ensure that the design of the facilities for this project is in line with currently accepted HSE principles and policies. In particular, the HSE premise has steered the design towards the goal of preventing/minimizing injuries, ill health, and damage to assets and the (natural and social) environment, to avoid/eliminate liabilities in the future. In the design of the facilities for this project, efficient use of natural resources and energy sources as a requirement has been taken into account. This is aimed at resource conservation and the protection of the environment through prevention/minimization of discharges that have adverse effects on the environment. The HSE premise is flexible enough to permit refinements and extensions arising from formal HSE deliverables that are likely to be produced during successive project development phases. The driving force for the design is the reduction of risks to people, assets, reputation and the environment in compliance with the principle of As Low as Reasonably Practicable (ALARP). Any residual risks/effects after the application of the ALARP principle shall be managed through continuous improvement of the operation of the gas pipeline Project.

7.7 Stakeholders Engagement

Nipco Gas Limited shall welcome suggestions and information from relevant stakeholders, contractors, visitors and the general public, which shall help improve its operations in order to minimize impact on the environment and worker health and safety. The office of the transmission manager shall be open to the general public for complaints and suggestions. Complaints received from the public shall be documented and follow-ups made to ensure that such grievances are addressed accordingly and in line the Nipco Gas Limited's grievance redress mechanism.

7.8 Monitoring

Project activities shall be monitored in order to:

- ensure that the EMP is implemented; and
- assess the efficiency of mitigation actions;
- provide updates where necessary

All contractors shall be required to self-monitor their performance with respect to environmental and social performance. The Nipco Gas Limited HSE Engineer shall also undertake quarterly environmental assessment and random walk through and spot checks throughout the project lifecycle. Assessment findings shall be reviewed by the project management team and where corrective actions are necessary, specific plans (with designated responsibility and timing) shall be developed to ensure continuous performance improvement. In addition to assessing operational aspects and monitoring assessments shall also consider compliance with agreed objectives and targets, and the effectiveness of the EMP and its implementation. The EMP shall, therefore, be subject to ongoing review and development to ensure that it remains appropriate for all aspects of the project. As is typical with all Federal Ministry of Environment and Department of petroleum Resources approved projects, the ministry will carry out an assessment before the end of the project to confirm compliance of project activities to the terms and conditions of the EIA approval.

7.9 Implementation of Mitigation and Enhancement Measures

The mitigation measures proposed for the significant negative impacts and the measures proposed to enhance the significant positive impacts have been developed into an EMP that provides a detailed action plan with roles and responsibilities for their implementation. Part of the conditions of the approval of the EIA by the Federal Ministry of Environment (FMEnv) is that there will be regulatory monitoring of the approved project impacts mitigations and monitoring measures.

7.10 Prevention of Accidents/Incidents

Prevention of workplace accidents and incidents during the proposed project shall be achieved using the Job Hazard Analysis (JHA) tool and written Work Instructions (WIs). Consequently, the HSE and Security Team Leaders shall arrange for JHA to be conducted for all HSE critical activities. Written and explicit work instructions from such activities shall be developed. Compliance to regulatory standards, operations/maintenance codes and specifications as well as HSE guidelines shall form the basis for the execution of the proposed project. However, emergency situations could still occur as a result of equipment failure, weather, negligence and/or sabotage. Consequently, a Contingency Plan shall be developed as back up to other containment systems put in place to handle such occurrences. As a minimum, the contingency plans that shall apply to both Nipco Gas Limited and contractors, shall address the following emergency situations.

- Fires and Explosions;
- Serious injury or illness;
- hydrocarbons/chemical spills
- Weather related disasters; and
- Land vehicle mishaps.
- Civil unrest and kidnapping

The HSE and Security Team Leaders shall ensure that adequate security arrangements are put in place. Such plan shall have inputs from host communities. The team shall also identify, evaluate and manage the risks to personnel and property arising from malicious practices, crime, civil disorder or armed conflict. The security activities shall be co-coordinated from a common viewpoint by all stakeholders and be in line with Nipco Gas security guidelines. In addition, each contractor shall be required to submit a project security plan to Nipco Gas Limited for review and approval. As part of the Environmental Management Plan and with the approval of the Project Manager, the Security Team Leader shall organize security workshops to identify, evaluate and recommend contingency plans for all security risks associated with the gas pipeline and associated facilities Project.

7.11 Training and Awareness

In order to assure competence and awareness amongst Nipco Gas personnel and Contractor staff, the project management shall establish, maintain and operate a training and awareness programme on health, safety and environmental issues. A great deal of attention shall be devoted to the locals in the contractors' teams. The training shall include accident emergency practices, basic First Aid, the use of Personnel Protective Equipment etc. Environmental Induction Course and subsequent refresher course relating to the project shall be organized for all work forces. The objective of the courses would be to develop environmental awareness and sensitivity amongst the personnel. The training and awareness programme shall be reviewed periodically by top management and shall include but not restricted to the following aspects:

- **Module I:** Environmental Overview
- **Module II:** Environmental Regulations and Acts
- **Module III:** Pollution
- **Module IV:** Environmental Impact Assessment
- **Module V:** Environmental Management System
- **Module VI:** Mobilization and Environmental Issues
- **Module VII:** Environmental Issues in the Project
- **Module VIII:** The Environmental Management Plan for construction Projects
- **Module IX:** Environmentally Sound Construction Management
- **Module X:** Long Term Environmental Issues in Management

Certificates of attendance shall be issued to successful participants. Nipco Gas Limited shall also conduct HSE awareness campaigns for the host communities and general public with the aim of sensitizing them to the potential impacts and hazards associated with its operations and the appropriate response to accidents/incidents. The public awareness campaigns shall be conducted periodically and the proceedings documented for subsequent Environmental Audits. The training modules are combined into different training components. There are overlaps in the composition of the target groups and the constitution of the training components. However, each training module would be developed keeping in view the composition and responsibilities of the target group members. Other Components may be imparted throughout the implementation period and held in the initial months of project implementation, preferably on site. The following tools are expected for the implementation of environmental training programme:

- Informal Training Sessions;
- Audio-Visual Communications;
- Case Studies;
- Lecture Sessions;
- Workshops;
- Group Discussions;
- Short-Term Training Courses;
- Seminars;
- Full-term Training Courses.

7.12 Maintenance Programme

The maintenance officer to be employed by the contractors for the project shall develop a comprehensive maintenance programme for all equipment. The maintenance schedule contained in the programme shall be designed in line with manufacturer's specifications for each of the equipment. A maintenance logbook shall also be operated and it shall be regularly audited/checked by the HSE and Security Team Leader. In addition, the maintenance status (last and next service dates) shall be displayed at appropriate and clearly visible points on each equipment and machine.

7.13 Construction Guidelines

7.13.1 Site Preparation/Clearance

Site preparation/clearance works shall be carried out within defined perimeters and only when necessary. The maximum permissible time lapse between site clearing and initiation of construction operations shall be reduced to the barest minimum necessary to permit safe operations. Areas cleared in excess of operational requirements shall be reinstated with indigenous topsoil and vegetation. During construction the portion of land not used for project activities shall be cordoned off and left undisturbed.

7.13.2 Health and Safety of Workers

Throughout the project development Hazards and Effects Management Process (HEMP) shall be applied and shall consist of identifying, assessing and controlling hazards, and putting in measures to recover from the consequences of hazards if the controls fail. Operations at all work sites shall be subject to government, industry and Nipco Gas Limited HSE policies and guidelines. All Nipco Gas Limited centre and Contractor staff shall be well informed and trained on the HSE policies and guidelines. All facilities shall also be designed to enhance safety planning and activities shall be executed within the confines of relevant legislation and stakeholders' interests. Contractors shall provide adequate health services as well as site first aid services for its workforce. The first aid services shall be extended to work related visiting personnel and employed casual workers. All construction activities shall be properly managed through careful planning and the application of relevant HSE policies including the following:

- Use of Permit to Work (PTW);
- Job Hazard Analysis and toolbox meetings;
- Use of PPE in designated hazard areas;
- Prohibition of alcohol during work hours and at work sites and facilities;
- Regular emergency drills;
- Prohibition of smoking in fire hazard areas.

7.13.3 Emergency Response

The following equipment shall be provided as minimum requirements for emergency response action.

- Safety showers at locations in the project site where accidental spillage of chemicals could occur. Supply shall be taken from the firewater system;
- Safety signs and notices shall be provided throughout the centre in accordance with NURC and FMEnv requirements and standards;
- A general alarm system shall be provided, capable of giving an audible alarm in all areas of the project facility and visual display in areas of high background noise;
- Emergency response procedures shall be put in place for snakebites, road traffic accidents, medevac/medial rescue and gas leaks.

During operations, firefighting and associated facilities shall be inspected and tested on a periodic basis to verify inventory and function. Also, Nipco Gas Limited through the administration department shall carry out programmes to educate the communities and local health facilities on what to do in case of a major incident of fire/accident. Nipco Gas

Limited's emergency response guidelines relevant to this project shall be publicly displayed at strategic locations. In order to safe guard the lives of personnel and contractors during emergency situation, NGL contractor shall develop and implement an emergency response plan. Emergency training shall be conducted by the HSE Manager to enhance worker's preparedness to respond appropriately to emergencies. Emergency drill shall be conducted periodically and such drill shall include fire, abandonment as well as first aid emergencies. Response time and roll call shall be monitored and recorded by the HSE Manager, supervisor or fire warden as required, at each drill/training to ensure compliance. All drills and training exercise shall be documented by the HSE Manager or the supervisor and copies sent to Nipco Gas . In situations where evacuation of personnel is necessary as a result of fire or any other related accidents, Nipco Gas Limited shall follow the emergency medical evacuation procedure with responsible parties.

7.13.4 Waste Management Guidelines

Waste shall be managed in accordance with Federal Ministry of Environment, Department of Petroleum Resources and the various local Government council Nipco Gas waste management procedures. The principle of waste reduction, recycling, recovery and reusing shall be practiced. In addition to the regulations, the project will also comply with other national and international environmental standards that are binding on all staff and contractors involved in the proposed project with respect to the following:

- emission or release of pollutant, exhaust and/or fugitive gases;
- discharge or spill of effluent into surface water or land; and
- discharge of wastes (including domestic waste) into surface water, swamp or land;

The NGL contractor is also expected to develop and submit for approval to Nipco Gas Limited a comprehensive waste management plan to be used during the construction phase of the project. This waste management planshall be in line with Nipco Gas HSE Management System and shall comply with national and international waste management standards. The handling, storage and disposal of all wastes that will be generated during the life of the project shall be in accordance with regulatory standards and approved waste management guidelines. These guidelines are binding on all staff and contractors involved in the proposed project with respect to:

- Emission or release of pollutants, exhaust and/or fugitive gases.
- Discharge or spill of effluent into surface water or land.
- Discharge of wastes (including domestic waste) into surface water or land.
- Generation of noise and vibration.

In the design of the waste management plan the focus shall be on reduce of use, optimal recycling and reuse of materials.

1) Waste Handling

Wastes for proper handling and disposal shall be well defined at source and the definition transmitted along with the waste to the final disposal points. Contractors and Nipco Gas Limited personnel shall define and document all wastes generated in the course of work. Basic information that must be provided, as a minimum, for adequate definition of wastes include:

- Waste type identification
- Proper waste categorization
- Waste segregation information
- Recommended Management practices.

ii) Waste Minimization

Waste minimization implies reduction to the greatest extent possible of the volume or toxicity of waste materials. The five principles of waste minimization process: recycle, reduce, reuse, repair and recover shall be adopted as applicable. Opportunities to achieve significant waste volume reductions during the proposed project are functions of activity level, age, depreciation and maintenance level of operating equipment.

iii) Waste Segregation

It is important that for effective implementation of appropriate wastes disposal methods, wastes be segregated, preferably at source into clearly designated bins at strategic locations. It is the responsibility of the contractors, during their operations to provide enough clearly marked bins at strategic locations to ensure proper segregation.

Different colour codes are assigned to specific waste bins

Table 7.1: Waste Bin Colour Code

Food/Vegetation Waste	Green
Glass waste	Blue
Plastic waste	Brown
General (non-useable)	Black
Medical waste	Yellow
Toner/developer	White
Metal scraps	Purple

For medical wastes (hazardous & non-hazardous) segregation at source into colour coded bags would be as follows:

Table 7.2: Medical waste colour code

Hazardous medical waste	
Clinical combustibles	Yellow or yellow tagged bags
Sharps	Cin bin
No sharp/non-combustible	Black or black tagged bags
Foul or infected linen	Red or pink bags
Recyclable linen	White or white tagged bag
Cytotoxic waste	Orange bin
Non-hazardous	
Paper	Clear or clear tagged bag

iii) Wastes Inventory

An inventory of waste generated shall be maintained. Weighing scales or measuring devices shall be provided to measure quantities of waste generated/discharged. Records of waste generated, treated and sent for disposal shall be maintained on site. Wastes to be transferred to offsite facilities for treatment and disposal shall be done in accordance with the various State Ministry of Environment waste transfer process and in line with other statutory requirements.

iv) Waste Disposal

All debris, spoil materials, rubbish and other waste, except excavated soil and rock, shall be cleared regularly from the site and cleared by approved various state approved waste managers. Instructions on material safety handling sheet shall be strictly adhered to and shall form the basis for the disposal of wastes related to such products. Wastes in transit shall be accompanied and tracked by consignment notes.

Table 7.3: Management of waste streams

Project Phase	Activity/Source of Waste	Waste Generated	Management Options
Pre-Construction	Delivery of equipment to site (light vehicles and heavy vehicles, portable toilets)	Packaging (ropes and strapping, cardboard), timbers-kids, fibre/nylon rope spacers, pallets, drums and scrap metals	Recycle metals; Dispose general off site to local licenced landfill
	Camp Site/site Office	General and paper wastes	General waste to local licensed landfill. Recyclable material to recycling facility (where available)
	Installation of fencing and gates	Fencing wire off cuts	General waste to local licensed landfill.
	Bush clearing	Green waste (felled vegetation and plant matter)	Stockpiled vegetation will be reapplied during restoration of RoW
	Excavation/Trenching	Topsoil and excavated material 9stockpilled for backfilling and application to RoW)	All topsoil and excavated material reused for backfilling in RoW
	Pipe bending, stringing	PVC or polyethylene pipe end caps	Recycling of PVC
	Welding	Mild steel pipe off cuts and defective pipe, metal filings	Recycling of waste metals
	Coating of welding joints	Chemical containers (i.e. paint/epoxy coating cans, empty containers of rust proofing agents	Transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill
	In field servicing and maintenance of construction plant and equipment	Oily rags, spent absorbent material in field servicing and maintenance waste oil and grease eglube oil hydraulic oil and engine oil waste associated with diesel generator operation and maintenance	Licensed contractor to transport regulated waste to a licensed recycling facility Waste oil to be recycle and reused, treated before disposal
Commissioning	Hydro-test	Hydrostatic test water not treated with biocides, corrosion inhibitor	Hydro-test water treated before discharge to land or water

Operation & Maintenance	Pipping	Pipe cleaning waste (pigging grit – scale, rust, or other foreign material) Contaminated excavated soil	Pigging grit – licensed contractor to transport regulated waste to a licensed regulated waste landfill incinerate with IDU before disposal.
		Spent toner and printer cartridges, electronic and electrical equipment, white goods, computers, office equipment.	Equipment reuse and recycle
	Office waste, construction materials and equipment store	Spent lamps and fluorescent tubes. Paper – office paper.	Recyclable material to recycling facility (where available) General waste to local licensed landfill.
		Wood (pallets) construction materials and other equipment.	Pallets will be collected by suppliers during subsequent deliveries.
Decommissioning	Restoration and rehabilitation (decommissioning and abandonment)	Construction materials, concrete, scrap metal, plywood, plastics, electrical wiring, etc.	On decommissioning any remaining material will be offered to local land owners for reuse or removed for treatment or disposal in accordance with the principles of the Corporation

The waste consignment notes shall contain the following information as a minimum:
- Date of dispatch;
- Description of waste;
- Waste quantity/container type;
- Type of waste
- Consignee/driver name and means of transportation; and
- Confirmation of actual disposal (time and date).

7.13.5 Pollution Control

i) Air Pollution

In operating equipment Nipco Gas Limited shall utilize all practical methods and devices available to control, prevent and otherwise minimize atmospheric emissions or the discharge of air contaminants. Good engine efficiency of equipment and vehicles shall be maintained. Indiscriminate burning of materials resulting from clearance of trees, bushes and combustible materials shall not be permitted.

ii) Water and Soil Pollution

a) Wastewaters: Nipco Gas Limited Pollution of surface water by project-related waste including excavation exercise and wastewater shall be prevented by proper management practices. Contaminated or potentially contaminated area run-offs shall be collected and treated to meet regulatory requirements before discharge.

b) Soil: Nipco Gas Limited shall ensure that all construction activities are performed by methods that will prevent pollution of the soil media by accidental spills of contaminants, debris, and other objectionable pollutants. In the event of a significant spill, relevant spill control measures shall be applied and contaminated soil shall be cleaned as appropriate. Regular checks shall be conducted on equipment to minimize minor lube oil and combustible leaks from engines.

(iii) Noise Pollution

Nipco Gas Limited shall comply with all requirements for noise control and with regulatory standards. For example, Nipco Gas Limited shall ensure that contractor plans activities such that FMEnv and NURC guidelines shall not be exceeded at the nearest communities especially at nights. All equipment shall be maintained at optimal working conditions and recommended work practices shall be employed to minimize noise. Night operations shall be avoided except when absolutely necessary. In such instances, adequate measures shall be taken to reduce the noise involved and keep working hours to a minimum. Earmuffs shall be provided for all workers and any visitor within the vicinity of high noise generating equipment or operations. If noise levels at any time give rise to public complaint, the issue shall be treated as public nuisance and Nipco Gas Limited will take appropriate measures to resolve the problem with the appropriate authorities. In any case, communities shall be consulted prior to periods of expected peak noise levels. Safe separation distances and buffer zones shall be established between facilities, work sites and host communities to reduce theimpact of high noise levels from the facilities. Also, noise mapping of the facility shall be done and a map produced and visibly displayed. The possibility of encroachment up to the fence line is taken into account in the design of noise reduction measures.

7.14 Site Inspection Procedures

Throughout the projects life, The Environmental Management Team and representatives of regulatory bodies shall carry out regular inspection of sites and facilities. The main objective of such inspections shall be to assess compliance level with mitigation measures and recommendations of the EIA. When the HSE and Security Team Leader request such inspection, the site shall therefore be made accessible to such inspectors upon authentication of identity to:

- Examine and inspect all equipment that could cause pollution;
- Collect samples of any atmospheric emissions, effluent discharges or waste deposition for analyses and interpretation;
- Examine all construction and operation logbooks for environmentally related issues.

After each inspection, the Team shall compile a site inspection report detailing the:

- Specific facilities or areas inspected,
- Details of project activities, and
- Highlights of any observed non-compliance/persistent negligence.

In case of non-compliance the Contractor shall be requested to take appropriate measures. The inspection procedure shall be repeated after implementation.

7.15 Audit Programme

FMEnv and NURC directed Environmental audit shall be conducted at the project site three (3) years after closeout of impact mitigation monitoring (1MM) Nipco Gas Limited Works Director on the advice of the HSE and Security Team Leader shall provide authorization. The audit process shall be used to confirm that mitigation measures listed in the EMP of the EIA have been followed and complied with as well as to assess the environmental performance of project management during the all phases of the project. This will ensure that environmental protection and management procedures are being enforced. In implementing the audit programme, facilities on the gas pipeline and other facilities perceived as having high environmental risks shall be thoroughly investigated. The audit programme shall:

- Examine compliance with regulatory requirements;
- Examine line management systems, pipeline operations, monitoring practices etc.;
- Identify current and potential environmental problems especially during the various phases of the project.
- Assure implementation of recommended practices and procedures; and
- Make recommendation for the improvement of the management system of the operations in the proposed gas pipeline.

After every audit exercise, the environmental auditor shall produce an Environmental Audit Report that shall be submitted to Nipco Gas Limited HSE, FMEnv, OGEPA, OYSME and NESREA. Audits of the facility activities shall be conducted in order to ascertain extent of compliance with set guidelines, policies and requirements. The audits shall be carried out by certified auditors (both in-house and independent auditors) and in accordance with regulatory requirement and ISO 14001 guidelines. The scope of the audit shall include the following:

- compliance with all necessary codes, standards and procedures;
- examination of line management systems, operations, monitoring practices etc.;
- identification of current and potential environmental problems especially during the operational phase of the project;
- checking the predictions in EIA and assure implementations and application of recommended practices and procedures; and
- make recommendation for the improvement of the management system of the operation.

Also as part of audit and review this EMP shall be reviewed annually to determine its adequacy/suitability for continuous use.

7.15.1 Capacity Assessments

Capacity assessment and development process for those to be charged with managing the mitigation measures and grievance procedures is usually a cyclical process. Such a cycle will comprise several steps, from recognition of capacity deficiencies/efficiencies to the implementation of capacity development initiatives. Contract Agreement requirement is that the NGL submit the resume of key personnel, especially for those who would be directly responsible for the implementation, reporting, and monitoring of the EIA impacts mitigation and monitoring measures. Approval of personnel will depend on their proven experiences and capability to manage the recommended measures. Those whose capabilities are determined to meet the requirement will be approved for engagement in the project but those whose experiences and skill are determined to be insufficient will not be approved. The implication is that the NGL may retain and engage their services from temporary to permanent basis if it so wishes but they will not be engaged by Nipco Gas Limited for the operation of the gas pipeline. NGL deliverables will include engagement of sufficient and skilled personnel for key project areas especially in the HSE and socio-economic sections to ensure effective implementation of the project impacts mitigation and monitoring measures. The Project and NGL's Environmental Management Plan will specify the roles and responsibilities of those charged with HSE duties especially for those responsible for implementing the mitigation and monitoring measures. The EMP will also include training programs for such personnel in order to enhance their capabilities and performance. The project specific plans to be developed by the NGL such as the Environmental Management Plan, Waste Management Plan, Regulatory Compliance Plan, Socioeconomic/Community Relations and Engagement Plan, and Spill Response Plan will be submitted to Nipco Gas project management team for review and approval prior to implementation. This will ensure that the key elements are captured in the plans. It will also ensure well-coordinated execution of project activities as well as confirm harmonized implementation of NGL's documented strategies in accordance with the terms and conditions of the approved project EIA. Nipco Gas Governmental Department shall be responsible for capacity assessment of NGL personnel responsible for the management and monitoring of impacts mitigation measures as documented in this EMP and as regularly updated to cover for the project life span. Capacity assessments and other trainings as well as competency certification and validations of personnel shall progress from before the commencement of the project, through construction and operation phases. Assessment shall also form part of the auditing/training program to be developed for the project. In addition to overseeing the implementation of the mitigation and monitoring measures, Nipco Gas HSE will also be responsible for operation of the grievance procedures. In order to assure the competency of Nipco Gas Limited personnel charged with the above responsibilities, experienced personnel will be engaged for the execution of the project. Capacities of personnel assigned to the project will be assessed prior to their involvement in the project and appropriate trainings provided to cover identified capacity gaps. Nipco Gas shall engage reputable consultancy firms to provide such capacity enhancement trainings and certifications. Federal Ministry of Environment (FMEnv) and the Nigerian Upstream Regulatory Commission (NURC) formerly the Department of Petroleum Resources (DPR) will be responsible for the regulatory monitoring of the implementation of the project EIA approved mitigation and monitoring measures. The Ministry assigns personnel with proven competencies to such tasks.

Table 7.4: Impact Management and Monitoring Plan

Project Activities	Impact Description	Impact Ranking	Mitigation Measures	Action Party	Parameter	Frequency
			Pre-Construction Phase			
Mobilization	Influx of migrant workers	M	• Employ most unskilled/semi-skilled workforce from communities	Nipco Gas	Work register	Quarterly
	Exposure to risk and contraction of STIs and HIV/AIDs	H	• Nipco Gas shall ensure contractors given health education to workforce, security agents shall ensure restriction of movement of non-staff to camp site; provision of condoms at site clinics	Nipco Gas	Compliance	Every 6 months
	Interference with public transport by high traffic	M	• Nipco Gas shall avoid mobilizing during rush hours or restrict mobilization to weekends; develop appropriate traffic plan; create awareness	Nipco Gas	Compliance	Monthly
ROW Clearing	Biodiversity lose vegetation an wildlife	H	• Nipco Gas shall restric survey lines, avaoid sensitive habitats.	Nipco Gas	Compliance	Quarterly
	Alteration of air quality from heavy duty machines	M	• Nipco Gas shall certify contractor equipment before mobilization; installation of catalytic converters on equipment that emit noxious gases; regular maintenance	Nipco Gas	Compliance	Monthly
	Topsoil removal and exposure to direct sunshine	M	• Nipco Gas shall revegetate at intervals after backfilling.	Nipco Gas	Compliance	Monthly
	Employment opportunity	Positive	• Nipco Gas shall use indigenous and qualified personnel; • Nipco Gas shall also develop procedure for indigenous	Nipco Gas Contractor	Compliance	Quarterly
Pipe stringing and welding	Environmental degradation from pipe/metal wastes	M	• Nipco Gas shall designate safe area for waste (scrap) disposal on site, develop appropriate waste management plan.	Nipco Gas Contractor	Compliance	Quarterly
	Employment opportunity	Positive	• Nipco Gas shall use indigenous and qualified personnel;	Nipco Gas Contractor	Compliance	Quarterly

			• Nipco Gas shall also develop procedure for indigenous labour Sourcing			
NDT	Exposure to radio active substances	H	• Nipco Gas shall conduct health awareness training prior to commencement of activity. Nipco Gas and contractor shall ensure that staff undergoes routine medical check-ups. • Contractor shall provide and enforce the use of productive aprons.	Nipco Gas Contractor	Compliance	Daily
Coating & holiday detection	Contamination of soil and surface water from chemicals used for coating	M	• Contractor shall provide the installation of cathodic protection devices to maintain the integrity of pipeline.	Nipco Gas Contractor	Compliance	Daily
Trenching & Excavation	Removal of top soil, that may lead to soil erosion	M	• Ensure trenches are covered with excavated soil and • Revegetate immediately	Contractor Nipco Gas	Compliance	Quarterly
	Surface water contamination from run-offs	M	• Nipco Gas shall ensure that non-off is directed into water bodies by using silt trap to • Remove sediments/particles	Contractor Nipco Gas	Compliance	Monthly
	Air quality disruption from increased dust and vehicular emission from exhaust	M	• Nipco Gas shall certify contractor equipment before mobilization; installation of catalytic converters on equipment that emit noxious • gases; regular maintenance	Contractor Nipco Gas	Compliance	Daily
Lowering & Backfilling	Alteration of soil profile	M	• Ensure soil returned are compacted properly	Contractor Nipco Gas	Compliance	Quarterly
Cathodic Protection	Contamination of soil and water (ground) from anodes	M	• Nipco Gas shall enforce the installation of cathoidc protection devices to • Maintain the integrity of pipeline	Contractor Nipco Gas	Compliance	Quarterly
HDD for River Crossing	Soil contamination for drilling chemicals.	M	• Restrict chemical stack area • Channel drill muds to recycle pits and reuse	Contractor Nipco Gas	Compliance	Quarterly
	Alteration in water quality status as a results of run offs	M	• Nipco Gas shall ensure that run-off is directed into water bodies by using silt trap to remove sediments/particles	Contractor Nipco Gas	Compliance	Quarterly

	Groundwater contamination	M	• Implements spill response when drill mud spill and remediate immediately to avoid percolation	Contractor Nipco Gas	Compliance	Quarterly
	Community issues as a result of contamination on farm land and crops	H	• Remediate immediately • Pay appropriate compensation to affected persons • Restrict chemical stack area	Contractor Nipco Gas	Incidents documentation	Quarterly
Thrust Boring for Road Crossing	Soil contamination for drilling chemicals	M	• Restrict chemical stack area • Channel drill mud to recycle pits and reuse	Contractor Nipco Gas	Incidents documentation	Quarterly
	Community agitation resulting from accidents caused by dishing	H	• Proper enlightenment before commencement; • Intervene and compensate adequately when it occurs	Contractor Nipco Gas	Compliance	Quarterly
	Contamination of soil by water used for hydro testing	M	• Contractor shall treat hydro-test water and dispose responsibly according to regulatory guidelines	Contractor Nipco Gas	Compliance	Quarterly
Hydrotesting	Contamination of surface water by discharged hydro-test water.	M	• Contractor shall treat hydro-test water and dispose responsibly according to regulatory guidelines • Avoid discharging into rivers/streams	Contractor Nipco Gas	Compliance	Quarterly
Pipping	Contamination of soil and surface water by condensate	H	• Nipco Gas shall bleed pressure from system before removal of condensate • Immediate remediation (bioremediation) of impacted site in the event of condensate spill	Nipco Gas	Work register	Quarterly
Maintenance	Severe damage to biodiversity in the event of fire/explosion	H	• Restoration of site by remediation and revegetation	Nipco Gas	Species composition	Quarterly
	Agitation due damage to farmlands, settlements, ect by fire	H	• Pay adequate compensation if explosion is a result of equipment failure	Nipco Gas	Compliance	Monthly

Excavation to remove pipes and other structure	Contamination of soil and water	M	• Nipco Gas shall carry out the excavation with state of the art technology to minimize impact	Nipco Gas	Compliance	Quarterly
	Temporal job creation	Positive	• Nipco Gas shall use indigenous and qualified personnel; Nipco Gas Limited shall also develop procedure for indigenous labour sourcing.	Nipco Gas	Work register	Quarterly
	Risk of STIs and HIV/AIDs as a result of influx of migrant workers and commercial sex workers	H	• Nipco Gas shall ensure contractors give health education to workforce; security agents shall ensure restriction of movement of non-staff to camp site; provisions of condoms at site clinics	Nipco Gas	Medical records	Quarterly
Abandonment	Social issues: Loss of jobs, increased social vices	H	• Nipco Gas Limited shall ensure full implement of existing MOUs. Nipco Gas /contractors shall ensure full implementation of contract agreements related to end-of-contract benefits	Nipco Gas	MoU records	Quarterly

7.16 EMP and Community Development

Most Community Development (CD) projects arise out of Participatory Rural Appraisal (PRA) exercises. The NGL shall ensure that in implementing the provisions of this EMP, development projects arising from PRAs do not conflict with the development programmes of government authorities, NGOs and aid agencies for project area. The EMT shall integrate whatever projects arise from the PRA for this project area with the community development programmes of external bodies.

7.17 Decommissioning, Restoration and Abandonment

The Federal Ministry of Environment (FMEnv) EIA process requires that a project of this status should contain an environmentally sound decommissioning and abandonment plan. This plan needs to be fully prepared a few years before decommissioning would actually take place and should take into account the best applicable technology at that time. A general approach will be to commence detailed planning of decommissioning and abandonment activities about five years to the decommissioning date.

Before decommissioning of this project, NGL shall develop decommissioning plans for:

- Facilities to be abandoned or removed
- Environmental aspects of the decommissioning activity
- Methods for facility re-use, recycling, disposal, removal or abandonment
- Proper consultation with all stakeholders (communities, other land users and regulators)
- Efforts to mitigate negative environmental impacts and appropriately rehabilitate the site
- Programmes for restoring the environment in accordance with national FMEnv. Regulatory requirements and international best-practices.
- Scope of work to assess possible residual impacts of the process on the environment; specifically, any future restrictions on other activities.

The content of the plan shall take into consideration the extent of the decommissioning (temporary or permanent, partial or complete shutdown), plans for future use of the site, and the condition of the site and the environment at the time of decommissioning. A detailed post-operational study of the impact of the project on the environment will be conducted to determine appropriate restoration and remedial measures. In general decommissioning activities shall be conducted in compliance with Federal Ministry of Environment guidelines. The NGL Health Safety and Environmental Management

Systems shall be implemented to assure safety of personnel and the public during decommissioning as well as minimize negative environmental impacts. Particular attention will be paid to the following:

- Protection from air pollutant emissions
- Protection from noise
- Waste handling
- Spill containment and management

7.17.2 Reporting

As required by regulations, a post decommissioning report (PDR) will be prepared and submitted to the FMEnv. The PDR will provide the following details:

- Overview of decommissioned facilities
- Details of methods used for decommissioning
- Nature of decommissioning (partial or whole)
- Record of consultation meetings
- Details of recyclable/reusable materials/facility components
- Decontaminated facilities
- Decommissioning Schedule
- State of the surrounding environment
- Waste Management Plan
- Plans for restoration/remediation where necessary

7.17.3 Sequenced Decommissioning and Abandonment Plan

NGL will develop sequenced decommissioning and abandonment plan which shall include:

- Identification of components of the project that will be removed.
- The choice of environmentally sound methods of removal, re-use, recycling or disposal and other waste that may arise from the decommissioning process, liaison with FMEnv and other relevant stakeholders.
- Expressly outline the time frame/schedule for the decommissioning and post decommissioning processes and communicate the same to FMEnv, NESREA, and OGMEnv and other relevant regulatory agencies as well as the affected or concerned persons and groups.
- Proper rehabilitation and decommissioning process.
- Appropriate site rehabilitation, remediation and enhancement technique and technologies.

There shall be post-decommissioning assessment to compare ameliorated project-related impact, relative to the baseline conditions

7.18 Managing Stakeholder Perceptions

Public interest in this project is expected to be high. The project will have impacts on the surrounding communities especially during construction and operation (e.g. noise, traffic, dust, emissions etc) and from the influx of workforce. Effective and realistic measures to mitigate/enhance these impacts have been proposed. Nevertheless, stakeholder perceptions are bound to persist, so a social action/stakeholder following actions amongst other others.

- Nipco Gas Limited shall ensure that the communities are involved in the environmental monitoring and management plan for this project.
- Use available records on community development and other community-based activities as evidence of a good corporate neighbour.
- Nominate Community Relation units to receive complaints
- Develop and establish a grievance redress mechanism.
- Palliative measures shall be conducted on the existing road and discussion will be conducted with relevant authorities on construction of the road
- A Memoranda of Understanding (MOU) explicitly stating the agreement between Nipco Gas Limited and all project affected community shall be established to prevent future frictions and agitations

7.19 Environmental Monitoring

Environmental monitoring programs for this sector shall be implemented to address all activities that have been identified to have potentially significant impacts on the environment during normal operations and upset conditions. Environmental monitoring activities shall be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the proposed gas pipeline project. Monitoring frequency shall be sufficient to provide representative data for the parameter being monitored. Monitoring shall be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data shall be analysed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. The overall objective of (performance) monitoring shall be to identify any unanticipated changes to the biophysical, health and social environment brought about by the proposed gas pipeline and associated facilities Project. Baseline information against which development and post development impacts and mitigation measures can be measured and compared has been established. Nipco Gas Limited shall ensure that deviations from the baseline beyond reasonable limits shall trigger corrective actions so that monitoring becomes a dynamic activity as opposed to passive collection of data. This Environmental Monitoring Plan has been formulated with the aim of ensuring that all the identified significant impacts from the project are mitigated to as low as reasonably possible and that key performance indicators are monitored periodically to track how effectively mitigation measures are implemented. It specifies the mitigation measures, monitoring requirements, duration and frequency of the monitoring, and the action parties to manage the biophysical, social and health environment at the various phases of the project. Tables 7.4 present the impact management and mitigation plan at the various stages of the project. In formulating this plan, care has been taken to ensure that Nipco Gas Limited complies fully with FMEnv and NURC regulatory control measures; international best practice and self- imposed standards. In addition, the plan also provides for measures to mitigate indirect impacts of the project that may result from influx of people into the project area as well as practical proposals for the enhancement of significant positive impacts. The national regulatory agencies in conjunction with the relevant states and local government authorities shall conduct routine impact mitigation monitoring visits as and at when due. It is recognized that many of the host communities lack basic infrastructure and have needs that though unrelated to the project, have generated concerns from stakeholders. These and related issues have been considered in a separate section on Community Development. Once this proposed Environmental Monitoring Plan has been reviewed, it shall be prepared as a stand-alone document and signed by the asset manager. This is to ensure ownership and implementation of the EMP and shall be updated as results of monitoring.

Table 7.5: Key Monitoring Parameters

S/N	Impact Parameter	Impact Indicator	Sampling Location	Sampling Method	Sampling Frequency	Sampling Duration	End Use of Data	Monitoring Party
1	Air Quality	• CO2 • CO • NOX • VOC	• Along pipeline route	*In situ* gas monitors	Weekly during excavation, monthly thereafter	Long Term	• Compliance • Data bank	• Nipco Gas • Contractor
2	Soil Quality	• pH • Organic Carbon • THC • Oil & Grease • Heavy Metals	• Pipeline Route	pH Meter UV Spec, AAS	Quarterly after construction	Long Term	• Compliance	• Nipco Gas • Contractor
3	Water Quality (surface)	• pH • BOD • COD • THC • Heavy Metals	• Pipeline River Crossing points	pH Meter UV Spec, AAS	Monthly (during construction); Annually thereafter	Short Term	• Data bank	• Nipco Gas • Contractor
4	Ground Water	• pH • BOD • COD • THC • Heavy Metals1	• Existing monitoring borehole	pH Meter UV Spec, AAS	Monthly (during construction); Annually thereafter	Long Term	• Compliance	• Nipco Gas • Contractor
5	Vegetation	• Morphology • Floristic Composition • Pathology • Species density	• Work site • Base Camp • Line Cuttings	Field assessment Culturing & Identification	monthly	Long Term	• Data bank	• Nipco Gas • Contractor
6	Consultation		• All Stakeholders	Interviews dialogue	Yearly	Long Term	• Openness	• Nipco Gas • Contractor
7	Waste	Collection, storage and disposal	• w Work site • Base Camp • Line Cuttings	Field assessment Culturing & Identification	Monthly	Short Term	• Compliance	• Nipco Gas • regulators

CHAPTER EIGHT
REMEDIATION PLAN AFTER DECOMMISSSIONING/CLOSURE

CHAPTER EIGHT

REMEDIATION PLAN AFTER DECOMMISSSIONING/CLOSURE

8.1 Introduction

This chapter discusses the activities associated with the decommissioning of the proposed pipeline Project, including the potential impacts associated with the decommissioning activities as well as the environmental and social measures to address the issues. In addition, an overview of the decommissioning plan for the Project at the end of its operating life is provided.

8.2 Decommissioning Activities

Decommissioning refers to the process of removing and managing all operating assets of a project after completion of its life cycle. The proposed gas pipeline Project is being developed for a projected 30-year operational life time. However, with regular maintenance, it is anticipated that the useful life of the Project could extend well beyond the designed life span. Planning for decommissioning shall begin from the design stage of the factory and shall continue throughout the lifetime of the facility.

The decommissioning activities will typically include the following:

- Dismantling and removal of equipment and structures;
- Removal of any surface installations;
- Waste generation and management;
- Rehabilitation of any impacted environmental component (e.g. water, soil).

8.3 Management of Decommissioning Activities

In the event of decommissioning, Nipco Gas shall ensure that the Project site is left in a safe and environmentally acceptable condition. A standard decommissioning, abandonment and closure programme shall be involved.

The task will include:

- Restoration of the Project environment to baseline conditions (as much as practicable) in line with legislative and regulatory requirements;
- Assessing the residual impact, if any, the Project has on the environment;
- Monitoring the abandoned Project environment as necessary.

Nipco Gas Limited will only begin decommissioning activities after due consultation with the relevant stakeholders including the regulatory authorities. The decommissioning activities shall be carried out in line with the relevant provisions of the

National Guidelines for Decommissioning of Facilities in Nigeria (2017) issued by the FMEnv. Typically, the following steps shall be undertaken for decommissioning:

- An updated plan which takes into account the most cost-effective and best practicable methods, legal requirements and industry practices at that time for the factory decommissioning shall be developed. The plan shall be submitted to the FMEnv and other relevant government agencies for approval, at least one (1) year prior to scheduled abandonment and decommissioning. The plan shall include, but not limited to the following:
- Description of the site and components to be decommissioned.
- Description of the decommissioning scope, objectives, end state and strategy;
- Activities to be performed during the decommissioning;
- Schedule of decommissioning activities;
- Estimate of the decommissioning cost;
- Estimated inventory of waste streams to be generated during the decommissioning and handling techniques;
- Decommissioning team (qualifications, roles and responsibilities)
- To ensure that due consideration is given to all options a detailed evaluation of facilities decommissioning options shall be carried out. The options will include facility mothballing, partial facility decommissioning or complete site decommissioning. The evaluation will consider environmental issues in conjunction with technical, safety and cost implications to establish the best practicable environment friendly options for the Project decommissioning.
- A risk assessment shall be conducted to ensure that nothing constituted as a hazard for other users of the site or for the environment in general, will be left at the site. The Project site shall be left in a safe and environmentally acceptable condition.
- Hazard identification and analysis shall be conducted to determine special safety concerns to be addressed.
- An appropriate Health, Safety and Environment (HSE) plan shall be implemented to ensure that the decommissioning activities are carried out in an environmentally sound manner and in conformity with relevant laws and regulations guiding such operations.
- Third party notifications shall be carried out before any demolition and shall be conducted in a phased sequence.

Consultation shall be made with relevant stakeholders including Nigerian Gas Company (NGC), the various Local Government Council, State Ministry of Environment and the

Federal Ministry of Environment to determine whether if any of the pipeline component could be useful if left in place. In such instance, the transfer of the responsibility of maintaining such facility shall be considered and documented to avoid any conflicts between interested parties.

- Socio-economic considerations of facility decommissioning shall be carried out. These will include assessment of potential effects associated with termination of employment (at the end of operational phase) and the measures to minimize the effects by:
  - Ensuring that employees are fully informed about the decommissioning and how it will affect them before the project finally closes.
  - Building community capacity to manage opportunities and impacts arising from the decommissioning and post-decommissioning phase of the gas pipeline.
  - Providing training to build local skills tailored to project decommissioning and post-decommissioning activities (e.g. equipment dismantling, rehabilitation activities, monitoring, etc.).
  - Providing training to transfer project-learned skills to alternative and secondary industries tailored to respond to market economy.

- An effective waste management plan shall be implemented for the decommissioning activities. The decommissioning options for redundant structures and equipment will include: the complete dismantling of structures and equipment with a detailed record of all suitable recycling materials shall be maintained. The environmental and social management measures for the identified potential impacts of the decommissioning activities are presented in Table 8.4.

8.4 Abandonment plan

Prior to site abandonment, NGL shall establish a standard procedure for incorporating the following practices:

- Identification of the pipeline components to be abandoned and/or removed;
- The proposed methods for abandonment or re-use of the equipment/material applicable;
- Processes put in place to mitigate potential environmental impacts associated with the abandonment process; and

Appropriate site rehabilitation programs (including re-vegetation of the site with native plant species) to return the Project environment to its original status (as much as practicable). The decommissioning, abandonment and/or closure programme shall generally be managed by a team of competent personnel, including the HSE personnel of Nipco Gas Limited and witnessed by relevant regulatory authorities such as the NGC, NURC, FMEnv and the various State Ministry of Environment. A close out report shall be prepared and archived for future reference.

Post Impact Assessment

A Post Impact Assessment (PIA) of the project site shall be conducted after decommissioning and remediation exercise to ensure that all negative impacts of the project have been effectively minimized.

Table 8.1: categorization of identified impacts

Project Phase	Project Activities/ Environmental Aspects	Potential and Associated Impacts	Positive/ Negative
Abandonment/ Decommissioning	Excavation to remove infrastructure	Increase in income	+
		Water contamination	-
		Air pollution	-
		Loss of Livelihood	-
		Reduction in economic activities	-
	Transportation of removed structures from site	Occupational and traffic accidents	-

Table 8.2: Impact Evaluation

Project Phase	Project Activity	Description of Impact	Impact Quantification						Impact Quantification						
			Adverse	Beneficial	Short term < 3moths	Long term > 3months	Reversible	Irreversible	L	R	F	I	P	F+I+P +R+L	Overall Ranking (High/ Medium/ Low)
Decommissioning Restoration and Abandonment	Structure and Dismantling, Demolition Excavation	Reduction in air quality. Increased dust and vehicular emissions during transportation	X			X	X		3	1	1	3	3	7	M
		Increase in ambient noise levels above baseline conditions from movement and activities of decommissioning equipment and automobile.	X			X	X		3	1	3	3	3	9	M
		Increase in respiratory tract diseases	X		X		X		0	5	3	3	3	9	M
		Increase in employment and business opportunities		X		X	X		-	-	-	-	-	-	p
		Increase in waste generation	X			X	X		3	5	5	5	5	23	H
		Potential for community unrest (from employment, pollution and resistance to dismantling of equipment)	X			X	X		0	5	3	5	5	13	M
		Stress on existing security structures	X			X		X	0	3	1	3	5	9	M
		Potential for increase in stock of farmland													P
		Risk of soil and adjoining surface water contamination from accidental oil and hazardous substance leakages and wastes from equipment, vehicles etc during decommissioning													M
		Risk of accident and injury to worker during demolition of structures													M

Table 8.3: Proposed Mitigation Measures

Project Phase	Project Activity	Description of Impact	Significance Rating Before Mitigation	Mitigation	Significance Rating After Mitigation (Residual Impact Rating)
Decommissioning Restoration and Abandonment	Surface equipment dismantling, Excavation, Removal and Disposal of concrete works	Reduction in air quality (dust, exhaust fumes)	Medium	• Nipco Gas Limited shall ensure that appropriate maintenance programs are in place for all equipment • Nipco Gas s Limited hall ensure that water is sprayed regularly to reduce dust levels in dry season	Low
		Increase in dust generation	Medium	• Nipco Gas Limited shall ensure proper of PPEs • Nipco Gas Limited shall ensure that water is sprayed to reduce dust levels	Low
		Increase in noise levels	Medium	• Nipco Gas shall inform communities in advance of likely increase in noise level during decommissioning • Nipco Gas shall ensure proper use of PPE (ear muffs)	Low
		Increase in respiratory tract diseases	Medium	• Nipco Gas shall ensure that all personnel are medically certified for the operation prior to engagement • Nipco Gas shall enforce appropriate use of PPE (nose mask) • Nipco Gas shall use barriers to separate dusty activities from non-dusty ones	Low
		Increase in waste generation	High	• Nipco Gas Limited shall ensure that wastes are disposed of in accordance with her waste management plan for this project	Low

		Potential for community unrest (from employment, pollution and resistance to dismantling of equipment)	High	• Nipco Gas Limited shall ensure fair community representation in the employment of local labour • Nipco Gas shall ensure that the waste management plan for this project is implemented • Nipco Gas Limited shall abide by the MOUs signed with the communities for this project.	Medium
		Stress on existing security structures	High	• Nipco Gas shal ensure that both contractor and Nipco Gas personnel develops a high level of security consciousness both within and outside the work area. • Daily security reports shall review by the Nipco Gas Limited Project Manager. • Special security force shall be established and deployed for the project. This shall include deploying some of Nipco Gas police to strengthen security in the area. • Nipco Gas shall ensure that a liaison to foster partnership with the community so as to guarantee security for the project is established and sustained. • In order to beef up security for the project, Nipco Gas shall contact government authorities to improve the strength of the police fore at project area and shall consider providing assistance with equipment e.g. patrol vehicles, to ensure improved security. • Nipco Gas shall ensure that safety workshops to identify, evaluate and recommend contingency plans for all security risks are regularly organized.	

Table 8.4: Impact Management and Monitoring Plan – Decommissioning and Abandonment

Project Activity	Impact (positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Party	Budget for Implementation (Naira)
Building and equipment dismantling, Excavation, Removal and Disposal of concrete works and steel	Increase in dust generation	Nipco Gas shall ensure proper use of appropriate PPE	Nipco Gas Policy	Compliance	weekly	Monthly	Nipco Gas Contractor	Included in contractor Management Cost
		Nipco Gas shall ensure that water is sprayed to reduce dust levels	None	Records of Compliance	Daiy	Weekly	Nipco Gas Contractor	Included in contractor Management Cost
		Nipco Gas shall inform communities in advance of likely increase in noise level during decommissioning	FMEnv and NURC Standard	Compliance	Weekly	Monthly	Nipco Gas Contractor	Included in contractor Management Cost
		Nipco Gas shall ensure proper use of PPE (ear muffs)	Nipco Gas Policy	Compliance	Weekly	Monthly	Nipco Gas Contractor	Included in contractor Management Cost
	Increase in respiratory tract diseases	Nipco Gas shall ensure that all personnel are medically certified for the operation prior to engagement	Nipco Gas Policy	Compliance	Monthly	Annually	Nipco Gas Contractor	
		Nipco Gas shall enforce appropriate use of PPE (nose mask)	Nipco Gas Policy	Compliance	weekly	Monthly	Nipco Gas Contractor	Included in contractor Management Cost
		Nipco Gas shall use barriers to minimize the spread of dust	None	Compliance Record	Monthly	Quarterly	Nipco Gas Contractor	
	Increase in waste generation	Nipco Gas shall ensure that Scraps are disposed of in accordance with her waste management plan for this project	Nipco Gas Policy	Compliance	Weekly	Monthly	Nipco Gas Contractor	Included in contractor Management Cost
	Potential for community unrest (from employment, pollution and resistance to dismantling of equipment)	Nipco Gas shall ensure fair Community representation in the employment of local labour.	None	Employment Records	Quarterly	Six month		
		Nipco Gas shall abide by the MOUs signed with the communities for this project.	Contractual	Compliance with MOU items	Yearly	Once during decommissioning	Nipco Gas Contractor	Included in contractor Management Cost

CHAPTER NINE

CONCLUSION AND RECOMMENDATION

CHAPTER NINE
CONCLUSION AND RECOMMENDATION

This EIA study was conducted to assess the potential impacts of the activities of the proposed Nipco Gas Limited gas pipeline project on the biophysical, social and health components of the environment. This study was carried out in accordance with relevant local and international regulations based on FMEnv approved terms of reference. The methodology applied for the study involved desktop studies, reviews of existing data and fieldwork including community consultations. To achieve this objective, a multidisciplinary approach was adopted in the assessment of the environmental status and sensitivities of the various ecological components of the project area using extensive literature, one season field sampling, measurements/testing as well as quantitative Nigerian Upstream Regulatory Commission (NURC) and qualitative analysis.

The biophysical characterization of soil, surface water and sediment around the project area showed that the soil, surface water and surficial sediment were consistent across sampling stations and compared well with values recorded in previous studies around similar environments. The EIA of the project shows that it would have a significant beneficial impact on both local and national economy. The identified adverse impacts were generally short-term and can be prevented, reduced, ameliorated, or controlled if the recommended mitigation measures are implemented. Further, an Environmental Management Plan (EMP) has been developed to ensure effective implementation of prescribed mitigation measures and for proactive environmental management throughout the life of the project. The EMP should therefore form the basis for the actual project implementation and future monitoring of environmental components. It is concluded that the execution of the activities of the proposed Project will not cause damage to the environment if the EMP is implemented. The approval of this EIA report for the execution of the proposed project is hereby recommended.

REFERENCES

Abam. T. K. S. (1999b) Impact of dams on the hydrology of the Niger Delta. Bull. mt. Assoc. Et1gni> Geol. & Environ.. 57, 239-251.

Ajayi,A. and O.F. Kamson (1983): Determination of lead in roadside dust in Lagos city byatomic absorption spectrophotometry. Environ. Inter. 2: 397

Akpabio, I. A. (2013): Social Impact Assessment for the Ikot Abasi Power Plant (IAPP) Project. Submitted to Environmental Resource Managers Ltd, Lagos.

Ayoade, J.O. (2004) Introduction to Climatology for the Tropics. 2nd Edition, Spectrum Books Limited, Ibadan.

Bernard, H. R. (2011). Research Methods in Anthropology: Qualitative and Quantitative Approaches (Fifth edition). Lanham, MD: Alta Mira Press.

Bhandari, G., K. Premarajan, N. Jha, B. Yadav, I. Paudel and S. Nagesh, 2006. Prevalence and determinants of unmet need for family planning in a district of eastern region of Nepal. Kathmandu Univ. Med. J., 4(2): 203-210

Bode, A., Estévez, M. G., Varela, M., and Vilar,J. A. (2015). Annual trend patterns of phytoplankton species abundance belie homogeneous taxonomical group responses to climate in the NE Atlantic upwelling. Mtn: En,'. Res. 110, 81—91. doj: i0.1016/j.marenvres.2015.07.017

Casas B, Varela M, Bode A. (1999) Seasonal succession of phytoplankton species on the coast of A Coruña (Galicia, northwest Spain). Bol Inst Esp Oceanogr 15:413—429.

Creswell,J.W. (2003). Research design: Qualitative, quantitative, and mixed methods approaches. Thousand Oaks, CA: Sage Publications.

DPR (2018) EGASPIN. Environmental Guidelines and Standards for the Petroleum Industry in

FAO (1983). Compilation of legal limits for hazardous substances in fish and fishery products. FNGP fishery circular No. 464, pp. 5-100.

Federal Environmental Protection Agency (1991): National Interim Guidelines and Standards for Industrial Effluents, Gaseous Emissions and 1-lazardous Wastes Management in Nigeria, pp. 66 and 71.

Federal Ministry of Health (FMoH) [Nigeria], and National Malaria Control Programme (NMCP). 2009. Strategic Plan 2009-2013 "A Road Map for Malaria Control in Nigeria" Abridged Version — 2009. Abuja, Nigeria: Yaliam Press Ltd.

Jam, R; Urban, L.V; Stacey, G.S and Balbach, H. (2002). Environmental Assessment 2i Ed. McGraw-Hill Companies. New York, N.Y.

Mishra C, Bagchi S, Namgail T, Bhatnagar YV. Multiple use of Trans-Himalayan rangelands: Reconciling human livelihoods with wildlife conservation. In: du ToitJT, Kock R, Deutsch JC, editors. Wild rangelands: Conserving wildlife while maintain, livestock in semi-arid ecosystems. 1. Oxford: Blackwell Publishing; 2010. pp. 291—311

Nigeria Demographic and Health Survey (NDHS) 2008. Abuja, Nigeria: National Population Commission and ICF Macro.Nigeria. Department of Petroleum Resources, Lagos, Nigeria. Pgl — 314.

Nogueira, E., Ibanez, F., Figueiras, F.G., 2000. Effect of meteorological and hydrographic disturbances on the microplankton community structure of the R'ia de Vigo (NW Spain). Mar. Ecol. Prog. Ser. 203, 23—45.

Nwankwo DI (1996). Phytoplankton diversity and succession in Lagos Lagoon, Nigeria. Arch. Hydrobiol. 135: 529-542

Offodile, M. E. Groundwater study and development in Nigeria. Mecon Engineering Services Ltd, Jos, Nigeria. 2002; Pp 239 — 345.

Olaniyan, C.I.O. (1975). An introduction to West African Ecology. Heinemann Education Books Ltd., London. l7Opp. 30.

Onyema I.C., 2008. A Checklist of Phytoplankton Species of the Iyagbe Lagoon, Lagos. Journal of Fisheries and Aquatic Science, 3: 167-175.

Onyema, I.C., Okpara, C.U., Ogbebor, C.I. Otudeko, O. and Nwankwo, D.I. (2007). Comparative studies of the water chemistry characteristics and temporal plankton variations at two polluted sites along the Lagos lagoon, Nigeria. Ecolog.

Rahaman, M. A. (1989). Review of the Basement Geology of South Western Nigeria. In Kogbe, C. A. Geology of Nigeria (2nd Edition), Rock View, pp. 39-56, Jos.

Ritchie and Lewis (2012). Qualitative Research Practice: A Guide for Social Science Students and Researchers. Sage, London.

RPI, 1985. Environmental Baseline Studies for the establishment of Control Criteria and Standard against Petroleum Related Pollution in Nigeria. Columbia, South Carolina, USA.

Sadler, B. (1996). Environmental Assessment in a Changing World: Evaluating practice to improve performance. International Study of the Effectiveness of Environmental Assessment Final Report, International Association for Impact Assessment and Canadian Environment Assessment Agency, Canada.

Ufoegbune, G. C., Lamidi, K I., Awomeso, J. A, Eruola, A. O., Eruola, A.O., Idowu, O. A and Adeofun, C.O. Hydro-geological characteristics and groundwater quality assessment in some selected communities of Abeokuta, Southwest Nigeria. Journal of Environmental Chemistry and Ecotoxicology. 2009; 1:010-022.

US Food and Drug Administration (USFDA) Food and drug administration Guidance document for arsenic in shellfish. Washington DC: DHHS/PHS/FDA/CFSAN/Office of Seafood; 1993

vesilind PA, Peirce JJ, Weiner RF (1994) Environmental Engineering. Butterworth-Heinemann Volumes 596—597, 15 October 2017, Pages 284-292

World Health Organization WHO) (2010): “Health Determinants” Accessed 21’ September, 2010

World Health Organization (WHO), (2006). Guidelines for drinking water quality (iii) Health Criteria and supporting information. World Health Organization, Geneva, 1-575.

World Health Organization (WHO), The World Health Report 1999: Making a Difference.

Yakub, A.S., Balgun, K.J., Ajani, G.E, Renner, K.O., Ariyo, A.A., Bello, B.O., Nkwoji,J.A., IgboJ.K. 2011. Distribution of Phytoplankton in some parts of Lagos Lagoon, Southwest Nigeria. International Journal of Biological and Chemical Science. 5 (1): 150-163.

APPENDICES

APPENDIX 1:

DETAILED SAMPLING METHODOLOGY

APPENDIX 1: DETAILED METHODOLOGY

Meteorology

Data for this study was acquired via field work measurement (microclimatic data) for a period of 24 hours and long term data (macroclimatic data) from the Nigerian Meteorological Agency Oshodi, Lagos state. During the course of fieldwork, a weather station was set up in an open ground and allowed to run for a minimum of 24 hours in order to establish a microclimatic baseline of the study area. All precautions usually taken when setting up a weather station 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 gadgets, 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. The parameters monitored and method of measurement and instrumentation are.

Climatic Variable	Instrumentation	Record Availability	
		Onsite	Synoptic
Air temperature	Dry bulb thermometer	√	√
Relative humidity	Psychrometer/hygrometer	√	√
Wind speed	Anemometer /Beaufort scale	√	√
Wind direction	Wind vane	√	√
Clourd cover	Direct observation	√	√
Rainfall	Rain gauge	√	√
Pressure	Barometer	√	-

Air Quality

A Bosean portable gaseous emission analyzer was used in-situ to measure the include oxides of nitrogen (NOx), oxides of sulfur (SOx), carbon monoxide (CO), volatile organic compounds (VOC) and hydrogen sulfide (H_2S). All equipment used were calibrated before usage. Gaseous Pollutants are monitored continuously by pulsed fluorescence. In this method, air is drawn through a sample chamber where it is irradiated with pulses of ultra-violet light. Any specified gas of interest in the sample is excited to a higher energy level and upon returning to its original state, light or fluorescence is released. The amount of fluorescence measured is proportional to the gas concentration.

Total Suspended Particulate Matter (TSPM)

A Met One Instrument Aerosol Mass Monitor meter was used to measure the concentration of particles in the ambient air (PM_{10}, $PM_{2.5}$ and SPM) and an Air metrics Minivol instrument was used to determine the heavy metals. Minivol Portable Air Sampler manufactured by Airmetrics is a portable ambient air sampler for particulate. The sampler consists of a vacuum system and filter housed in a shelter and operates on the same principle as a vacuum cleaner. A known volume of air is drawn through a pre-weighed filter for an 8-hour period. The filter is then re-weighed to determine the mass of the particles collected. The digested filter paper is then analyzed for trace metal concentrations.

Noise

A ExTech Model sound level meter was used to measure noise levels in each location. Noise Level at each point is measured with a pre-calibrated digital readout. The equipment measures noise via microphone probe that generates signals appropriately proportional to sound waves. The sensor of the noise meter was directed upwards and the average reading over a period of two minutes was taken to be the Noise-level at each point. The noise levels were measured in decibels (dBA).

Vegetation

A transect belt and quadrats of 100 m by 100 m was established along the proposed pipeline route across the three project affected states which served as a representative sample of the entire vegetation. Data was collected on the predominant vegetation type, land use types and the status and vigor of the vegetation in the area. Vegetation type was characterized based on the prevalent physical and biological features. The presence of indicator plant species was evaluated. The biological feature utilized was the presence of specific indicator plant species. Plant identification was assessed by visual observation and with the aid of a field guide. Land use type was assessed by visually observing the anthropogenic activities in the surrounding and satellite imagery.

Wildlife

Three sampling methods namely indirect, direct and food chain analysis were used in the assessment. The indirect sampling method involved the use of surrogate evidence to record the activities and presence of certain animal species within the transects. Such surrogate evidence consisted of food leftovers, feathers, foot prints, burrows, faeces, talons, sloughed skin, carcass and vocalizations were all combined to detect species presence. Similarly, the portraits of previously killed animals were collected with consent from the phones of hunters and security staff. The direct methods involved the use of field gear such as binoculars and reptilian grab stick to systematically probe burrows, leaves, grasses, and tree branches for signs of animal wildlife especially for amphibians and reptiles. In each site, an average of four (4) transects of 40m were established and patrolled dislodging logs, panels, for concealed or basking reptiles, feeding birds, other vertebrates as well as invertebrates. The Food chain analysis involved the monitoring of feeding relationships of plant and animal species that shared the same ecological systems.

Soil Studies

Composite soil samples were collected at two depths: 0-15cm (topsoil) and 15-30cm (subsoil) with the aid of Dutch stainless steel hand auger at different locations within the proposed project area of influence and one control station outside the project area. The samples were neatly labelled, stored in ice chest in a cooler and taken to the laboratory for analysis.

Surface water

Sampling was designed to describe the existing characteristics of the study environment that constitute reliable measurable indices in natural environmental status. Thus, any change caused by the proposed project can be effectively identified. Sampling of surface water, sediment, and hydrobiology covered Physico-chemistry and microbiology of surface water and sediment with Phytoplankton, Zooplankton and Benthos. All samples were preserved in ice chest (coolers) prior to transportation to the laboratory for analysis. Unstable physicochemical parameters of the water such as pH, DO, temperature, salinity, turbidity and conductivity, were measured in-situ, using pre-calibrated portable digital meters. Samples for laboratory analysis were taken and preserved as follows: General physicochemical parameters: Samples were collected into 1-liter polyethylene bottles. The bottles were previously washed and rinsed with distilled water and with some portion of the surface water prior to sampling. Heavy metals- Samples were collected into 1 liter pre-cleaned polyethylene bottles and preserved by the addition of 2 ml Analar grade concentrated nitric acid. Oil and grease and THC- Samples were collected into 1 liter pre-cleaned glass bottles and preserved by the addition of 2 ml concentrated Sulfuric acid. Microbiology- Samples were collected into 25 ml sterilized glass bottles. BOD - Samples were collected into 300 ml amber-coloured BOD bottles. Samples collected were stored at 4°C±2 ice chest on the field before transportation to the laboratory for further storage at 4°C±2.

Sediment

Sediment samples from bottom of the water body were collected using a mechanized grab sampler (Ekman grab). Sediment samples collected for physico-chemistry were kept in polythene bags; samples for hydrocarbon and microbiology analyses were kept separately in brown glass containers, preserved in an ice chest and transported to the laboratory for analysis.

Quality Control /Assurance

The quality control measures also included avoiding samples contamination and deterioration as sampling tools and containers were pre-sterilized, pre-treated and preserved on transit in ice-cooled chest (<40C) and transported to the laboratory. All samples were immediately and effectively labelled with tags and ineffaceable markers. Samples were stored in refrigerator pending subsequent analyses especially for parameters having short holding times such as total hydrocarbon, microbiological and heavy metal analyses.

Microbiology

Heterotrophic bacterial and total fungal counts were enumerated by inoculating plates in duplicate with 0.lml aliquot of serially diluted sample in peptone water. 1ml was transferred into 9ml sterile peptone water to make a 10 fold dilution. Inoculum was taken from the 10-3 dilution. Sterile molten nutrient agar was aseptically poured into the bacteria plates to support bacterial growth while sterile molten sabouraud dextrose agar was aseptically poured into the fungi plates to support fungal growth. The plates were incubated at 28°C for 24h. Hydrocarbon utilizing bacteria and fungi were enumerated by inoculating plates in duplicate with 0.lml aliquot of serially diluted sample in peptone water. 0.1 ml solution of tetracycline was added into the fungi plates to inhibit bacterial growth while 0.lml solution of flagyl was added into bacterial plates to inhibit fungi growth. Sterile molten mineral salt agar of Mills et al. (1978) was aseptically poured into all the plates. The hydrocarbon source was supplied through the vapour phase by placing filter papers (Whatman No 1) impregnated with lml of filter sterilized Bonny light crude oil on the lids of the plates. The plates were incubated at 30oc for 7 days.

The laboratory methods used in the analysis of bottom samples are the same as the one used for surface water samples. APHA (1985), Allison (1965) and Bray & Kurtz (1945).

Total Heterotrophic Bacteria and Fungi

Heterotrophic bacteria and fungi were estimated by aerobic standard plate count (Pour Plate technique). Serial dilutions of the samples were performed using sterile peptone water as diluent. Sample (1.0 ml) was transferred aseptically into 9.0ml sterile peptone water to give a 10-fold dilution (101). Bottle containing peptone water and sample was vigorously shaken and allowed to stand for a minimum of 5mins. Further dilutions were carried out until a desired dilution factor (10-s) was achieved which depends on the source of the sample.

Aliquot (0.lml) of the dilution fold of 10^{-3} was used to inoculate sterile Petri dishes in triplicates. Sterile molten nutrient agar was then aseptically poured (Pour Plate Method) into sterile plate to support bacterial growth while Sabouraud dextrose agar was used for fungi growth with addition of acid. Culture plate were allowed to solidify and then inverted, followed by incubation at 28C ± 2.0°C for 24h. Sabouraud dextrose agar plates were incubated at same temperature for 3 days.

After incubation, culture plates were counted (Total Viable Count (TVC) and results calculated thus:

$$\text{cfu/ml} = \frac{\text{TVC x dilution factor}}{\text{Inoculum vol.}}$$

Final results obtained were expressed in cfu/ml for surface water.

Hydrocarbon Utilising Bacteria and Fungi

The vapour-phase method (Mills et al 1978) was employed for determination of hydrocarbon utilizing bacteria and fungi. Aliquots (0.lml) of serially diluted sample in peptone water was inoculated into a sterile Petri-dish in duplicates for both bacteria and fungi culture. Tetracycline solution (0.lml) of 50mg/l was added to the fungi plates to suppress bacterial growth while flagyl solution (0.lml) of 50mg/l was added to bacterial plates to inhibit fungal growth.

A sterile molten mineral salt agar [NaCl (10g/l); $MgSO_4.7H_2O$ (0.42g/l); KC1 (0.2g/l); KH_2PO_4 (0.83g/l); Na_2HPO_4); $NaNO_3$ (0.42g/l); Agar Power (20g/l); Crude Oil (1%v/v) and Distilled Water(l000ml)] to which trace metals of specific volume had been added (usually 2m1/l) was then poured aseptically into all inoculated plates. The plates were allowed to stand for solidification after which they were inverted. A piece of Whatmann filter paper which had been previously soaked in Bonny light Crude oil was then picked using a forceps and placed in the lid of each Petri-dish. Culture plates were incubated in inverted position at 30°C for 7 days for Hydrocarbon Utilizing Bacteria and 14 days for hydrocarbon utilizing fungi.

Total and faecal Coliform

Total and fecal coliform bacteria were determined using Multiple Tube Fermentation Technique expressed as Most Probable Number (MPN) APHA 9222C.

Presumptive Coliform Test

A 10ml water sample was dispensed into 10mi sterile double strength Mac Conkey broth in test tubes containing inverted Durham tubes for gas collection. A 1ml water sample was also dispensed into 5ml single strength Mac Conkey broth (sterile) in test tubes incorporated with inverted Durham tubes. To another three (3) set of test tubes containing 5m1 sterile single strength Mac Conkey broth to which inverted Durham tubes had been incorporated, was 0.lml of the water sample dispensed.

All tubes were incubated at 37°C for 24hours. The numbers of coliform organisms present were determined by the presence of gas and acid using the most probable number table. Results were expressed in MPN/l00ml.

Confirmation Test

To confirm that the gas forming organism in the sample is E. coli, the 24-hour culture was streaked unto to an Eosin—Methylene Blue (EMB) plate and incubated for 24 hours. E. coli grown on EMB gives a characteristic colony with a metallic sheen. The presence of such colonies was taken as a positive confirmed test.

Completed Test

A loop from the positive tubes in the differential coliform test was cultured into sterile single Mac Conkey broth in test tubes containing inverted Durham tubes for the collection of gas. All test tubes were incubated at 44°C for 24hr for feacal coliforms and 37°C for total coliforms. Test tubes showing the production of gas and acid indicate the presence of *E. coli*. Quantitative estimation of the number of *E. coli* present was then recorded using the MPN Table. Results were expressed in MPN/l00ml.

Hydrobiology

Phytoplankton

Phytoplankton samples were obtained by the direct method where a sample of surface water (1 litre) was collected in opNGPue plastic containers and fixed with 5% formalin-water mixture. In the laboratory the organisms were identified with the aid of a binocular microscope using appropriate keys (Durans and Leveque, 1980; Kadiri, 1988.

Zooplankton

Zooplankton samples were collected with the aid of plankton net. This was done by sieving a known volume of water through plankton net and the materials in the collection bottle was then transferred into sample containers and preserved in 5% formaldehyde-water mixture. In the laboratory, few drops of laboratory prepared lugols iodine were added to the samples to aid the identification process. Identification keys from Barnes, (1980), Newell and Newell, (1977) were used as guide for the zooplankton identification and classification.

Benthos

An Ekman grab was used for the collection of sediment / benthos samples and emptied into a plastic bucket. This was washed through a 0.5 mm mesh size sieve and the materials retained in the sieve put into a plastic container and fixed with 10% formalin-water mixture and carefully packaged for laboratory analysis. In the laboratory, the organisms were sorted, identified and classified using appropriate keys.

Fisheries

Data were collected by means of a structured interview schedule on fisher folks, consultations and literature review were also used to obtain information on species diversity, relative abundance of fish species in the study area, their seasonality of abundance and sizes. Furthermore, fishes were caught using the services of local fishermen and supplemented by observations of fishing gears and crafts. Fish samples were collected and transported to the laboratory in polythene bags containing ice blocks to prevent spoilage and then stored in a deep freezer to avert posthumous deterioration. In the laboratory, fish samples were identified using reliable identification keys compiled by Holdeen and Reed (1972), Reed et al. (1967), sorted into species and families, and each fish weighed to the nearest 0.lg using the Citizen Electronic balance and also determined for condition factors, Total Length (TL) and Weight Measurements.

Condition Factor

The condition factor (kF), an index of the well-being of the fish was computed using the formula.

$$kF = \frac{100W}{L^3}$$

Where,

W = weight of fish in grams

L = standard length of fish in centimetre

Total Length (TL) and Weight Measurements

Fish total length (cm) was measured using a measuring board as described by Lagler (1970), while weight was measured using the Citizen Electronic balance with sensitivity of 0.lg after identification of the sampled species.

Fish Tissue Metal Analysis

Samples of gills, Spleen, liver, gonads and Kidneys of *Oreochromis nilolicus, Parachana obscura and Clarias gariepirnis* were rinsed with distilled water and oven dried at 105°C. The dried fish was crushed and powdered in an agate mortar, and kept in polyethylene bottles for analysis. One (1) gram portions of fish tissues were digested and analysed using a GBC Avanta AAS (Model number: A6600)

Hydrogeology

Auger drilling method was used throughout. This involved driving a 5-inch auger into the ground and adding the drill stems continuously until the desired depth was reached. The auger did the drilling and was also used to bail out soil samples for lithologic/stratigraphic log description and sieve analysis. The boreholes were screened, gravel-packed and developed until there was clean water before sampling. PVC materials were used to construct the boreholes. This drilling method ensured the collection of representative samples from the boreholes as no chemicals were used.

Lithologic sampling

Lithologic samples were collected from the auger as the boreholes were being drilled.

Groundwater Sampling

Water samples were collected from drilled boreholes and open dug wells. The water samples were taken with an ISCO bailer from the boreholes drilled in clean 1.5-litre plastic bottles after rinsing each bottle with the sample to be collected. In-situ measurements were taken for the fast changing parameters. The water samples werestored in ice-packed coolers and transported to the laboratory for analysis within 24 hours.

Determination of permeability of soil materials

The permeability of the sands was estimated from Hazen's Formula. The sands were sieved through a stack of sieves, the data generated were plotted on a semi-log paper, d10 values were obtained from the plot, and used to calculate the permeability from Hazen's Formula as follows:

$$K = Cd_{10}^2$$

Where

K = Permeability

C = constant. For K in cm/s and d_{10} in mm, C = 1 (Freeze and Cherry, 1979)

dl0 = effective diameter, mm defined as diameter such that that 10 % by weight of theporous matrix consists of grains smaller than it.

The permeability of the clays was calculated from consolidation test using the formula:

$$K = c_v m_v r_{w/1+} e_o$$

Where K = permeability

C_v = coefficient of consolidation

m_v = coefficient of volume compressibility

r_w = unit weight of water

a_y = coefficient of compression and

e_o = void ratio

These parameters were obtained from the consolidation test results.

Social Impact Assessment

Data collection relied on a largely pre-coded household questionnaire administered face-to-face to a probability sample of household respondents at one point in time by trained assistants; discussions with Focus Groups (especially occupational sub-groups); interview of Key Informants (knowledgeable persons within the community); observations and measurements of key community features undertaken by trained assistants; as well as photography. Data analysis mainly entailed use of univariate summary statistics and population projection models. The study belongs to the class described as "passive observational", in the sense that subjects were studied *in situ*, without any form of experimental manipulation.

Health Study

Primary data was collected by means of Household Survey, Focus Group Discussions, Key Informant Interviews (KII), Indept interviews and Nutritional Assessment of children below the age of five years and Environmental Health Survey.

Household Survey

Information was collected from a sample of households' representatives in the five communities with an approved standard HIA structured questionnaire. The questionnaire sought information on demographic and other socio-economic characteristics of the households as well as respondents' perception of prevalent illness, causes of death and their determinants. In addition, other pieces of information were obtained on drug and alcohol use, sexual behaviour including commercial sex work, patronage of orthodox and traditional practitioners, immunization

Focus Group Discussion (FGD)

Focus Group Discussions (FGD) were held to mainstream views and input of specific sub-groups that might not have been adequately captured during the Household Survey. Thus, FGDs were held with Youths, Men, Women, Teachers, clergymen and the Elderly following standard procedures for conducting FGDs. The discussions sought additional qualitative information on all issues raised during household survey with the aim of clarifying and obtaining consensus opinions and explanations.

Key Informant Interviews

Certain specialized social and health information were captured through interviews of key informants, such as opinion leaders, traditional rulers, community leaders, workers in- charge of health facilities, Traditional Birth Attendants (TBAs), teachers, health workers, etc. From these informants, information was obtained about cultural practices, living conditions in the communities, presence of health-related risk factors as well as health seeking behaviour; available health facilities (orthodox and traditional) and their utilization pattern; opinion about common disease and health concerns as well as expectations from the project implementation. All interviews were conducted in an environment that guaranteed valid responses.

APPENDIX 2
SIA AND HIA QUESTIONNAIRES

APPENDIX 2
NIPCO GAS LIMITED
SOCIAL IMPACTASSESSMENT QUESTIONNAIRE

Instruction: *Please answer the following questions to the best of your knowledge. Tick or fill in as appropriate.*

LOCATION

1. Name of Settlement (or Village): ……………………………………………
2. Local Government Area: ……………………………………………………..

PERSONAL/DEMOGRAPHIC PROFILE

3. How old are you? …………………………………

4. Sex of respondent (please tick
   (a) Male ( ) (b) Female ______ ( )

5. Marital Status (please tick)
   (a) Married ( ) (b) Single ( ) (c) Divorced ( ) (d) Widow ( )
   (e) Never ( ) (f) other ( )

6. Respondent's position in household (please tick)
   (a) Head ( ) (b) Spouse to Head ( ) (c) Son/daughter ( )
   (d) Other relations ( )

7. Please state the number of persons in your household (including yourself) who fall into the following categories.

Age cohorts (years)	Gender		Total
	Male	Female	
0 – 4			
5 – 9			
10 – 14			
15 – 19			
20 – 24			
25 – 29			
30 – 34			
35 – 39			
40 – 44			
45 – 49			
50 – 54			
55 – 59			
60 – 64			
65 and over			

8. What is your state of origin? ……………………………………………………….
9. Of what origin are the natives of your village? …………………………………..

10. Are there people from other parts of Nigeria in your Community? ……………
11. If any, were do they come from? …………………………………………………

ECONOMIC ACTIVITIES, EMPLOYMENT AND INCOME

12. What is your primary occupation/employment status (Please specify the sector)?
(a) Public (govt) ( ) (b) Company ( ) (c) self-employed ( )
(d) Not employed ( )

13. If you are self employed, please tell us what your occupation is:
(a) Fishing ( ) (b) Farming ( ) (c) Hunting ( ) (d) Trading ( )
(e) Business ( ) (f) Other ( )

14. If you are unemployed, please state what you do for a living ………………………

15. Kindly estimate your income from the following in a month:
(a) Primary occupation (₦) (b) Other sources (₦)

16. Please estimate (and tick) the amount of money your household (family) expends in a month.

A	( )	Less than N10,000	G	( )	N60,000 – N69,999
B	( )	N10,000 – N19,999	H	( )	N70,000 – N79,999
C	( )	N20,000 – N29,999	I	( )	N80,000 – 89,999
D	( )	N30,000 – N39,999	J	( )	N90,000 – 99,999
E	( )	N40,000 – N49,999	K	( )	N100,000 or more
F	( )	N50,000 – N49,999			

17. What fraction of your income (in %) do you spend on the following?
(a) Food …………. (b) Clothing …………. (c) Education ………….
(d) Health …………. (e) Housing …………. (f) Transportation ………….

18. By what means can someone in the village claim land to be his heritage:

Inheritance:	(i) Very common …	(ii) Common …	(iii) Not common …
Pledge:	(i) Very common …	(ii) Common …	(iii) Not common …
Gift:	(i) Very common …	(ii) Common …	(iii) Not common …

19. Duration of bush under fallow:
(a) 30 years ago ……… (b) 10 years ago ……….. (c) Now ………..

20. Which of these crops do you cultivate? (rank in order of importance with 1,2,3, etc.):
(a) Yams ………… (b) Cassava ……….. (c) Cocoyam ……..
(d) Potatoes ……….. (e) Tree crops ………… (f) Green vegetables
(g) Plantain

SOCIAL ENVIRONMENT

21. Are you (a) Christian ( ) (b) Muslim ( ) (c) Pagan ( )
(d) Free thinker ( )

22. Name the cultural activities festivals that your people observe
(a) ………………………………… (b) …………………………….
(c) ………………………………… (d) …………………………….

23. Name the classes of Chiefs in your community (a) ………. (b) …………..

24. How are Chiefs selected and by whom? …………………………………...

25. Please rate with (high & low) the role of the following in your community's governance.

(a) Chiefs …..…(b) Youth Leaders ..… (c) Elders …… (d) Women leaders …….
(e) Age grade ……….

26. Do you belong to any of the following organization?

S/N	Group	Yes	No
A	Political party		
B	Cooperative society		
C	Social club		
D	Educational group		
E	Religious organization		
F	Cultural organization		
G	Any other (specify) ……………………….		

27. Educational status of respondent: (please tick/underline)
(a) No formal Education (b) Primary (c) Secondary (d) Post Secondary

28. How many of the following exist in your settlement (village)?
(a) Nursery schools …………….. (b) Primary schools ………………….
(c) Secondary schools ………….. (d) Post Secondary schools

PERCEPTION OF COMPANY OPERATIONS

29. Rate between 1 - 10 what you consider the most beneficial aspects of Nipco Gas Gas Pipeline Project presence in your locality.
( ) Increased employment ( )Improvement in infrastructure
( ) Scholarship awards ( ) Taxes to government
( )Opportunities for contract ( )Improvement in social services

30. Rate between 1 – 10 what you consider the most undesirable aspects of Nipco Gas Gas Pipeline Project presence in your locality.
( ) Damage to the environment
( ) Disruption of traditional occupation
( ) Lack of employment
( ) Loss of traditional values
( ) Pressure on existing infrastructure
( ) Other (specify) …………………………..

31. Are you familiar with the Nipco Gas Gas Pipeline Project?
(a) Yes ( ) (b) No ( )

32. State briefly how the construction of Nipco Gas Gas Pipeline Project will affect your livelihood………………………….………………………………………………….

33. Will you say that the construction of the Yard will affect any of the following?
(Please tick)

S/N	Group	Yes	No
A	Floodways, flood and river flow regime		
B	Cultural sites (e.g. shrines, sacred forests)		
C	Excessive water in ponds/lakes		
D	Drying ponds/lakes		
E	Productivity of farmlands		
F	Economic trees		
G	Water transportation		
H	Domestic water supply		
I	Any other (specify) ……………………….		

34. Over the years will the effects observed diminished (please specify which and how)?
(a) ………………………………………………………………………
(b) ………………………………………………………………………

35. Suggest uses that the most impacted areas could be put to apart from your normal uses.
………………………………………………………………………………
………………………………………………………………………………

36. Is your level of agricultural production satisfactory to you?
(a) Yes ( ) (b) No ( )

37. If no, suggest ways of improvement.
………………………………………………………………………………
………………………………………………………………………………

38. Is your land more fertile now than before the construction of this yard? Please tell us whether it is more or less fertile now ……………………………

39. Where do you fish? (please tick)
(a) in the river ( ) (b) in the swamp ( ) (c) in the lake ( )

40. Is there any major change in species of fish caught since the construction of the yard started?
(a) Yes ( ) (b) No ( )

41. Please name the species of fish that are most affected.
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

UTILITIES/INFRASTRUCTURE

42. From which of these sources do you obtain your water supply?
(a) rain ( ) (b) river ( ) (c) well ( ) (d) borehole
(e) stored runoff ( ) (f) pipe borne ( )

43. How do you dispose your wastes (solid/domestic and farm wastes?
(a) burning ( ) (b) burying ( ) (c) dumping ( )
(d) throwing into running water ( )

44. How is human waste (excreta) disposed of?
(a) ( ) simple pit latrines
(b) ( ) into water channels
(c) ( ) surrounding bushes
(d) ( ) pail system
(e) ( ) open public sewer
(f) ( ) VIP (ventilated) latrine
(g) ( ) Other means (specify) ……………………….

45. By what means of transportation do you trvel from your village to neighbouring communities?
(a) To the next village? …………………………………..
(b) To the nearest town? …………………………………

46. Is your community is connected to any public power (electricity) supply system who installed it?
……………………………………………………………………….

LIVING ENVIRONMENT AND QUALITY OF LIFE

47. Which of these types of dwelling places do you live in?
(a) ( ) mud and wattle thatch
(b) ( ) mud and wattle zinc
(c) ( ) cement blocks zinc
(d) ( ) earth blocks thatch
(e) ( ) cement blocks asbestos
(f) ( ) earth blocks zinc
(g) ( ) timber wall thatch
(h) ( ) timer wall zinc

48. Are you (a) Tenant ( ) (b) Landlord ( ) (c) Homeless ( )

49. How many rooms are there in yoiur house? ……………………………………..

50. Do you consider them adequate for your household? ………………………………

51. Do you own?
(a) A bicycle ………………………………….
(b) A motor car ………………………………….
(c) A pick-up Van ………………………………….
(d) A motor cycle ………………………………….
(e) A bus ………………………………….
(f) A radio …………………………………..
(g) a refrigerator …………………………………..
(h) A T.V. …………………………………..
(i) A generator …………………………………..
(j) An air conditioiner …………………………………..

ETHNIC RELATIONS

52 Are your from this town? ……………………….…….

53. Why did yo move to this town?
(a) For employment ………………………………
(b) To fish ………………………………
(c) To farm ……………………………..
(d) To trade ……………………………..
(e) To go to school ……………………………..
(f) Any other reason ……………………………..

54. How how long ago did you move to this town? ………

55. Have your living conditions improved since you settled here?
(a) Same ( ) (b) better ( ) (c) worse ( ) (d) don'know ( )

56. Do you intend to live there permanently or do you intend to return to your home town? (a) intend to live here ( ) (b) intend to return home ( )
(c) Not yet decided ( )

57. If your intern to live here permanently what are your reasons for doing so?
……………………………………………………………………………………………

58. If you intend to return to your home town what are your reasons for doing so?
……………………………………………………………………………………………

59. Which of the following is a likely cause of conflict between you and your neighbouring communities?

(a) ( ) land boundary
(b) ( ) water boundary
(c) ( ) lakes
(d) ( ) hunting rights
(e) ( ) fishing rights
(f) ( ) other (please specify) …………………….

60. How are such conflicts usually resolved?

(a) ( ) The court
(b) ( ) The paramount ruler
(c) ( ) The council of chiefs
(d) ( ) Amicably by the parties
(e) ( ) Local government council
(f) ( ) Other (please specify) ………………………

61. Do you take part in the administration of the town? ……………………………

62. Which of these projects have been initiated and/or completed in your community?

(a) ( ) roads/bridges
(b) ( ) health center
(c) ( )market stalls
(d) ( ) electricity
(e) ( ) water supply
(f) ( ) school blocks
(g) ( ) scholarship
(h) ( ) micro-credit facility
(i) ( ) other (specify) ………………………..

63. Specify which of the following Organizations provided the above facilities

(a) Federal govt. ( ) (b) Local govt. ( ) (c) State govt. ( )
(d) NDDC ( ) (e) Other (specify) ……………………………………..

Thank you for your cooperation.

NIPCO GAS LIMITED

HEALTH IMPACT ASSESSMENT QUESTIONNAIRE

Instruction: Please answer the following questions to the best of your knowledge. Tick or fill in as appropriate.

Please fill in or tick as appropriate.

(A) Socio-Demographyic Variables

(1) Name of Town/Village …………………………………………………………………..

(2) Age (Last Birthday) ……………………………………………………………………….

(3) Sex: (a) Male ( ) (b) Female ( )

(4) What is your marital status?

Single	
Married	
Divorced	
Separated	
Widow/Widower	

(5) Educational Statuus:

No formal education

Primary school

Secondary school

Tertiary (NCE / OND / HND / Degree)

Higher degree

(6) Occupation:

(a) Farming ( )(b) Fishing ( ) (c) Trading ( ) (d) Civil servant ( )

(e) Other (specify) ……………………………………….

(7) In yoiur work place, what health problems are you reposed to …………………………………..

…………………………………………………………………………………………………….

(8) Income Per month (Audlts only) ……………………………………………………………….

(9) How much does it cost you to takecare of your family in a month? ……………………………...

(10) Religion ……………………………………..

(11) Ethnic group ………………………………..

(12) How long have you lived in this community? ………………………………..

(13) Have you changed your residence in this community within the last five (5) years?

(a) Yes ( ) (b) No ( )

14. If your answer to question 6 is Yes, please state why ……………………………………………

B. Reproductive Health Data:

How many children were born in your household between Jan. 1, 2019 and Nov. 1, 2019 and what are the ages of their mothers?

Age of mother	Total number of children ever born by the same mother		Number of children born between Jan. 1, 2019 and Dec. 31, 2019	
	Male	Female	Male	Female
(i)				
(ii)				
(iii)				
(iv)				
(v)				
(vi)				

(C) Lifestyle Habits

(1) Do you drink alcohol? Yes / No

(2) If Yes, How often

- o Everyday
- o At least once a week
- o Occasional

(3) Do you smoke? Yes / No

If yes, how many sticts/day ………………………

(4) Exercise: Yes / NO

What type of exercise do you do? ………………………………………………………………

(D) Knowledge, Attitude, Practices and Behaviour on Sexually Transmissible Infections

1. Do you have sexual partners not married to you? Yes / No
2. How many are they? Yes / No
3. Have you heard of sexualy transmissible Infection before? Yes / No
4. Have you ever had any Sexually Transmissible Infection? Yes / No

5. What symptoms (compliants) did you have them ………………………………………..
6. Were you treated by a Doctor, a Nurse or by yourself?
    - Treated by a Doctor Yes / No
    - By Nurse Yes / No
    - By self Yes / No

7. How many times have you had STIs before? …………………………………………
8. Have you heard of HIV/AIDS before? Yes / No
9. Do you know how HIV/AIDS can infect somebody? Yes / No
10. Name the mthod by which somebody can get HIV/AIDS

    ……………………………………………………………………………………………
11. Have you checked your HIV status? ……………………………………………………
12. Do you know anybody who has HIV/AIDS? Yes / No
13. How many do you? …………………………………………………………………
14. Has any member of your family, friend or community had or having tuberculosis?

    Yes / No

(E) Morbility and Mortality

1. Please list persons (if any) who died in your household between Jan. 1, 2019 and Dec. 31, 2019.

Name (Optional)	**Sex**	**Age**	**Casue of death (if know)**
(i)			
(ii)			
(iii)			
(iv)			
(v)			
(vi)			
(vii)			
(viii)			

2. Please indicate number of members of your household that suffered from each of the different disease listed below between Jan. 1, 2021 and Dec. 31, 2021. (If any).

S/N	Types of Disease	Male	Female	Total
i	Diarrhea			
ii	Dysentery			
iii	Measles			
iv	Pneumonia			
v	Tyhoid fever			
vi	Malaria			
vii	Cholera			
viii	Polio			
ix	Yeloow fever			
x	Childen pox			
xi	Diphtheria			
xii	Cancer			
xiii	Tetanus			
xiv	Tuberculosis			
xv	AIDS			
xvi	Guinea worm			
xvii	Sleeping sickness			
xviii	River blindness			
xix	Stroke			
xx	Others (specify)			

3. Please indicate how many members of your family that are below 5 years who have suffered from the underlisted conditions between Jan. 1, 2021 and Dec. 31, 2021

S/N	Clincial Condition	Male	Female	Total
i	Kwashiorkor			
ii	Anaemia			
iii	Rickets			
iv	Goiter			
v	Others (specify)			

4. How many members of your family died from each of the disease listed below between Jan. 1, 2021 and Dec. 31, 2021 (if any)

S/N	Types of Disease	Male	Female	Total
i	Diarrhea			
ii	Dysentery			
iii	Measles			
iv	Pneumonia			
v	Tyhoid fever			
vi	Malaria			
vii	Cholera			
viii	Polio			
ix	Yeloow fever			
x	Childen pox			
xi	Diphtheria			
xii	Cancer			
xiii	Tetanus			
xiv	Tuberculosis			
xv	AIDS			
xvi	Guinea worm			
xvii	Sleeping sickness			
xviii	River blindness			
xix	Stroke			
xx	Others (specify)			

(F)

S/N	Types	Total Number	Total Number of Midwives/Nurses	Total Number of Doctors	Total Number of Medical Staff
i	Hospital				
ii	Maternity				
iii	Dispensary				
iv	Health Centre				
v	Private Clinic				
vi	Patent Medical Store				

vii	Pharmacy (Chemist)				
viii	Traditional Healing Home				

(G) Health Seeking Behaviour Data

1. Indicate types/member of health care institutions I nyour community
2. What treatment did/do you employ when sick?
   - (i) Attended hospital /clinic
   - (ii) Buys drugs from nearby chemist
   - (iii) Consult native doctors
   - (iv) Self medication

3. Where did/you go for child delivery (ies)?
   - (i) Attend hospital /health centre ……………..
   - (ii) Maternity/private clinic …………………….
   - (iii) At home alone ………………………………..
   - (iv) Native Doctor/traditional midwife ………..
   - (v) Any other (specify) …………………………..

H. Environmental Helath Data:

1. What is the major source of water available to your household? (Tick the correct option).
   - (i) River/stream
   - (ii) Well
   - (iii) Pond
   - (iv) Rain water
   - (v) Public pipe-borne water
   - (vi) Mono pump
   - (vii) Borehole (commercial)
   - (viii) Borehole (private)
   - (ix) Commercial tanker

S/N	Types of houses (by Nature of Construction Materials	Total Number
i	Wood (Batcher	
ii	Mud	
iii	Corrugated iron sheets (zinc batchers	
iv	Cellophane (nylon)	
v	Thatch	
vi	Block (cement or brick)	

1. What type(s) of residential house do you have in your community?
2. How many persons live in a house? …………………………………..
3. How many rooms are in your house/residence? ……………………
4. What types of facility do you use? Please tick from below:
   - Pit
   - Buch
   - Prier head
   - Bucket
   - Water closet
   - Others (specify)
5. How do you dispose of your household refuse? Please tick from the list below:
   - Private open dump
   - Public open dump
   - Organized collection (by Local Government Community etc)
   - Organized collection (by individual – Commercial)
   - Burning
   - Bush
   - Burying

Table 4.18.1: Results of analysis on top soil for wet season

Parameter(s)	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13	SS14
Sand (%)	67.4	79.4	74.4	81.4	78.4	76.32	76	82.6	73.6	81.6	75.56	71.56	70.4	67.4
Silt (%)	3.92	1.92	1	1.96	2.92	1.84	3.52	1.88	3.88	1.88	1.96	3.92	3.08	6.2
Clay (%)	28.68	18.68	24.6	16.64	18.68	21.84	20.48	16.52	22.52	16.52	22.48	24.52	26.52	26.4
Particle Size Distribution	SCL	SL	SCL	SL	SL	SCL	SCL	SL	SCL	SL	SCL	SCL	SCL	SCL
Porosity	0.365	0.39	0.376	0.402	0.388	0.382	0.38	0.41	0.372	0.341	0.383	0.37	0.372	0.369
Permeability (g/cm^3) x 10^{-3}	0.14	0.15	0.13	0.13	0.12	0.14	0.16	0.11	0.12	0.11	0.14	0.13	0.16	0.11
Bulk Density (g/cm^3) x 10^{-3}	1.68	1.63	1.4	1.83	1.75	1.46	1.54	1.48	1.53	1.75	1.83	1.46	1.45	1.36
pH	6.62	7.1	4.99	5.07	5.55	4.45	6.18	7.7	4.76	6.12	6.26	6.41	6.13	4.51
CEC (meq/100g)	6.42	11.818	1.986	3.845	4.077	1.592	11.487	20.012	4.363	19.639	9.881	9.897	8.842	2.733
TOC (%)	1.209	1.326	0.975	1.677	0.978	0.702	1.014	1.521	1.053	0.468	1.365	1.521	1.443	1.365
Moisture Content (%)	16.34	14.6	14.75	18.53	14.34	12.65	14.63	13.88	13.28	15.38	18.23	11.75	13.27	13.84
Colour	Black	Brown	Brown	Brown	Black	Black	Dark	Black	Brown	Dark	Brown	Dark	Brown	Brown
Total Nitrogen (%)	0.105	0.115	0.084	0.145	0.084	0.061	0.088	0.131	0.091	0.04	0.118	0.131	0.125	0.118
Nitrate, No_3^- (mg/kg)	0.25	0.18	0.33	0.18	0.14	0.18	0.16	0.27	0.21	0.4	0.34	0.21	0.17	0.28
Nitrite, NO_2^- (mg/kg)	0.002	0.003	0.003	0.003	0.003	0.002	0.003	0.002	0.003	0.002	0.002	0.003	0.002	0.002
Phosphate, PO_4^{3-} (mg/kg)	0.75	0.69	0.27	0.86	0.69	0.67	0.35	0.4	0.78	0.4	0.27	0.23	0.27	0.4
Carbonate, CO_3^{2-} (mg/kg)	2	8	5	15	3	5	15	25	32	10	15	5	3	5
Sulphate, SO_4^{2-} (mg/kg)	0	2	2	3	4	2	3	4	5	2	4	2	2	2
Ammonium, NH_4^+ (mg/kg)	0.007	0.05	0.1	0.05	0.05	0.05	0.05	0.06	0.06	0.12	0.1	0.06	0.05	0.08
BTEX (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TPH (mg/kg)	<0.001	158.6	1.52	<0.001	0.85	<0.001	5.83	94.88	1.85	54.88	187.1	111.2	318.5	0.95
THC (mg/kg)	<0.01	211.5	2.03	<0.01	1.13	<0.01	7.77	126.5	2.47	73.17	249.5	148.3	424.7	1.27
PAH (mg/kg)	<0.001	0.684	0.006	<0.001	0.003	<0.001	0.023	0.38	0.007	0.22	0.749	0.445	1.274	0.004
Oil & Grease (mg/kg)	<0.01	185.3	1.65	<0.01	1.07	<0.01	6.53	114.6	1.95	66.75	214.8	127.8	375	1.15
Sodium, Na^+ (mg/kg)	79.51	98.36	82.13	110.6	73.89	90.01	122.8	91.96	135.5	125.6	104.9	110.1	100.7	82.78
Potassium, K^+ (mg/kg)	76.21	675.5	43.7	80.38	32.15	49.91	639.3	448.4	253.9	700.3	634	666.2	548.5	24.78
Calcium, Ca^{2+} (mg/kg)	576.5	653.5	86.59	174.9	301	59.83	347.4	2,216.50	119	1,649.20	330.1	312	310.4	103.8
Magnesium, Mg^{2+} (mg/kg)	359.5	766.8	130.1	273.9	260.3	92.88	909.2	882.5	303.4	1,086.10	737.7	738	653.5	214.8
Iron, Fe (mg/kg)	5,104.20	5,329.00	3,579.20	3,234.10	2,758.90	3,038.30	5,175.60	3,580.50	4,181.10	6,429.60	4,570.80	4,731.00	3,640.40	6,365.80

Cadmium, Cd (mg/kg)	0.69	0.37	0.07	0.78	<0.001	<0.001	0.1	<0.001	0.26	0.13	0.07	<0.001	0.24	0.29
Chromium, Cr (mg/kg)	13.44	11.14	6.85	1.42	8.71	5.28	11.05	3.83	2.9	2.51	6.09	10.48	4.87	1631
Copper, Cu (mg/kg)	1.68	6.27	<0.001	<0.001	1.74	<0.001	4.79	1.5	<0.001	<0.001	<0.001	1.01	<0.001	1.18
Nickel, Ni (mg/kg)	3.6	3.45	3.77	1.83	3.4	3.96	4.42	2.11	3.07	8.15	5.18	2.89	1.98	1.31
Vanadium, V (mg/kg)	0.17	0.16	0.18	0.09	0.16	0.19	0.21	0.1	0.15	0.39	0.25	0.14	0.09	0.06
Lead, Pb (mg/kg)	3.45	28.8	<0.001	2.8	3.93	10.35	20.31	16.66	3.27	1.98	7.81	11.13	10.13	0.43
Zinc, Zn (mg/kg)	12.86	53.1	7.7	11.4	6.37	4.14	52.92	36.46	8.83	32.1	17.83	15.91	14.34	7.57
Barium, Ba (mg/kg)	0.05	0.2	<0.001	<0.001	0.06	<0.01	0.15	0.05	<0.01	<0.01	<0.01	0.03	<0.01	0.04
Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	0.02	0.06	<0.01	<0.01	0.02	<0.01	0.05	0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01
THB (CFU/g)	400000	1300000	260000	350000	280000	370000	1200000	280000	410000	2600000	36000	1400000	220000	330000
THF (CFU/g)	230000	600000	110000	220000	21000	210000	70000	120000	270000	1600000	240000	900000	120000	180000
HUB (CFU/g) X 10^3	0.7	1.1	0.3	0.5	1	0.4	0.8	0.8	1.1	0.5	0.7	1.3	0.6	0.9
HUF (CFU/g) X 10^3	0.3	0.6	0.1	0.3	0.6	0.4	0.3	0.3	0.6	0.3	0.4	0.6	0.3	0.7
SRB (MPN/100g	4	6	4	3	6	3	0	0	3	11	3	0	9	3
Fecal Coliform (MPN/100g)	42	21	23	23	43	21	15	23	43	15	9	23	28	11

Parameter(s)	SS15	SS16	SS17	SS18	SS19	SS20	SS21	SS22	SS23	SS24	SS25	SS26	SS27	SS28
Sand (%)	73.28	84.6	77.6	79.84	70.68	84.68	81.76	82.68	81.76	79.8	76.8	84.76	81.76	76.8
Silt (%)	3.2	3.72	3.72	3.92	6	2	2.88	2	1.96	2.96	2.88	2.96	2.92	1.84
Clay (%)	23.52	11.68	18.68	16.24	23.32	13.32	15.36	15.32	16.28	17.24	20.32	12.28	15.32	21.36
Particle Size Distribution	SCL	LS	SL	SL	SCL	LS	SL	SL	SL	SL	SCL	LS	SL	SCL
Porosity	0.38	0.42	0.395	0.4	0.372	0.42	0.393	0.398	0.393	0.385	0.38	0.42	0.395	0.38
Permeability (g/cm^3) x 10^{-3}	0.14	0.15	0.16	0.14	0.12	0.14	0.12	0.12	0.14	0.16	0.13	0.11	0.15	0.16
Bulk Density (g/cm^3) x 10^{-3}	1.73	1.48	1.65	1.72	1.54	1.31	1.27	1.63	1.43	1.53	1.4	1.6	1.6	1.6
pH	4.96	6.87	6.77	5.64	4.98	6.64	5.8	5.4	5.62	5	7.35	6.62	5.37	8.05
CEC (meq/100g)	2.286	9.284	8.174	3.171	2.741	8.93	11.092	15.328	4.695	2.097	9.126	4.223	2.099	23.004
TOC (%)	1.326	0.819	1.17	1.404	1.716	1.092	0.546	2.106	1.911	0.273	0.702	0.936	1.326	0.78
Moisture Content (%)	11.78	12.63	11.95	13.68	17.45	14.31	13.75	17	11.6	13.6	13.31	18.11	14.51	16.3
Colour	Brown	Brown	Dark	Dark	Light	Dark	Dark	Black	Black	Brown	Brown	Black	Brown	Brown
Total Nitrogen (%)	0.115	0.054	0.101	0.121	0.148	0.094	0.047	0.182	0.165	0.024	0.061	0.081	0.115	0.067
Nitrate, No_3^- (mg/kg)	0.28	0.42	0.34	0.17	0.31	0.27	0.31	0.4	0.4	0.17	0.65	0.25	0.31	0.6
Nitrite, NO_2^- (mg/kg)	0.002	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.002	0.003	0.003	0.002	0.003
Phosphate, PO_4^{3-} (mg/kg)	0.27	0.65	0.65	0.75	0.78	0.75	0.63	1.14	1.25	0.02	0.3	0.1	0.04	1.25
Carbonate, CO_3^{2-} (mg/kg)	5	17	5	3	7	18	20	19	20	1	18	5	2	28
Sulphate, SO_4^{2-} (mg/kg)	5	4	2	1	2	2	4	5	5	0	3	5	2	4
Ammonium, NH_4^+ (mg/kg)	0.08	0.1	0.1	0.05	0.1	0.08	0.09	0.12	0.12	0.05	0.19	0.007	0.09	0.17
BTEX (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TPH (mg/kg)	1.03	32.98	74.83	8.18	48.92	43.1	41.38	10.07	1.75	<0.001	2.06	<0.001	2.6	<0.001
THC (mg/kg)	1.37	43.97	99.77	10.9	65.23	57.47	55.17	13.43	2.33	<0.01	2.75	<0.01	3.47	<0.01
PAH (mg/kg)	0.004	0.132	0.299	0.033	0.196	0.172	0.166	0.04	0.007	<0.001	0.008	<0.001	0.01	<0.001
Oil & Grease (mg/kg)	1.1	37.65	86.45	9.64	57.51	52.4	50.07	12.1	2.1	<0.01	2.34	<0.01	2.84	<0.01

Sodium, Na^+ (mg/kg)	72.02	107.4	79.67	83.8	110.7	83.94	73.2	83.78	68.97	63.83	82.96	75.97	66.57	104.8
Potassium, K^+ (mg/kg)	31.13	465.7	429.7	53.9	55.49	372.8	660.4	552.9	234	77	271.8	150.4	52.01	246.1
Calcium, Ca^{2+} (mg/kg)	73.56	441.1	362.6	134	124.5	435.1	395.6	1,007.60	232.4	89.54	709.1	135.5	60.81	3,029.40
Magnesium, Mg^{2+} (mg/kg)	183	650	589.5	239.9	179.4	651.9	852.4	1,020.90	315.9	141	542.6	339.5	164.7	812.4
Iron, Fe (mg/kg)	4,827.10	2,418.00	5,996.30	2,964.60	6,012.20	2,304.20	4,115.60	3,704.70	3,710.10	2,931.20	2,035.60	790.7	4,921.70	7,181.50
Cadmium, Cd (mg/kg)	0.13	0.08	0.4	<0.001	<0.001	<0.001	0.07	1.65	<0.001	<0.001	<0.001	<0.001	<0.001	0.32
Chromium, Cr (mg/kg)	5.82	2	10.23	2.43	7.79	3.71	10.74	7.72	8.29	2.47	<0.001	<0.001	9.49	14.86
Copper, Cu (mg/kg)	<0.001	0.28	7.48	<0.001	2.78	<0.001	<0.001	4.75	1.76	<0.001	<0.001	<0.001	<0.001	2.25
Nickel, Ni (mg/kg)	1.69	2.59	2.05	3.47	2.99	2.33	3.69	3.33	3.31	1.48	1.05	1.16	1.74	7.17
Vanadium, V (mg/kg)	0.08	0.12	0.1	0.17	0.14	0.11	0.18	0.16	0.16	0.07	0.05	0.06	0.08	0.34
Lead, Pb (mg/kg)	3.13	2.53	18.63	1.17	6.23	3.08	9.22	22.24	6.77	6.46	7.1	<0.001	5.43	14.54
Zinc, Zn (mg/kg)	4.48	25.77	39.53	9.5	11.05	26.35	18.57	15.15	17.72	5.07	16.88	4.49	5.63	9.78
Barium, Ba (mg/kg)	<0.01	0.01	0.27	0.11	0.1	<0.01	<0.01	0.15	0.06	<0.01	<0.01	<0.01	<0.01	0.07
Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	<0.01	<0.001	0.02	0.03	0.03	<0.01	<0.01	0.04	0.02	<0.01	<0.01	<0.01	<0.01	0.02
THB (CFU/g)	320000	2000000	430000	1700000	380000	1800000	290000	360000	1100000	1800000	310000	2000000	320000	280000
THF (CFU/g)	230000	2700000	210000	110000	210000	210000	180000	210000	150000	6000	120000	1000000	160000	100000
HUB (CFU/g) X 10^3	0.8	0.7	1	1.2	1.3	1	0.7	1.4	1.7	0.8	1.2	1.4	0.9	0.6
HUF (CFU/g) X 10^3	0.2	0.2	0.6	0.6	0.8	0.3	0.2	0.6	0.8	0.4	0.7	1	0.2	0.1
SRB (MPN/100g	11	7	3	4	7	3	6	3	4	0	0	3	4	0
Fecal Coliform (MPN/100g)	42	28	15	6	3	24	43	21	23	28	9	11	28	15

Parameter(s)	SS29	SS30	SS31 C	SS32 C
Sand (%)	72.92	67.92	79.84	80.72
Silt (%)	2.24	6.4	2.48	2.56
Clay (%)	24.8	25.68	17.68	16.72
Particle Size Distribution	SCL	SCL	SL	SL
Porosity	0.376	0.372	0.385	0.393
Permeability (g/cm^3) x 10^{-3}	0.12	0.13	0.15	0.15
Bulk Density (g/cm^3) x 10^{-3}	1.41	1.23	1.18	1.43
pH	6.07	6.54	6.07	5.97
CEC (meq/100g)	2.872	6.065	14.233	11.727
TOC (%)	0.897	1.17	1.014	0.936
Moisture Content (%)	14.34	16.1	14.34	15.16
Colour	Brown	Brown	Black	Black
Total Nitrogen (%)	0.078	0.101	0.088	0.081
Nitrate, No_3^- (mg/kg)	0.25	0.36	0.16	0.03
Nitrite, NO_2^- (mg/kg)	0.002	0.002	0.003	0.002
Phosphate, PO_4^{3-} (mg/kg)	0.1	1.27	0.23	0.17
Carbonate, CO_3^{2-} (mg/kg)	7	37	4	0
Sulphate, SO_4^{2-} (mg/kg)	2	8	1	0
Ammonium, NH_4^+ (mg/kg)	0.07	0.11	0.05	0.01
BTEX (mg/kg)	<0.001	<0.001	<0.001	<0.001
TPH (mg/kg)	<0.001	2.15	2.8	<0.001
THC (mg/kg)	<0.01	2.87	3.73	<0.01
PAH (mg/kg)	<0.001	0.009	0.011	<0.001
Oil & Grease (mg/kg)	<0.01	2.43	3.27	<0.01
Sodium, Na^+ (mg/kg)	103	100.5	144.5	136.4
Potassium, K^+ (mg/kg)	51.19	479	743.7	398.9
Calcium, Ca^{2+} (mg/kg)	155.9	320.2	541.9	673.4
Magnesium, Mg^{2+} (mg/kg)	181.6	335.9	1,077.40	809.3
Iron, Fe (mg/kg)	3,449.40	6,735.40	5,006.80	2,335.10
Cadmium, Cd (mg/kg)	<0.001	0.33	0.02	<0.001
Chromium, Cr (mg/kg)	11.91	34.1	12.23	2.36
Copper, Cu (mg/kg)	<0.001	7.31	3.47	1.74
Nickel, Ni (mg/kg)	1.07	2.32	5.37	2.48
Vanadium, V (mg/kg)	0.05	0.11	0.26	0.12
Lead, Pb (mg/kg)	2.03	14.37	6.26	4.96
Zinc, Zn (mg/kg)	4.6	10.73	13.9	9.79

Barium, Ba (mg/kg)	<0.01	0.24	0.11	0.06
Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	<0.01	0.07	0.03	0.02
THB (CFU/g)	1200000	2200000	250000	1700000
THF (CFU/g)	260000	140000	110000	150000
HUB (CFU/g) X 10^3	1	0.6	0.8	1.2
HUF (CFU/g) X 10^3	0.4	0.3	0.2	0.6
SRB (MPN/100g	3	4	9	7
Fecal Coliform (MPN/100g)	9	21	43	28

Table 4.18.1: Results of analysis on sub soil for wet season

Parameter(s)	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13	SS14
Sand (%)	65.51	77.5	72.53	80.61	76.15	74.23	73.15	82.86	71.65	80.6	76.43	70.42	72.1	68.13
Silt (%)	4.8	3.12	2.23	3.6	4.25	3.1	4.25	2.79	4.45	2.12	2.25	4.53	3.65	4.17
Clay (%)	29.69	19.38	25.24	15.79	19.6	22.67	22.6	14.35	23.9	17.28	21.32	25.05	24.25	27.7
Particle Size Distribution	SCL	SL	SCL	SL	SL	SCL	SCL	LS	SCL	SL	SCL	SCL	SCL	SCL
Porosity	0.368	0.383	0.37	0.401	0.381	0.375	0.372	0.416	0.37	0.408	0.385	0.372	0.376	0.368
Permeability (g/cm^3) x 10^{-3}	0.15	0.14	0.16	0.12	0.13	0.15	0.15	0.13	0.13	0.11	0.15	0.14	0.12	0.13
Bulk Density (g/cm^3) x 10^{-3}	1.75	1.63	1.65	1.45	1.82	1.65	1.35	1.65	1.43	1.68	1.35	1.53	1.27	1.87
pH	7.08	6.74	4.7	5.22	6.74	3.98	6.07	7.51	4.76	7.71	6.22	6.22	5.85	4.64
CEC (meq/100g)	5.156	7.574	1.869	1.657	6.277	1.858	6.211	12.021	4.201	15.351	10.367	8.842	24.706	2.524
TOC (%)	1.149	1.216	0.768	1.275	0.868	0.695	0.868	1.32	0.878	0.423	1.246	1.275	1.201	1.252
Moisture Content (%)	15.75	15.33	20.75	17.53	15.38	13.34	15.41	14.32	14.68	14.75	18.28	12.1	14.5	12.85
Colour	Black	Dark Brown	Black	Brown	Black	Black	Brown	Dark	Brown	Black	Brown	Brown	Brown	Brown
Total Nitrogen (%)	0.099	0.105	0.066	0.11	0.075	0.06	0.075	0.114	0.075	0.036	0.108	0.11	0.104	0.108
Nitrate, No_3^- (mg/kg)	0.35	0.27	0.25	0.32	0.2	0.17	0.25	0.17	0.35	0.27	0.3	0.34	0.27	0.34
Nitrite, NO_2^- (mg/kg)	0.003	0.002	0.003	0.002	0.003	0.003	0.003	0.003	0.002	0.002	0.003	0.003	0.002	0.002

Phosphate, PO_4^{3-} (mg/kg)	1.75	0.48	0.8	1.27	0.95	0.45	0.23	1.21	0.65	0.53	0.14	0.17	0.32	0.17
Carbonate, CO_3^{2-} (mg/kg)	21	8	4	2	20	21	10	7	24	5	5	20	8	5
Sulphate, SO_4^{2-} (mg/kg)	4	2	1	0	0	5	2	2	4	1	2	4	2	2
Ammonium, NH_4^+ (mg/kg)	0.1	0.08	0.07	0.1	0.06	0.05	0.07	0.05	0.1	0.06	0.1	0.1	0.08	0.1
BTEX (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TPH (mg/kg)	<0.001	109	1.1	<0.001	<0.001	<0.001	3.56	77.35	0.84	34.01	123.5	82.73	161.4	0.83
THC (mg/kg)	<0.01	145.3	1.46	<0.01	<0.01	<0.01	4.75	103.1	1.12	45.34	164.6	110.3	215.2	1.1
PAH (mg/kg)	<0.001	0.436	0.004	<0.001	<0.001	<0.001	0.014	0.309	0.003	0.136	0.494	0.331	0.646	0.003
Oil & Grease (mg/kg)	<0.01	126.3	1.1	<0.01	<0.01	<0.01	3.8	95.6	1.1	42.1	155.8	98.33	175.3	1.03
Sodium, Na^+ (mg/kg)	79.03	98.39	79.02	57.03	73.63	105.1	99.73	99.21	106.6	121.3	86.6	99.75	115.2	102.1
Potassium, K^+ (mg/kg)	27.61	433.9	30.5	13.36	78.02	50.77	205.7	487.4	170.1	743.7	653.5	626.3	663.9	23.72
Calcium, Ca^{2+} (mg/kg)	507.2	345.9	93.17	75.15	493.7	73.56	284.5	858.5	181.9	679.7	319.8	288.9	2,598.90	92.57
Magnesium, Mg^{2+} (mg/kg)	264.6	516.4	117.7	119.9	394.9	108.3	459.2	725.6	287	1,142.10	805.8	642.8	1,140.90	186.7
Iron, Fe (mg/kg)	2,260.30	4,271.60	4,915.30	3,110.30	2,704.30	3,522.80	4,554.40	5,083.90	4,606.30	2,569.10	5,384.60	4,542.80	6,541.10	4,748.60
Cadmium, Cd (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	0.23	0.11	0.02	0.15	0.09	0.06	0.13	0.18	<0.001
Chromium, Cr (mg/kg)	3.31	9.21	12.84	3.59	9.18	4.99	3.43	2.3	3.37	3.18	12.99	11.1	28.26	5.31
Copper, Cu (mg/kg)	<0.001	1.89	<0.001	<0.001	1.56	0.21	0.56	1.42	<0.001	<0.001	0.89	<0.001	30.79	<0.001
Nickel, Ni (mg/kg)	1.41	0.92	2.26	2.29	2.29	2.31	3.66	2.16	1.96	3.86	5.6	4.86	5.92	1.87
Vanadium, V (mg/kg)	0.07	0.04	0.11	0.11	0.11	0.11	0.17	0.1	0.09	0.18	0.27	0.23	0.28	0.09
Lead, Pb (mg/kg)	<0.001	14.7	0.23	<0.001	4.06	2.85	6.99	9.34	9.47	0.25	19.15	12.19	108.4	2.76
Zinc, Zn (mg/kg)	8.01	35.87	4.58	4.16	9.22	4.05	13.67	16.64	6.24	14.18	15.53	14.53	24.81	3.91
Barium, Ba (mg/kg)	<0.01	0.06	<0.01	<0.01	0.05	0.01	0.02	0.05	<0.01	<0.01	0.03	<0.01	0.99	<0.01

Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	<0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01	0.01	<0.01	<0.01	0.01	<0.01	0.28	<0.01
THB (CFU/g)	280000	800000	180000	240000	260000	280000	400000	190000	320000	1800000	270000	1100000	180000	280000
THF (CFU/g)	170000	30000	60000	150000	150000	160000	50000	60000	120000	800000	140000	500000	70000	100000
HUB (CFU/g) X 10^3	0.4	0.7	0.1	0.3	0.7	0.3	0.5	0.3	0.8	0.3	0.5	0.8	0.4	0.6
HUF (CFU/g) X 10^3	0.2	0.4	NIL	0.2	0.3	0.2	0.2	0.1	0.5	0.2	0.2	0.5	0.1	0.2
SRB (MPN/100g	3	3	3	0	3	3	0	0	0	3	0	0	4	3
Fecal Coliform (MPN/100g)	35	9	4	7	28	11	6	12	36	11	3	11	16	11
Parameter(s)	**SS15**	**SS16**	**SS17**	**SS18**	**SS19**	**SS20**	**SS21**	**SS22**	**SS23**	**SS24**	**SS25**	**SS26**	**SS27**	**SS28**
Sand (%)	72.68	82.48	76.65	77.64	71.18	81.73	81.64	82.65	80.63	77.64	77.64	83.63	80.64	75.66
Silt (%)	5.86	4.64	4.18	4.26	6.24	3.32	3.25	3.1	2.1	3.1	3.12	2.75	2.83	2.46
Clay (%)	21.46	12.88	19.17	18.1	22.58	14.95	15.11	14.25	17.27	19.26	19.24	13.62	16.53	21.88
Particle Size Distribution	SCL	LS	SL	SL	SCL	LS	SL	LS	SL	SL	SL	LS	SL	SCL
Porosity	0.379	0.41	0.395	0.398	0.382	0.392	0.392	0.395	0.387	0.381	0.381	0.4	0.387	0.379
Permeability (g/cm^3) x 10^{-3}	0.15	0.14	0.15	0.14	0.12	0.11	0.13	0.13	0.15	0.15	0.14	0.14	0.15	0.11
Bulk Density (g/cm^3) x 10^{-3}	1.63	1.53	1.83	1.64	1.48	1.1	1.8	1.54	1.4	1.63	1.55	1.75	1.53	1.4
pH	5.11	7.26	6.78	5.47	4.59	6.48	5.34	5.38	5.02	5.27	7.6	6.38	5.34	7.08
CEC (meq/100g)	3.46	8.504	8.521	3.133	2.19	11.964	7.865	7.964	4.36	3.097	12.225	8.581	2.504	2.689
TOC (%)	1.224	0.724	1.013	1.103	1.423	0.842	0.42	1.214	1.453	0.208	0.416	0.725	1.17	0.625
Moisture Content (%)	11.45	12.48	12.1	14.03	16.24	12.8	16.75	14.7	13.15	12.17	19.68	17.8	16.34	15.78
Colour	Light	Brown	Dark	Dark	Brown	Dark	Dark	Black	Dark	Brown	Brown	Light	Brown	Brown
Total Nitrogen (%)	0.108	0.063	0.088	0.095	0.123	0.073	0.036	0.105	0.126	0.018	0.036	0.063	0.101	0.054
Nitrate, No_3^- (mg/kg)	0.14	0.25	0.3	0.27	0.32	0.31	0.27	0.45	0.25	0.57	0.45	0.46	0.25	0.35
Nitrite, NO_2^- (mg/kg)	0.002	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.002	0.002	0.003	0.002	0.002	0.003
Phosphate, PO_4^{3-} (mg/kg)	0.67	0.72	0.49	0.69	0.53	0.4	1.03	0.68	0.45	0.03	0.25	0.03	0.04	0.24

Carbonate, CO_3^{2-} (mg/kg)	4	18	5	2	4	25	24	10	10	1	7	2	3	3
Sulphate, SO_4^{2-} (mg/kg)	1	4	2	1	1	4	5	3	4	0	2	0	0	3
Ammonium, NH_4^+ (mg/kg)	0.04	0.08	0.1	0.08	0.1	0.09	0.08	0.15	0.07	0.17	0.13	0.13	0.07	0.1
BTEX (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TPH (mg/kg)	0.89	19.58	46.25	6.5	30.94	30.9	30.47	8.12	<0.001	<0.001	0.86	<0.001	1.7	<0.001
THC (mg/kg)	1.18	26.1	61.67	8.67	41.25	41.2	40.62	10.83	<0.01	<0.01	1.15	<0.01	2.27	<0.01
PAH (mg/kg)	0.004	0.078	0.185	0.026	0.124	0.124	0.122	0.032	<0.001	<0.001	0.003	<0.001	0.007	<0.001
Oil & Grease (mg/kg)	1.15	21.3	59.03	7.45	38.65	38.31	36.65	9.37	<0.01	<0.01	1.1	<0.01	1.95	<0.01
Sodium, Na^+ (mg/kg)	102.5	104.2	76.24	65.19	78.2	89.55	122.6	79.73	64.91	70.49	74.39	76.81	75.25	97.86
Potassium, K^+ (mg/kg)	27.57	383.5	371.3	23.62	24.14	576.9	334	479	265.6	93.88	684.3	537.9	112.5	111.7
Calcium, Ca^{2+} (mg/kg)	126	391.6	466.3	156	73.32	708.1	338.6	273.8	216.5	149.2	527.3	130.9	98.15	111.4
Magnesium, Mg^{2+} (mg/kg)	277.5	613.2	588.7	241.1	170.5	786.6	573.9	602.4	277.7	216.5	901.2	745.6	167.8	170.5
Iron, Fe (mg/kg)	6,923.40	2,030.20	6,582.50	5,852.90	6,811.90	2,093.00	2,309.70	2,612.30	4,172.10	4,307.10	3,538.00	1,870.10	6,780.00	7,063.60
Cadmium, Cd (mg/kg)	0.46	<0.001	0.07	0.02	0.41	<0.001	<0.001	0.07	0.69	<0.001	0.08	<0.001	0.76	0.06
Chromium, Cr (mg/kg)	23.01	2.24	22.4	11.09	20.01	<0.001	0.63	0.48	7.55	11.22	4.24	7.23	16.67	22.6
Copper, Cu (mg/kg)	2.68	<0.001	3.65	<0.001	1.25	7.47	<0.001	<0.001	4.32	<0.001	<0.001	<0.001	0.2	0.89
Nickel, Ni (mg/kg)	3.91	1.41	2.46	4.51	3.43	1.89	2.81	2.55	4.9	2.12	1.07	3.06	2.48	5.13
Vanadium, V (mg/kg)	0.19	0.07	0.12	0.21	0.16	0.09	0.13	0.12	0.23	0.1	0.05	0.15	0.12	0.24
Lead, Pb (mg/kg)	5.57	3.11	16.69	<0.001	10.67	4.12	1.66	1.48	11.66	4.16	2.96	3.78	5.98	11.9
Zinc, Zn (mg/kg)	9.1	25.27	38.15	6	8.28	38.04	15.17	15.63	18.18	5.94	11.82	11.82	4.15	5.48
Barium, Ba (mg/kg)	0.09	<0.01	0.08	0.15	0.11	0.24	<0.01	<0.01	0.14	<0.01	<0.01	<0.01	0.01	0.03
Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Arsenic, As (mg/kg)	0.02	<0.01	0.02	0.04	0.03	0.07	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	0.01
THB (CFU/g)	210000	1200000	700000	800000	220000	600000	170000	280000	400000	1000000	230000	240000	250000	200000
THF (CFU/g)	110000	400000	400000	30000	70000	130000	120000	300000	70000	20000	80000	160000	130000	60000
HUB (CFU/g) X 10^3	0.4	0.3	0.9	0.7	1	0.5	0.4	0.8	1	0.6	0.5	1.1	0.4	0.2
HUF (CFU/g) X 10^3	0.2	0.1	0.3	0.4	0.3	0.1	0.2	0.2	0.6	0.2	0.3	0.7	0.1	NIL
SRB (MPN/100g	4	3	3	3	0	3	3	3	3	0	0	0	3	0
Fecal Coliform (MPN/100g)	23	9	4	3	3	9	11	11	15	23	3	3	4	9

Parameter(s)	SS29	SS30	SS31 C	SS32 C
Sand (%)	72.83	69.25	78.64	79.53
Silt (%)	2.6	5.14	2.98	3.78
Clay (%)	24.57	25.61	18.38	16.69
Particle Size Distribution	SCL	SCL	SL	SL
Porosity	0.376	0.374	0.382	0.391
Permeability (g/cm^3) x 10^{-3}	0.13	0.14	0.13	0.14
Bulk Density (g/cm^3) x 10^{-3}	1.17	1.31	1.27	1.14
pH	5.76	5.94	5.23	5.85
CEC (meq/100g)	1.933	6.137	11.927	9.963
TOC (%)	0.843	0.843	0.758	0.847
Moisture Content (%)	14.75	15.63	15.23	14.75
Colour	Brown	Dark	Brown	Black
Total Nitrogen (%)	0.073	0.073	0.066	0.073
Nitrate, No_3^- (mg/kg)	0.34	0.46	0.23	0.03
Nitrite, NO_2^- (mg/kg)	0.002	0.003	0.003	0.003
Phosphate, PO_4^{3-} (mg/kg)	0.03	1.1	0.14	0.18
Carbonate, CO_3^{2-} (mg/kg)	2	19	2	0
Sulphate, SO_4^{2-} (mg/kg)	0	5	1	0
Ammonium, NH_4^+ (mg/kg)	0.1	0.13	0.07	0.01
BTEX (mg/kg)	<0.001	<0.001	<0.001	<0.001
TPH (mg/kg)	<0.001	0.93	1.58	<0.001
THC (mg/kg)	<0.01	1.24	2.1	<0.01
PAH (mg/kg)	<0.001	0.004	0.006	<0.001
Oil & Grease (mg/kg)	<0.01	1.15	1.98	<0.01
Sodium, Na^+ (mg/kg)	70.86	70.9	135.1	126