TRANSMISSION COMPANY OF NIGERIA
ABUJA. NIGERIA

ENVIRONMENTAL IMPACT ASSESSMENT OF 200KM JOS – KADUNA 330KV DC TRANSMISSION LINE AND ASSOCIATED SUBSTATIONS FACILITIES PROJECT

DRAFT REPORT

SUBMITTED TO

FEDERAL MINISTRY OF ENVIRONMENT, ABUJA

2017

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LIST OF ABBREVIATIONS AND ACRONYMS

GENERAL

BDL	Below Detection Limit
BOD	Biochemical Oxygen Demand
DO	Dissolved Oxygen
DS	Dissolved Solids
EC	Electrical Conductivity
EDTA	Ethylenediaminotetra-acetic acid
HC	Hydrocarbon
HSE	Health, Safety and Environment
SS	Suspended solids
TDS	Total Dissolved Solids
TPA	Tons per Annum
TPD	Tons per Day
TSP	Total Suspended Particulate
VOC	Volatile Organic Compounds

UNITS OF MEASUREMENT

%	Percentage
µg	Microgramme
µm	micrometer
µS	micro Siemen
cfu/ml	Colony forming unit per milliliter
cm	Centimeter
dBA	Decibel
ft	Feet
g	Gramme
g/cm	Gramme per Centimeter
Ha	Hectare
Hz	Hertz
Kcal/kg	Kilo calories per kilogramme
kg	Kilogramme
Km	Kilometer
KV	Kilovolt
KWH	Kilowatt per hour
m	Meter
m/s	Meter per second
m^3	Meter Cube
meq	Milliequivalent
mg	Milligramme
mg/Kg	Milligramme per kilogramme
mg/l	Milligramme per litre
ml	Millilitre
mm	Millimetre

mmtpa	million metric tonnes per annum
NTU	Turbidity Unit
$^{o}/_{oo}$	Parts per thousand
^{o} N	Degree North
pH	Hydrogen ion concentration
ppb	parts per billion
ppm	parts per million
T^{o}C	Temperature in degrees Celsius
V	Volt

CHEMICAL ELEMENTS AND COMPOUNDS

Al	Aluminum
C	Carbon
Ca	Calcium
$CaCO_3$	Calcium Carbonate
Cl	Chloride
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Cr	Chromium
Cu	Copper
Fe	Iron
H	Hydrogen
H_2O	water
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
NH_4F	Ammonium flouride
Ni	Nickel
NO_2^-	Nitrite ion
NO_3^-	Nitrate ion
NO_X	Nitrogen Oxides
O_2	Oxygen
P	Phosphorus
Pb	Lead
PO_4^{3-}	Phosphate
SiO_3^{2-}	Silicate
SO_2	Sulphur dioxide
SO_4^{2-}	Sulphate ion

V	Vanadium
Zn	Zinc

STRUCTURES AND EQUIPMENT

AAS	Atomic Absorption Spectrophotometer
GPS	Geographical Positioning System

ORGANIZATIONS

APHA	America Public Health Association
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAO	Food and Agricultural Organization of the United Nations
FEPA	Federal Environmental Protection Agency
FMEnv	Federal Ministry of Environment
ISO	International Standard Organisation
IUCN	International Union for Conservation of Nature
NIMET	Nigeria Meteorological Agencies
TCN	Transmission Company of Nigeria
SEPA	State Environmental Protection Agency
TBA	Traditional Birth Attendants
USDA	United States Department of Agriculture
SEEMS	Scientific Energy and Environmental Management Systems
WB	World Bank
WHO	World Health Organisation

LIST OF REPORT PREPARERS

SEEMS' Project Team

Name	Task	Qualification
Prof. A.F. Oluwole	MD/Project Director	Ph.D. Physics Engineering
Prof. I.F. Adeniyi	Team Leader/ Ecology	Ph.D. Limnology
Prof S.O. Oke	Vegetation and Wildlife	Ph.D. Botany
Prof. (Engr.) I.F. Adejumobi	Electrical Power Engineering	Ph.D. Electrical Engineering (Power)
Prof. J. Oyedele Dr. O. Tijani	Soil and Land Use	Ph.D. Soil Physics Ph.D. Soil Physics
Prof P.O. Ogunjuyigbe Dr Sanni Musa	Socio-Economics & Health Impacts/Consultation	Ph.D. Social and Demography Ph.D. Social and Demography
Dr Ola Akintorinwa Mr A.D. Adebiyi	Geology & Geophysics	Ph.D. Geophysics M.Sc Geophysics
Joshua Oluwasesan	Meteorology, Air Quality, Climate and Noise Data	M.Sc. Chemical Engineering/ M.Phil. Applied Chemistry
Dr. A. I. Aduwo Mr Taiwo Adesakin	Water Quality /Wildlife & Artefacts	Ph.D. Limnology M.Sc. Zoology
Fasuyan Abiodun	Waste Management /HSE Officer	M.Sc. Applied Physics
Miss Ramat Salaudeen	Admin Officer	B.Sc. Mass Communication

Project Proponent: Transmission Company of Nigeria (TCN), Abuja

ACKNOWLEDGEMENT

Transmission Company of Nigeria (TCN) wishes to acknowledge with thanks, the opportunity granted it by the Federal Government of Nigeria, through its agencies, to conduct this Environmental Impact Assessment of the proposed 200Km Jos – Kaduna 330kv Double Circuit Transmission Line and Associated Substations Facilities Project.

This report has been prepared in line with the national and international regulatory requirements and standards. The Project Team enjoyed a cordial working relationship with the Federal Ministry of Environment, Kaduna and Plateau State Government, four (4) affected Local Governments and the Elders, Chiefs and Youths of the host communities.

The active participation of the TCN, HSE Department Team in the EIA studies right from the inception, supervision and review of the preliminary documents is hereby acknowledged.

EXECUTIVE SUMMARY

CHAPTER ONE: INTRODUCTION

Background

The Transmission Company of Nigeria (TCN) in line with its mandate of transmitting and distributing electric power through the Nigerian national grid has proposed the 200km Jos – Kaduna 300KV DC Transmission line and associated substation facilities project. The project development involving facilities and activities with potential and associated impacts on the environment require an environmental impact assessment (EIA) study in line with the EIA Decree No 6 of 1992 of the Federal Ministry of Environment (FMEnv). The main purpose of the study is to establish the environmental (biophysical and socio-economic status) sensitivities and impacts of the project and propose necessary mitigation measures in order to execute the project with minimum harm to the environment. The scope of work for the EIA include public consultation on the project, project and process description, development of application legal and administrative frame and description of the existing condition in the project area, among others. The main methods project adopted to obtain the required information for the study include consultation and reconnaissance, literature review / desktop studies and main field survey.

Legal and Administrative Framework

Power transmission and distribution fall within the public utility sector of the Nigerian economy and their activities and operations are guided and or regulated by a wide range of national legislation, international treaties and conventions to which Nigeria is a signatory. Some of listed and/or discussed are as follows.

National Legislations

- FMEnv Guidelines for undertaking EIAs
- FMEnv Sectorial Guidelines for EIA
- National Effluent Limitation Regulation, 1991
- National Environmental Protection (Pollution and Abatement in Industries and facilities Producing Waste) Regulation, 2009
- Harmful Waste Act Cap. HILFN 2004
- The Labour Act (1990)
- The Factories Act (1990)
- Electric Power Sector Reform (EPIR) Act 2005

State Legislations

- Kaduna State Environmental Protection Agency Edit No 1 1998.
- Plateau Environmental Protection and Sanitation Agency (PEPSA) Act 2000

Other Relevant Guidelines and Standards

- World Bank Environmental and Social Safeguard policies
- Health, safety and Environmental Policy Statement of TCN

Structure of the Report

The format of this report is essentially in line with the recommended format and guidelines by the Federal Ministry of Environment (FMEnv). The report is organised into none chapter as follows:

- Chapter One: Introduction
- Chapter Two: Project Justification
- Chapter three: Project and process description
- Chapter Four: Description of the Existing Environment
- Chapter Five: Project Potential and Associated Environmental Impact
- Chapter Six: Impact Mitigation Measures
- Chapter Seven: Environmental and Social Management Plan (ESMP)
- Chapter Eight: Project Decommissioning
- Chapter Nine: Conclusion

CHAPTER TWO: PROJECT JUSTIFICATION

The Need and Benefits of the Project

The proposed 200km Jos – Kaduna 330kV DC Transmission line has been designed to supply electricity to the other parts of the country. There is no existing transmission line of a similar configuration suitable to perform the function of power evacuation and distribution as proposed and envisaged, hence the need for the present proposed project.

The objectives of the proposed 200km Jos – Kaduna 330kV D/C Transmission line and associated Substation Facilities are to:

- Enable the evacuation of power from 330kv Substation at Jos
- Provide a more efficient route for the transmission/distribution of power to consumers

Project Alternatives

The following project alternatives were considered having regard to the objectives of the project, pertinent environmental and economic factors and community concerns:

(i) Do nothing
(ii) Different Transmission Capacity
(iii) Alternative Technologies
(iv) Alternative Starting/Ending Points

Project Sustainability

The proposed project is expected to be technically and environmentally sustainable because of the following:

- Proven transmission line construction technology and expertise available within the country
- Strict adherence to internationally accepted engineering design and construction standards as well as codes of practice at all stages of the project

- Periodic inspection of facilities in accordance with the operational procedures developed through TCN's extensive experience;
- Management of the project by fully trained and qualified personnel who are conversant with the TCN's policy guidelines

In accordance with the sustainability principle of 'engaging and working with stakeholders' during projects, project-affected groups and local non-governmental organizations (NGOs) will be consulted about the project's environmental and social aspects and taking their views into account as necessary. Effective community relations and condusive environment will be maintained in the project area during construction and throughout the life span of the project

CHAPTER THREE: PROJECT AND PROCESS DESCRIPTION

Project Overview

The Federal Government of Nigeria through the Transmission Company of Nigeria (TCN), a subsidiary of the former Power Holding Company of Nigeria (PHCN) embarks on the construction of a 200km Jos – Kaduna 330kV Double Circuit (DC) Transmission Line and Associated Substation Facilities Project. This is in line with the decision of the government to increase the capacity of power transmission network and to strengthen the national grid system. The project will provide evacuation link for addition generating power and improve the voltage profile on Jos to Kaduna transmission line, thereby increase system reliability, stability and operational efficiency of the national grid network. The project shall originate from Kaduna (Regional Centre) Transmission Substation, traversing communities such as Rigachikun, Chukka farm, Kangimi, Panturawa, Barwa, Yaidi-Kauru, Pole-Wire and Danjaba in Kaduna State; Katako and Gurum in Plateau State. The line at both ends will terminate at the proposed 330kV line bays (to be located at the existing Transmission Substations) at Mando-Kaduna Regional Centre 330kV Substation and Jos 330/123kV substation.

The proposed project involves but not limited to the following major work:

- Clearing the Transmission Line Right of Way (TLROW) of all vegetation
- Construction of tower foundation, erection of towers and stringing of the line
- Extension of 2 x 330KV line bays at Jos and Kaduna
- Provision of communications, protection and metering facilities at the two substations.
- Development of land access (from nearby roads) to TLROW to facilitate construction and maintenance work.

Construction

- Installation of Conductor and Accessories
- Installation of Overhead Ground Wire and Accessories, Optical Fibre Ground Wire and their Accessories including joint boxes (OPGW) and Optical Fiber Armoured Cable (OFAC) and Termination Boxes, etc.
- Design, Fabrication, Proto Type Testing, Assembly of Tower. Body Extensions and Leg Extensions at Works,

- Installation of Transmission Line Tower Foundations
- Erection of Transmission Line Towers
- Installation of Conductors
- Erection of Tower Signs and Accessories
- Installation of Insulator Strings
- Installation of Transmission line Tower Grounding
- Laying of OFAC from terminal gantry of S/S to Communication room/S/S control room and making connections with OPGW at terminal gantry and in the termination box in the Comm. Room/S/S control room as specified by the Engineer.
- Final Inspection, Reinstatement and Cleanup of Site

Operation and Maintenance

- Maintenance of the transmission line ROW, clearing dangerous vegetation etc.
- Routine surveillance and checking of transmission line sag and integrity.

Decommissioning, Rehabilitation and Restoration

The following steps will be taken towards the decommission process:

- Dismantling of the towers, tower foundations and conductors
- Removal of all material from transmission line
- Restoration of land to its original situation as much as possible
- Handover of the reclaimed land to the original community and landowners.

CHAPTER FOUR: DESCRIPTION OF THE EXISTING ENVIRONMENT

Climate and Meteorology

Information on the climate and meteorology of the project area is based largely on data on the weather conditions in Jos and Kaduna, the two major towns in the area with long-term meteorological stations. The information was supplemented with recent data on the two towns obtained from the Nigerian Meteorological Department (NIMET) as well as data obtained by direct measurements during the EIA study fieldwork.

The climate of Jos is the moist Monsoon climate type which is characterised by cool nights with average daily minimum temperature of all months of the annual cycle below 20^0C (68^0F). The climate of Kaduna is classified as Hot Equatorial Tropical with moist dry monsoon characterised by five months of humid months. Temperature is generally higher in Kaduna than in Jos with extreme monthly minimum in the range of 14.4 – 22^0C and 10.0 – 18.9^0C and monthly maximum range of 27.7 – 36.6^0C and 24.4-31.2^0C respectively. In both stations minimum temperature attains a peak in April while maximum temperature attains peak in March. The comparison of long-term temperature data with recent time values suggest increase in recent time thus confirming the effect of global warming in the area.

The wind patterns in Jos and Kaduna area are determined largely by occurrence and interaction of the two major air masses in Nigeria, *viz:* the moist maritime winds from the south and the dry

cool continental winds from the Sahara desert. In Kaduna the frequency of prevailing winds is SW>W>S>E>NE in the rainy season and E>NE>S>W>N in the dry season. On other hand in Jos it is E>W>SE>NE in the dry season as opposed to W>E>NE>SE in the rainy season. The dominant wind speed types in Jos is light breeze (56.5%), fresh breeze (30.4%) and strong breeze (13.1%) as opposed to Kaduna with light air (37.5%) and light breeze (62.5%) respectively.

The range and mean values of relative humidity (RH) in Jos (range = 0.0 – 92%, mean±s.d. = 62.2±25.7%) were generally higher than in Kaduna (range = 19.0 – 84.0%). Generally, the onset of the rainy season is about one week earlier in Jos than in Kaduna while the cessation is also about one week later in Jos than in Kaduna. On the average the rainy season (April - October) covers 185 days in Jos as opposed to 173 days in Kaduna. Longterm annual rainfall in the two towns are in the range of 899.6 – 1654.3 mm in Kaduna and 948.6 – 1729.4 mm in Jos. The pattern of monthly variation in evapotranspiration in the two towns are the same, being characterised with a peak in February and a minimum in August. Humidity Index (HI) is directly correlated with rainfall but inversely related to potential evapotranspiration (PET). The annual pattern in both towns is characterised by a pre-humid period in January to April, a humid period in May to September and a post humid period in October to December.

Air Quality

Ambient air environment was sampled and analysed for a number of air pollutants (CO, NO_2, SO_2, H_2S and NMHC) and particulates at 12 selected sampling locations along the transmission ROW using portable air and particulate analysers. Measurements were carried out over one hour averaging period at each of the sampling locations.

The concentration of NO_2, H_2S and NMHC were generally below detection limits in all the investigated sites (<0.01ppm). Carbon monoxide (CO) was detected in only 4 of the 12 sites and generally in the range of 1 – 2ppm while SO_x was detected in 8 of the 12 sites over the range of 0.01 – 0.05ppm (median / mode = 0.01ppm). Total suspended particulate (TSP) occurred over a rather wide range of 42.0 – 154.0µg.m^3 during the field study and 221 – 322µg.m^3 during the dry season of an earlier study. However all the recorded values of TSP (42.0 – 323µg.m^{-3}) occurred below the FMEnv maximum allowable level of 600µg.m^{-3} and the previously recorded values.

Noise Level Measurements

Noise measurements were carried out in the project area during the fieldwork using a CEL-24X sound level meter for one hour averaging period at each sampling site as in air quality study. The equipment was calibrated before and after usage and measurements taken at a height of about 1.2 m above the general ground level. The recorded sound levels varied from 37.1 – 66.60 dBA over the period of study. The main sources of noise in the area are human conversation and vehicular movements. The average noise level recorded was below the maximum allowable value of FMEnv (85.0dBA) and within the range values recorded in the previous study (50.8 – 67.0 dBA).

Geological and Geophysical Investigations

The geological / hydrogeological aspects of these investigations were based largely on literature review which was supplemented by direct observation of outcrop and superficial deposits in the study area. The geophysical investigation involved the application of the electrical Schlumberger

array of VES techniques. Altogether, eleven VES stations were occupied comprising nine along the proposed transmission line and one each at the Jos and Kaduna substations. The VES data are presented in depth sounding curves. Site description of the VES test points and their UTM (zone 32) as well at Lat. – Log. geographical co-ordinates are given. The VES interpreted results were used to generate geo-electrical sections.

The proposed Jos – Kaduna transmission line is underlain by the Jurassic young rocks at the Jos axis and undifferentiating Precambrian Basement Complex rocks at the Kaduna ends. The lithological unit along the line route varies from migmatite from Kaduna substation to Barwa, granite from Panturawa through Jos substation, quartzite at Gurum and Grunite at Katako and Damjaba. Groundwater is contained in the fractured Basement Complex and the weathered layer columns. The infilteration of surface precipitation (rainfall) is the main source of acquifer recharge in the area while discharge is mainly through abstraction from boreholes and hand-dug wells as well as evapotranspiration. Six VES curve types *viz:* H, A, QH, KH, HKH and KHKH were detected. The geo-electrical section is of four layers comprising first layer of top soil (0.9 – 1.9m thick, resistivity 65 – 1152ohm-m), second layer of predominantly sand clay (4.4 – 24.m depth, resistivity = 49 – 7960 ohmm), a third layer of fractured basement (6.9 – 117.1m depth, resistivity = 16-227) and a fourth layer of fresh Basement (6.4 – 25.9m thick, resistivity = 1150 & ohm-m).

The subsoil resistivity within the depth range of 0-2m within which the base of transmission line towers will be buried are slightly corrosive to practical non corrosive. Hence the tower base and embedded metal structure are not likely to suffer significant corrosion threat. However, heavy electrical transformers will require to be properly earthed. The Basement bedrock constitutes the competent bedrock in the subsurface sequence delineated beneath the proposed transmission line. Depth to this competent Basement bedrock vary from 6.4 – 25.9m. To avoid the settlement of the tower foundation (platforms) the tower must be anchored on friction piles.

Soil and Land Use Studies

Soil samples were taken at about 20km intervals along the transmission line route while observation of soil formation (through pit profiling) were made at 10km intervals along the ROW. The sampling and observation sites were geo-referenced using a portable global position system (GPS) set. Representative soil samples were taken from each location at two depths, *viz:* 0-15cm (surface soil) and 15-30cm (subsurface soil) and from 50 each horizon of the pit formations. Soil samples were treated using standard methods for physico-chemical characterisation, heavy metal determination and organic contents analysis.

Except for the locations of the substation in Kaduna and Jos metropolis, the terrain along the transmission ROW is predominantly of arable farmlands with small settlements and villages. The major use of the land in the area is for agricultural purposes and this makes the soil to be susceptible to erosion especially the area with steep slope. Physically, the soils ranged in texture from sandy loam to sandy clay in the topsoil / surface soil and from sandy loam to clay loan at the subsoil. The three grain particles were in the range of 37 – 69% sand, 16 – 48% silt and 13 – 39% clay.

Soil reaction in the study area was mainly in the acidic range and may limit the production of most arable crops. Effective cation exchange capacity (ECEC) of the soils was in the range of 2-11cmol kg^{-1} (confirming that the soils are moderately fertile) with base saturation in the range of 72 – 96%. The levels of organic matter and available phosphorus being just moderately adequate implies that regular application of fertilizers are required to sustain crop productivity and yield. The levels of heavy metals (Cd, Cr, Ni, Pb and Zn) in the soils are within the ranges for either agricultural or urban soils. The populations of heterotrophic bacteria (THB) and fungi (THF) as well as hydrocarbon degraders (HDB and HDF) all show low levels or non-contamination of the soils. The major crops grown on the area are surface – feeding arable crops, notably *Zea mays* (Maize), *Manihot esculenta* (Cassava), *Vigna unguiculata* (Cowpea), *Arachis hypogeal* (groundnuts) and *Sorghum bicolour* (Sorghum). On the whole built up areas constitute about 5% of the total study area. Report with one plate and four text tables.

Terrestrial Vegetation

The study of the terrestrial vegetation of the project area covered plant species composition, density and habitat conditions. Systematic sampling was carried out regularly at 20km intervals all through the transmission line from one substation the other using the Quadrat Belt method covering a 20m x 25m ($500m^2$) plot at every sampling site. All plants within each quadrat plot were evaluated by counting and identification to species level.

In general, the vegetation of the study area falls within the Northern Guinea Savannah made up of mixtures of trees, shrubs, herbs and grasses. A total of 41 plant species belonging to 17 families / subfamilies were recorded. Trees of the family Caesalpiniaceae (e.g. *Afzelia africana, Isoberliana doka, I. dalzielli, Piliostigma thonningii*) and Ochnaceae (e.g. *Monotes kerstingii*) are particularly common in the study area. The herbaceous genera recorded are mainly of the families Fabaceae, Euphorbiaceae, Cleomaceae and Asteraceae while the commenst monocotyledonous plants are mainly grasses and sedges of the family Poaceae, Araceae and Cyperaceae. The mean density of trees and shrubs, the biomass of herbaceous layer (kg/ha) and species diversity index were all highest within the savannah woodland and lowest in grassland with crop / farmland in between. About 65% of the plant species are Phanerophytes while epiphytes and Chamaephytes were not encountered. The density of economic plants in the area is about 180/ha of which more than 50% belong to legumes of the sub families Caesalpiniaceae and Mimosaceae. Most of those plants are used as fuel, timber, dyes, vegetable as well as religious and medicinal applications. The system of farming practised in the area is mainly land rotation and bush fallowing with mixed cropping. Text with five tables and ten plates.

Water Quality

The physical and chemical water quality characteristics of surface (rivers and streams) and subsurface (hand-dug wells and boreholes) in the project area were investigated during the fieldwork. The investigated water quality parameters were selected in line with the recommended criteria of Nigerian regulatory authorities (FMev and DPR) and comprise broadly physical parameters, general chemical parameters, major anions and cations, nutrient compounds organic matter and heavy metals. Standard methods were adopted for all the specific analysis carried out.

The chemical reaction of underground water sources varied in the pH range of moderately acidic (5.78) to moderately alkaline (8.0) while those of surface water varied from slightly alkaline (7.52) to alkaline (8.90). For both surface and subsurface water sources, the salinity parameters (conductivity, TDS) all indicate that the waterbodies are freshwater, generally soft but well buffered. The cationic order of the underground water was $Ca^{2+}>K^{+}>Mg^{2+}>Na^{+}$ as opposed to Ca>Mg>K>Na in the surface water. However, the anionic order of $HCO_3>Cl>SO_4$ was common to both the surface and subsurface water sources. There was no evidence of organic pollution as the applicable parameters, (notably organic matter, nutrients compounds) and biological oxygen demands (BOD) were generally low while dissolved oxygen concentration and saturation varied from medium to super saturation. There was also no evidence of inorganic / mineral pollution of the water sources as most of the heavy metal contents were all within the allowable / permitted levels for drinking water.

Hydrobiology

Hydrobiology studies were limited to surface waterbodies only. The specific investigation carried out comprised sediment physico-chemical characteristics, plankton biota (phytoplankton and zooplankton), benthos (benthic macro-invertebrates) and water and sediment microbiology. The analyses of samples for the respective investigations were based on standard methods.
Sediment samples of surface waterbodies in the study area were mostly silty sand and sand. In chemical reaction they ranged from moderately acidic to through neutral. They were low in nutrients (N, P) and organic matter and there was no inorganic pollution as most of heavy metals were below the geochemical background levels.

The phytoplankton flora comprised a total of 33 species in four major algal divisions in the order of Charophyta>Bacillariophyta>Chlorophyta>Ochrophyta with 21, 7, 3 and 2 species respectively. The abundance of total (sedimented) samples (215,000org/m^3) was significantly higher than that of net sample (4422org/m^3). Phytoplanktons that are indicators of organic pollution were not recorded. Gross photosynthetic primary productivity comprised 57% respiration and 43% net productivity. Gross productivity was higher in surface waterbodies in the Jos area (6.66±0.54kcal/m^3/day) than in the Kaduna end area. The zooplankton fauna comprised altogether 12 species including nine species of Rotifers, two species of Copepods and one species of Dipteran insect. Net samples were richer and more diversed but lower in abundance than the total (sedimented) samples.

The benthic macro-invertebrates of the surface waterbodies belonged to two main groups namely: Arthropoda and Mollusca with six insects and five gastropod species respectively. Most of the recorded insects are indicator species of clean environment. A total of seven bacteria and sixteen fungal species isolates were recorded from the water source. The most widely occurring bacterial isolates were *Pseudomonas aeruginosa* (100%) and the coliform *Klebsiella edwardsiii (92%).* The fungal flora of the water sources comprised mostly of molds with *Rhizopus japonicas* being the most occurring isolate. In general, more bacteria and fungi were recorded from sediment samples than from water samples. The dominant fungal isolates in sediment were the genera *Aspergillus* and *Mucor* each with three species. However the most widely occurring fungal isolates were *Rhizopus japanicu* (83% occurrence) and *Clonestachys roseaf* (50%). The mean abundance of total heterotrophic bacteria (THB) and total heterotrophic fungi (THF) in

water samples were $4.2x10^4$ cfu/ml and $3.6x10^3$ cfu/ml as opposed to $4x10^{10}$ cfu/ml THB and $8.3x10^3$ cfu/ml THF in the sediment samples.

Terrestrial Wildlife

The survey and assessment of wildlife fauna was based both on direct and indirect methods. The former involved actual sighting of the animal species while the latter involved sighting of signs (e.g. footprints) left by animals and information obtained from local farmers and hunters within the study area. The wildlife fauna was dominated by members of the vertebrate classes Amphibians, Reptilia, Aves (birds) and mammals recorded mostly from farmlands open woodland and residential area. The most occurring mammals were rodents and mice while the larger mammals include mostly antelopes. The avian populations were the most dominant both in terms of species and number. The most notably ones include the weaver birds, the common garden bulbul and francolin which is the only bird of economic importance. The bronze manikin (*Lonchura cucullatus*) was the most wildspread, occurring in all the sampling locations. Species occurrence and distribution was influenced by vegetation type and availability of food e.g. the weaver birds (*Ploessus cuculatus*) were observed only in areas with plenty of grasses with seed on them. Other notable birds were the black kites (*Milvus nigrans*), Chicken hawk (*Accipter erythropus*), cattle egret (*Ardeola ibis*), while egret (*Egretta alba*) whydah, pied crow and wood peckers. The hepertological fauna (i.e. amphibians and reptiles) was dominated by snakes, lizards and frogs. Many recorded species showed seasonal distribution, i.e. limited and/or occurring mostly in one season of the annual cycle. On the whole, data is insufficient to assign conservation status to the recorded wildlife species. Following the UCN guidelines they should be given the same protection as threatened taxa until their status can be properly evaluated.

Socio-Economic and Health Status Survey

Under this survey, the likely and potential impacts of the project on the cultural, archaeological, economy resources and health were investigated. The survey was based on semi-structured questionnaires, in-depth personal interview (IDI) and focus discussion groups (FDG). The key stakeholders involved were trandiitonal rulers, community leaders, and youths. Over 30 communities in six Local Government Area (Igabi, Kauru, Sabo, Lere and Bassa) across Kaduna and Plateau States were covered by the TCN transmission line. Seven of these communities mainly in Igabi and Lere LGAs were selected for detailed study.

The inhabitant population of the surveyed communities are predominantly Hausa and Fulani while the other tribes also found (Yoruba, Gbayo, Ibo, Lemono, Amo and Kurama) make up less than 5% of the population. Four of the communities were over 10,000 people in population, *viz:* Mararaban Jos (41,262), Rigachikun (29,600), Mando (27,192) and Barakallalai (10,402).

The common marriage type is polygamous and majority of the households have an average of six children per household. Most of the inhabitants are either Muslim or Christian but predominantly Muslims. All the affected communities have primary schools while in four of them (Mando, BarakalLahu, Rigachikun and Marataban Jos) there are also secondary schools. Water supply is mainly by borehole while pipe borne water supply is available only in the four major communities. Most of the communities are connected to the national grid, and have good road network. Majority of the inhabitants have no formal education. The dominant occupation among

the population is subsistence farming but of a low annual income (about ₦30,000 per year) i.e. below the national average income. There are inadequate health facilities and based on the prevalence of common childhood condition disease burden is fairly heavy in the surveyed communities. However based on the indicators used the quality of life of the people in most of the communities can be rated as poor. A general improvement in the quality of life of the people is therefore being expected from the enhancement of the infrastructure and economic activities that will be associated with the proposed project.

CHAPTER FIVE: POTENTIAL AND ASSOCIATED IMPACTS

Assessment Method

This chapter provides information on the potential and associated environmental and social impacts of the proposed 200km Jos – Kaduna transmission line and associated facilities project by TCN. The assessment involved impact identification, classification or quantification, impact prediction and impact evaluation of the proposed project activities. Impact identification involved the use of impact indicators for the various environmental and social components considered. Impact prediction was based on a combination of the Peterson Interaction Model and the Rau Ad Hoc method. A significant impact is considered to be an impact that should be taken into account during the decision-making process. The magnitude as well as the significance or importance of total impact was determined using Leopold matrix assessment method. The criteria / rationale for assessing the likelihood of impact was based mainly on project activities and phases, baseline conditions and comparison with FMEnv guidelines and standards.

Total Impact Scores

A matrix table showing the options of impact type, magnitude, duration, risks and importance in relation to the various project activities and phases was developed. Most of the environmental components were characterised by impacts of low significance. On the other hand, soil, geology, geophysics, ecology and socio-economics were of medium significance while health status and safety were of high importance. The project activities with the highest impact ranking include construction of access road and excavation / backfilling. On the other hand, project activities with the lowest total impact rating are the containment of waste and debris and workforce demobilization. Total adverse impact on environmental components will be highest during construction phase, followed by operation and maintenance phase and lowest during decommissioning phase of the project development. Most of the positive / beneficial impacts will occur under socio-economic and health status, notably increased job opportunity and income.

Description of Identification Impacts

The various specific environmental, social and health impacts under each of the project phases, *viz:* Land preparation and construction, project operation and maintenance and decommissioning phases were identified. For each of these three phases the environmental components for which impacts were identified were air quality, noise, land use and agriculture, soil and geology / geophysics, water quality, animal and plant ecology / biodiversity (including wildlife). The social and health impact components include demography, socio-economics, lifestyles, infrastructure, and cultural properties. Impacts on each aspect was rated with regard to nature, extend, duration and overall significance.

Associated Project Risks

Some of the specific impacts and risks associated with the operational and maintenance phase include increase morbidity and mortality, increased traffic accidents, risk of electrocution, loss of property and life through bush fire, and increased emissions. Other risks include tower collapse, fuel and lubricant spills, and risk of sabotage activities. Health risks include the prevalence of malaria, diarrhoea, skin rashes, respiratory tract infection, injury (from toxic chemicals, dropped objects, welding, conductor breaks).

CHAPTER SIX: IMPACT MITIGATION MEASURES

A major goal of a typical developmental project EIA study is to assess fully the potential and associated environmental, social and health impacts of the project activities and proffer mitigation measures against all significant negative impacts and also to enhance the positive impacts in order to derive full benefits of the project and preserve the integrity of the environment. Hence a whole chapter is usually devoted to impact mitigation measures in EIA study reports as applicable to the present project. The mitigation measures proffered for the identified impacts of the 200km Jos – Kaduna TCN transmission line project took cognisance of the applicable legal and administrative framework in Nigeria (Chapter 1) and Best Available Technology (BAT) for sustainable development and the views and concerns of the project stakeholders. The mitigation measures are discussed in relation to the impacts of the activities under each project phase.

Impact Mitigation Measures during Land Preparation and Construction Phase

On the whole, impacts were highest during this phase of the project development especially on the biophysical components of the environment. On land use and agriculture, TCN shall compensate host communities for land take and affected farmland but as much as possible use existing access / ROW to avoid excess land take. In addition the productivity of farmers can be increased through training and increased awareness.

To mitigate impacts of water quality TCN shall ensure the use of equipment compactible with Best Available Technology (BAT), carry out major construction / civil works during dry season, put in place dust control measures and require all workers to wear nose and mouth masks during land preparation / construction activities.

For impact on noise level, TCN shall use only equipment which confirm with national standards and specifications, enforce workers to use noise defenders, ear muffs and acoustic barriers. For impacts on water, TCN shall ensure no contamination of the environment during refuelling, enforce proper management and minimise runoff and erosion contamination of surface and groundwater sources. To protect biodiversity, there should be no hunting of game animals or poaching and avoid excess land take.

Mitigation measures during operation and maintenance phase

For line maintenance, TCN shall ensure regular clearance, provide security and surveillance and use qualified and experienced staff for the work. In order to maintain traffic volume and reduce

accidents, TCN shall put in place visible warning signs, put speed breakers at sections traversing communities and enforce journey management policy.

To enhance the positive impacts of the project, TCN shall pursue community assistance programme to boost the socio-economic and health conditions in the area. TCN shall give preference to youths from the host communities in unskilled labour employment. For the demobilization of workforce, TCN shall provide counselling for staff in preparation for demobilisation and ensure contractors adopt transparent approach towards staff on the matter.

Mitigation measures during decommissioning and abandonment phase
TCN shall re-vegetate all bare areas, restore land to original form as much as possible and return to indigenes for other use. The potential impacts and recommended mitigation measures are detailed in a table (Table 6.2.1). Adequate mitigation measures have been provided to ensure that all high and medium ranking impacts are reduced to low ranking impacts.

CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

Need for ESMP for the Project
Environmental management is a planned, integrated programme aimed at ensuring that unforeseen and unidentified impacts of a proposed project are contained and brought to an acceptable minimum. An environmental and social management plan (ESMP) has been developed for the 200km Jos – Kaduna Transmission line project to ensure that the environmental (biophysical and social) considerations and mitigations measures of the project impacts (Chapters Four, Five and Six) are implemented and to guarantee the accommodation of the provision of the Health, Safety and Environment (HSE) plan of the proponent (TCN) in subsequent stages of the project development. In addition, it is intended to monitor the effectiveness of environmental protection strategies and audit the success of the overall project strategy.

ESMP Objectives and Scope
The overall goal of the project ESMP is to ensure that environmental and social impacts (both identified and unforeseen) of the project are kept to the barest minimum or completely mitigated. The various specific objectives are to adhere to the provision of the HSE policy of TCN, increase awareness of the importance of the project among stakeholders and encourage adherence to the principles of good housekeeping and the application of best available technologies.

The project ESMP is comprehensively developed and covers all the phases of the project from the design stage through mobilization, construction, operation and maintenance to project decommissioning. The two-pronged framework for implementing the plan is the adoption of an environmental management system (EMS) and an environmental monitoring programme. The EMS is established largely on the HSE policy of TCN and it is to assist the company to achieve excellence in sustainable environmental development. It includes organizational structure,

planning activities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining its HSE policy.

Environmental monitoring plan is the systematic schedule for collection of environment data and for this Jos – Kaduna transmission line project will comprise two main types, *viz:* effect monitoring and compliance monitoring. The former is to detect changes in environmental conditions which can be attributed to the project. On the other hand, the latter compares regulatory requirements to the existing operational occupation and environmental conditions.

Project EMS Requirements

The major roles to be undertaken by TCN in respect of the project include but not limited to the followings:

- Staffing and training
- Development of emergency contingency plan
- Facilities planning and implementation strategy
- Project operations

TCN shall ensure that every category of operational staff is adequately trained, and attend regular induction courses and/or refresher courses / programme. Emphasis should be on handling safety equipment, fire fighting and other contingencies. Contingency should be for the lifespan of the project and shall cover actual and potential incident / accidents that may occur. There should be constant equipment / facilities surveillance to detect on time, the malfunctioning or deterioration and sabotage and to take prompt action TCN shall implement all inputs by regulatory agencies into proposed project operations and also ensure that the agencies are carried along as the project advances. This is to ensure that the highest level of safety and environmental practices are brought to bear in project operations.

Environmental Monitoring Requirements

There is the need to identify relevant monitoring indicators and give priority to environmentally sensitive area. In a tabular form, the recommended mitigation, monitoring and training for each category of environmental components / resources and impact are presented. Air quality monitoring shall involve measuring the levels of particulates (TSP) and pollutant gases (SO_x, NO_x, CO, H_2S and NMHC) at least biannually and/or as specific by the regulators along the transmission line. Similarly the noise levels to which workers are exposed shall be monitored during project activities and quarterly thereafter.

The soil and sediment quality status in the project area shall be monitored on regular basis based on their physic-chemical characteristics (pH, anions, exchangeable cations, organics, heavy metal) microbiology and macro invertebrate fauna. Water and waste water effluent quality (pH, conductivity, oxygen parameters, turbidity, hydrocarbon, plankton biota and microbiology) shall be monitored at regular intervals.

The socio-economics parameters depicting social, economic, population settlement pattern, health, safety and security shall be monitored mostly during the construction. Health parameters shall continue to be monitored on workers in the different sections of the project operations. Waste management shall employ the four Rs principle i.e. reduce, replace, recycle and recover

through the process of optimization, efficient procedure and good housekeeping. Solid wastes should be sorted and disposed of in designated areas. Aqueous wastes (black and grey water, diesel, oil and condensates) shall be disposed off in accordance with national standards and guidelines. Contractors and TCN personnel shall define and document all waste generated.

Detailed information on parameter for monitoring, frequency of monitoring / inspection, frequency of formal reporting as well as the action party for monitoring are comprehensively documented (Table 7.3). Depending on the issue / environmental component involved monitoring frequencies are quite variable (weekly, monthly, quarterly, six monthly or annually). They also depend on project phase and activities involved, TCN is the principal or sole action party in most of the monitoring programmes. However in some instances, the Federal Ministry of Environment and LGAs too are involved.

Emergency Contingency Planning Requirements

Contingency plans are usually designed to handle accidents and unforeseen events / incidents which may occur from equipment failure, human error or third party sabotage inspite of all care and diligence exercised in project execution TCN has incorporated into the engineering design of the proposed project all the necessary safety measures to ensure that accidents, incidents, hazards and near misses are drastically minimised if not completely eliminated.

Management and Regulatory Responsibilities on the ESMP

For the effective implementation of the proposed ESMP, a well set up organizational structure which designates operational responsibilities to individual personnel involved in the project life cycle has been put in place. TCN has put in place responsibility commitments designated to its operational and managerial departments and staff to help achieve the desired goals.

Line management will take full responsibilities for environmental issues. An HSE committee consisting of General Manager, Assistant General Manager, Directors and Head of engineering, HSE manager, company doctor and HSE representatives for logistics has been set to co-ordinate HSE performance. The committee is charged with responsibility of managing the EMP and associated plans, conduct periodic audits and give regular and/or incidental reports to TCN management. Each member of the HSE committee has specific responsibility of reviewing and/or reporting.

Managing stakeholders' perception is an important aspect of the ESMP as public interest in the project is bound to be high as the issue of electricity supply has always been a sensitive one in Nigeria. In executing the 200km Jos – Kaduna transmission line project – TCN shall manage stakeholders' perception by employing and sustaining dialogue and involving the host communities and other stakeholders in all phases of the project. TCN shall ensure that in implementing the ESMP, development project arising from Participatory Rural Appraisal (PRA) do not conflict with the development of government authorities NGOs and AID agencies for the project area.

CHAPTER EIGHT: DECOMMISIONING PLAN

The proposed 200km Jos – Kaduna Transmission Line project has a life expectancy after which the performance of the project scales to diminishing returns or the project is no more viable and then be decommissioned. As required in the guidelines for the EIA study a decommissioning plan has been developed for the project (chapter eight). The goal of the decommissioning plan is to restore the project environment into its original or near original status at the termination of the project life expectancy.

The project decommissioning plan will include consultation with various stakeholders including the host communities, nearby facilities owners, regulatory bodies and relevant NGOs. The plan should start about five years ahead of the due time to allow for a carefully planned redeployment and where necessary, disengagement of personnel involved as appropriate. In general, the activities to be carried out during the decommissioning phase shall include dismantling of equipment and facilities (towers, conductors and wires) and their removal and disposal.

The decommissioning phase too is characterised by a number of potential impacts. These include the physical disturbance of the environment arising from removal of equipment and facilities, associated hazards and the problem of waste management. A definite strategy is developed to mitigate the associated impacts. Facilities and ancillary equipment shall be dismantled completely, the debris shall be removed from the environment. The dismantling process may result in potential for work-related injuries and fatality but may make more land available for agriculture and other land use especially if the reclaimed land is handed to the original community and/or landowners. All facility components that can be used or recycled will be identified and quantified. The cleared locations will be re-vegetated using fast growing native plant species. As required by regulations a post – decommissioning report will be prepared for submission to the regulatory authorities on demand. The report will provide information on the overview of the facilities involved, the methods used for decommissioning, record of consultative meetings, details of recyclable / reusable materials, state of the surrounding environment as well as the restoration / remediation carried out.

CHAPTER NINE: CONCLUSIONS

The Transmission Company of Nigeria (TCN) plans to construct the 200km Jos – Kaduna 330KV DC transmission line to evacuate electricity from Jos substation for supply to other parts of the country through the national grid. The project is of great value and found to be economically, commercially technically and environmentally sustainable. The EIA study of the project was conducted in accordance with the Nigerian regulatory requirements. Most of the identified potential and associated environmental and social impacts of the project were rated low in significance. On the whole, impacts were highest during the land preparation and construction phase of the project development especially in the biophysical components of the environment. Mitigation measures were proffered for the few high and medium rated negative impacts to reduce them to levels as low as reasonably possible (ALARS) while recommendations

were made to enhance the positive ones. Environmental and social management plan (ESMP) comprising a series of environmental management system (EMS) and monitoring programme has been put in place for sustaining the project. Based on these considerations and the fact that the project will result in substantial economic benefits to the local communities and the country at large (through increased electric power transmission and distribution) there is justification for the authorisation of the project development.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

The Transmission Company of Nigeria (TCN) is charged with the responsibility of transmission of electricity in Nigeria but address the increasing electricity demand by consumers in the country line, the Nigerian Government opened up the electricity market for private sector participation. In line with its mandate, the Transmission Company of Nigeria (TCN) has proposed to embark on the construction of 200km Jos – Kaduna 300KV DC Transmission line and Associated Substation Facilities Project. Among the numerous objectives of the on-going reform in the Nigeria Power sector is to produce radical expansion of the existing grid network. It is expected that in the next few years, a much larger, fortified and stable grid will replace the scanty, unstable and fragile grid that exists presently.

This study is to provide a comprehensive Environmental Impact assessment of the proposed 200km Jos – Kaduna 330kV Double Circuit Transmission Line in conformity with International environmental standards and the Environmental laws of Nigeria. While the justification for Power Transmission Line development project from socio-economic considerations cannot be overemphasized, the project in general involves activities and equipment with potential environmental consequences. In Nigeria, projects of such magnitudes require Environmental Impact Assessment as stipulated by Environmental Impact Assessment (EIA) Decree No. 86 of 1992 of the Federal Ministry of Environment (formerly Federal Environmental Protection Agency (FEPA)). Similarly the multilateral aid agencies, African Development (AFDB) Bank and the World Bank require EIA as part of their conditions for project funding. In view of this, SEEMS Limited has been commissioned by TCN to carry out the Environmental Impact Assessment (EIA) study of the proposed project.

The project is the construction of 200km Jos – Kaduna 330KV Double Circuit Transmission line and Associated Substation Facilities. The Project involves but not limited to the following major work:

- Clearing the Transmission Line Right of Way (TLROW) of all vegetation
- Construction of tower foundation, erection of towers and stringing of the line
- Extension of 2 x 330KV line bays at Jos and Kaduna
- Provision of communications, protection and metering facilities at the two substations.
- Development of land access (from nearby roads) to TLROW to facilitate construction and maintenance work.

1.2 THE PROJECT LOCATION

The 200km Jos- Kaduna Transmission line and substations project area, shown in Figure 1.1, lies in the geographical region that can be approximately defined by the following coordinates (UTM, Zone 32N): E326286 – E483331 and N171052 – N1103902. It stretches over a distance of approximately 200km, traversing two States in Nigeria – Kaduna and Plateau States (see Figure 1.1) and four (4) Local Government Areas.

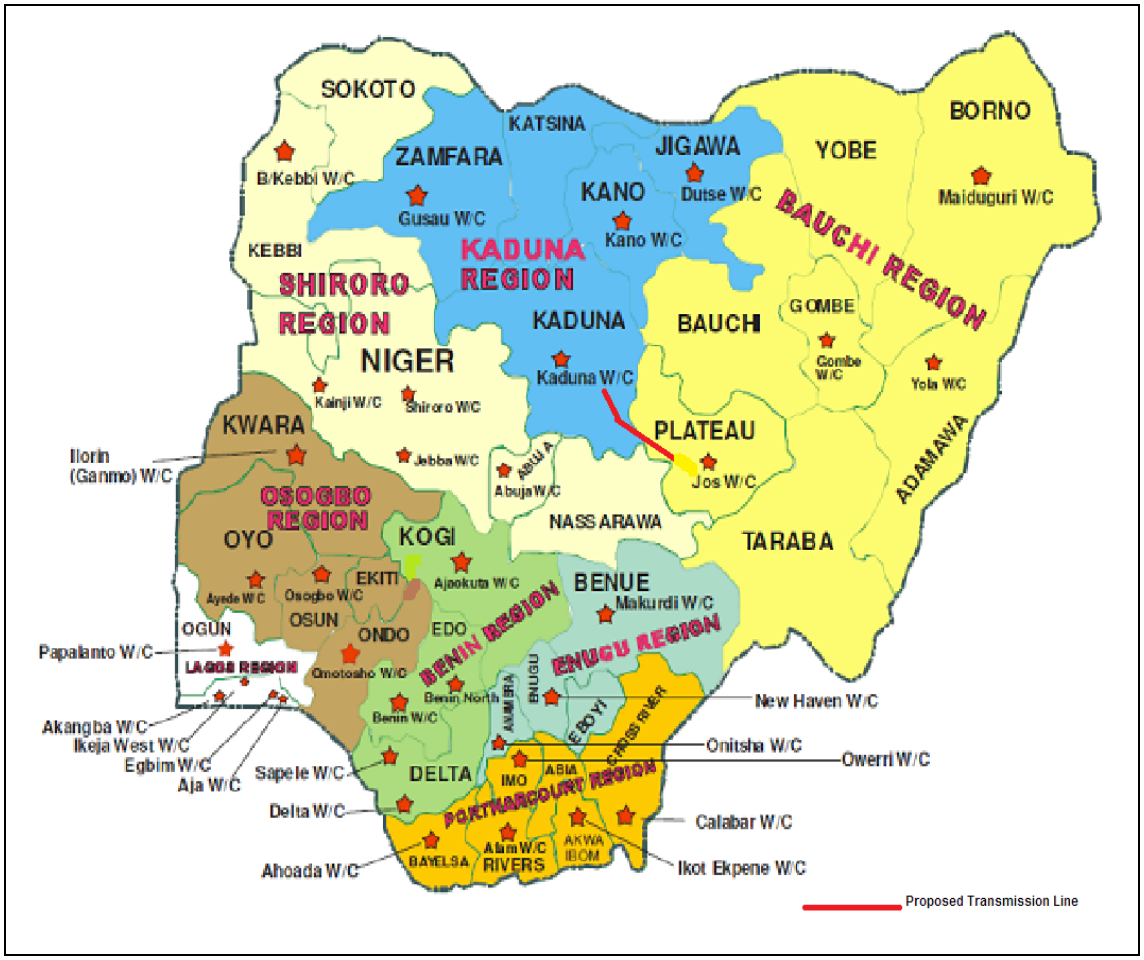

Figure 1.1: Map of Nigeria showing 200km Jos-Kaduna Transmission line (with Red line) and traversed two states

1.3 OBJECTIVES OF THE EIA

This EIA study has been carried out with the principal objective of getting the required permit from the Federal Ministry of Environment FMEnv to execute the proposed transmission line project in compliance with applicable national and international regulations. The main purpose of the study is to establish the environmental sensitives and impacts of the project and propose necessary mitigation measures in order to execute the project with minimum harm to the environment. The main specific aspects are as follows:

- Establishment of the existing biophysical, ecological and socio-economic conditions of the project area;
- Establishment of the environmental and socio-economic sensitivities of the area to the new project;
- Identification, evaluation and prediction of the impacts of the project on the environment including socio-economic and health aspects with adequate interfacing and project interaction;
- Development of control strategies with a view to mitigating and ameliorating significant impacts which the project would have on the totality of measurable environmental characteristics;
- Development of an Environmental Management Plan (EMP) that will ensure environmental sustainability throughout the project life span

1.4 SCOPE OF WORK

The scope of work for the EIA includes but not limited to the following:

- Project and Process Description, and Project Justification
- National Statutory Environmental (Legal and Administrative) Framework
- Description of the Environment including Baseline data for wet and dry seasons
- Identification/prediction of Associated and Potential Environmental and Social Impacts of project activities
- Proffer Mitigation/Enhancement Measures for impacts
- Recommend project specific Environmental Management Plan (EMP) – compliance, monitoring and auditing schedules.
- Public Consultation and Enlightenment Programme.
- Recommend Remediation Plan for Decommissioning/Abandonment.
- Project Recommendation.

1.5 OVERALL STUDY PLAN AND EIA METHODOLOGY

In developing a study plan for this EIA, especially in selecting the investigated environmental components and the impact indicators to be investigated, due reference was made to the sectorial guidelines on public utilities into which the project can be classified following the scheme of FEPA (FEPA, 1991). The main methods adopted to obtain the required necessary information for the study comprised mainly the following:

(i) Consultation and reconnaissance

(ii) Literature Review and Desktop Studies

(iii) Field survey

1.5.1 Consultation and Kick-off Meeting

Consultation on the project began, shortly after the project contract was reviewed and awarded, between representative of SEEMS and Transmission Company of Nigeria (TCN) Team. The reconnaissance meeting was held at TCN office in Conference room on October 12, 2016. The meeting commenced at 10:00am and the following participants were present;

1. Mrs Z.K.Aliyu (CR& E, TCN)
2. Engr. K.Z. Baduk (Engineering, TCN)
3. Mr Yusuf Danjuma (CR& E, TCN)
4. Mr Joshua Oluwasesan (SEEMS)

The reconnaissance made it possible for the team of consultants involved to draw up a definite work plan for the field survey. It also afforded the consultants the opportunity to obtain information on contact person along the proposed Transmission Line and logistics' planning. The consultation was carried out from October 17 through to 28, 2016 all over the project area.

1.5.2 Literature Review and Desktop Studies

Information on aspects of the general features of the project area e.g. climate, geology, hydrology and drainage is based mainly on literature sources, personal communication or/and desktop sources as applicable. The major sources of information for these aspects were journals, textbooks, technical reports, maps, previous EIAs and Audit reports that were made available by the proponent. All cited references and bibliography are duly acknowledged and listed in this report (see references).

1.5.3 Field Survey

Prior to the commencement of the actual fieldwork on October 17, 2016 the entire members of the study team were involved in the tool box meeting and safety brief. Details of the field survey are given under the respective specific studies in chapter four (Description of the existing environment).

1.6 LEGAL AND ADMINISTRATIVE FRAMEWORK

For sustainable development, the activities and operations of the Nigerian industrial sector is guided and regulated by a wide range of legal and administrative framework. These include local, state and national legislations as well as international treaties and conventions to which the country is a signatory. The power project is affected by the following legislations.

1.6.1 National Legislations

(i) Environmental Impact Assessment Act No. 86 of 10 December 1992

This Act provides the guideline for activities or development projects for which EIA is mandatory in Nigeria. Such developments include oil and gas fields, conversion of mangrove swamps covering area of 50 hectares or more for industrial use, land/coastal reclamation projects involving an area of 50 hectares or more. The EIA Act No 86 sets out the procedure for prior consideration of environmental issues in certain categories of public and private development projects.

FMEnv Guidelines for Undertaking EIAs

The National EIA procedure flowchat as developed by FMEnv for all industries is illustrated in Figure 1.6.1.It consists of the following steps:

Registration of Project Proposal

Project proposal must be submitted to FMEnv for project registration. This must be accompanied with a Draft Cheque for N500, 000 for registration which includes an application fee of N50, 000. Thereafter, FMEnv shall issue a Registration number, acknowledge receipt and put in place necessary documentation

Screening

FMEnv will categorise project using criteria such as magnitude, scope, duration, risks, impact significance and magnitude mitigation measures proposed. FMEnv may undertake a site visit. FMEnv will provide advice (screening report) within 10 working days of proposal receipt.

Scoping

Proponent will ensure that all significant impacts and reasonable alternatives are addressed in the Terms of Reference indicating the scope of the EIA are to be submitted FMEnv may demand a Preliminary Assessment Report to assist in vetting scope and Terms of Reference of the proposed study.

Draft EIA Report

Fifteen (15) copies of Draft EIA report are to be submitted to FMEnv. It is important to note that the report is required to contain proceedings of consultation with adjoining settlements and other stakeholders held in a Public Forum or fora. Participation should be a continuous programme for the environmental and economic sustainability of the project.

Draft EIA Review

This can be done by FMEnv in-house, by a panel or by the Public. Public review will include display for 21 days of document at the Local Government Area, State EPA and FMENV Headquarters. This may also include Site Visits. Agency will inform proponent of method so chosen within 15 days of the date of acknowledgement.

Final EIA

Final EIA report shall be submitted to the Ministry within 6 months of the receipt of Ministry Comments. This will include all amendments suggested by the FMEnv. fifteen 15 copies of Draft EIA report are to be submitted to FMEnv.

Certification

Upon receipt of final EIA report, FMEnv will issue a Certificate to the proponent FMEnv shall publish its decisions to inform the public. After which proponent can start implementation of the project.

Monitoring

FMEnv will ensure that Impact Mitigation Monitoring (during construction) and compliance monitoring and Environmental Audit (during operation) are conducted in due course by the project proponent.

(ii) Federal Environmental Protection Agency Act No 58 of 30 December 1988 (as amended by Act 59 of 1992 and further amended by Act 14 of 1999)

The Federal Environmental Protection Agency (FEPA), now Federal Ministry of Environment (FMEnv), was established by Act No. 58 of 1988 (amended by the FEPA Act 59 of 1992). The Agency has responsibility for the protection and development of the environment in general and environmental technology, including initiation of policies in relation to environmental research and technology.

(iii) Federal Ministry of Environment Sectoral Guidelines for EIA

The FEPA Act, cap 131, LFN, 1990 allocates powers of environment legislation making and enforcement to the Federal Environmental Protection Agency (FEPA). In-line with its functions, FEPA has published the EIA Sectoral Guidelines (revised in September 1995). The guidelines cover major development projects and are intended to inform and assist proponents in conducting EIA studies.

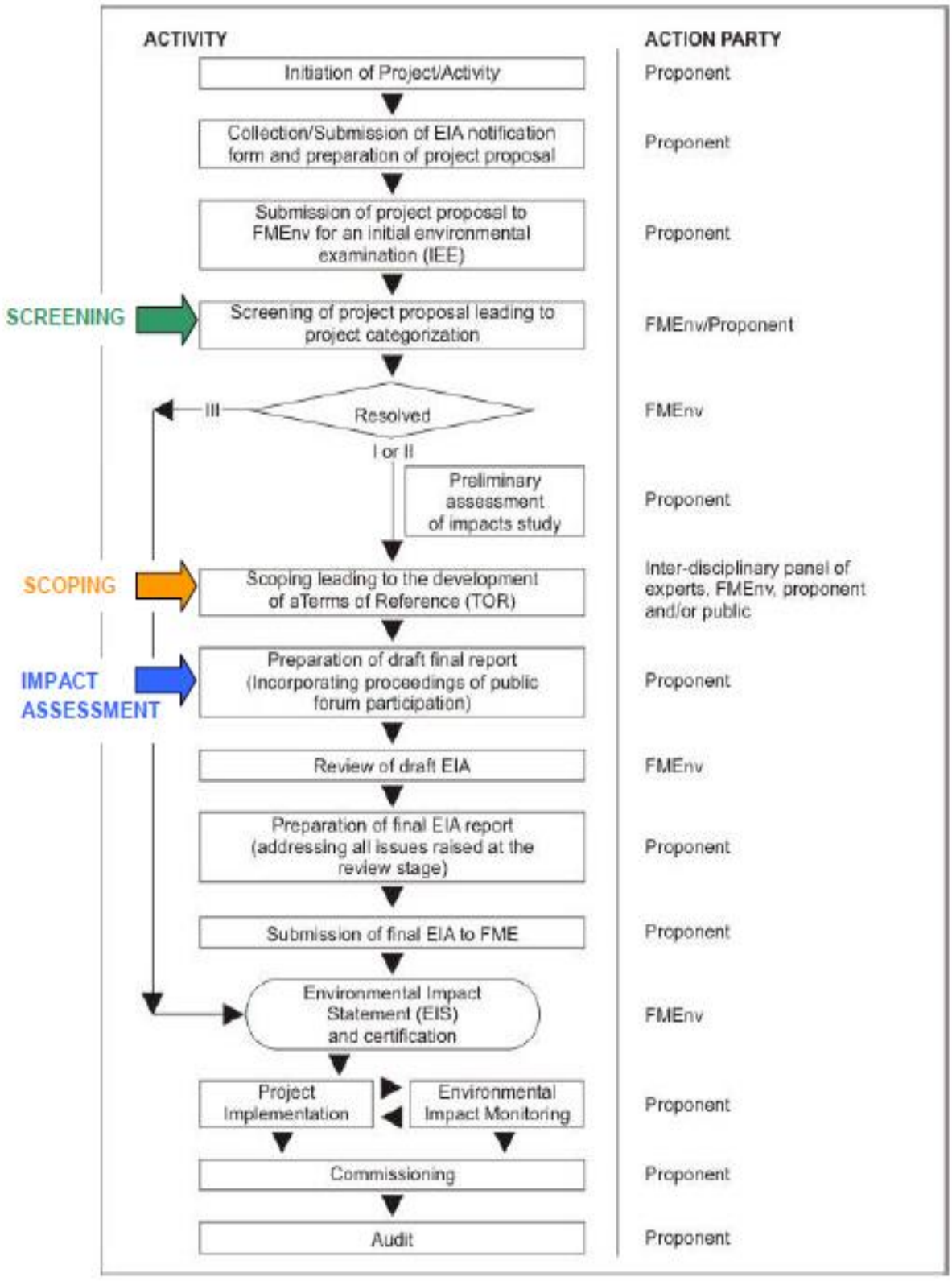

Figure 1.6.1: Environmental Impact Assessment Process Chart by FMEnv

(iv) National Effluent Limitation Regulations 1991

This Act was issued in 1991. It provides national Guidelines and Standards for industrial effluents, gaseous emissions, noise, air quality and hazardous wastes management for Nigeria.The Act also provides regulations on strategies for waste reduction, permissible limits of discharge into public drains, protection of workers and safety requirements, environmental audit (or environmental impact assessment for new industries) requirements and penalties for contravention.

(v) National Environmental Protection (Pollution and Abatement in Industries and Facilities Producing Waste) Regulations, 2009

This regulation provides general guidelines for the containment of pollution in industries that generate harmful wastes. These include: Regulations S.I.28 – 36 of 2009, and S.I.11 – 23 of 2011 as follows.

- **National Environmental Protection (Effluent Limitation) Regulations S.I.8**
  No company shall discharge effluent onto land, into a watercourse or into a water body unless the company ensures that the parameters of the effluent do not exceed the permissible limits (appendix 4)

- **National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations – S.I.9.**
  Every company shall evaluate its installations and ensure that routine controls are sufficient to prevent risks of noise pollution. Noise abatement measures must be in place to achieve a maximum increase in background levels of 3 decibels A (Appendix 4)

- **National Environmental Protection (Management of Solid and Hazardous Wastes) Regulation S.I.15**

  Industries are obliged to notify the FMEnv of all toxic hazardous and radioactive wastes which are stored on site or which are generated as part of operations (Regulations 1991, Article 2).

  With regard to waste management, a legal basis exists in Nigeria for the establishment and implementation of a "cradle-to-grave" tracking system. Specifically, the Solid and Hazardous Wastes Management Regulations 1991 provide for the establishment of a documentation scheme to cover the generation, transport, treatment and disposal of hazardous wastes.

  Every company shall ensure environmentally sound management of solid and hazardous wastes and dispose by approved agency to their designated disposal site.

1.6.2 Statutory Limits/Standards

The guidelines and standards for Environmental Pollution Control in Nigeria (1991) of the Federal Ministry of Environment provides interim permissible effluent limits as protective measures against the indiscriminate discharge of particulate matter and untreated industrial

effluent into lakes, rivers, estuaries, lagoons and coastal waters. These statutory limits shall also form the basis for future environmental monitoring of the project.

Harmful Waste Act Cap. H 1 LFN 2004

Harmful Wastes (Special Criminal Provisions etc.).

The Guidelines and Standards on waste disposal provide the *modus operandi* for the most viable options for the disposal of harmful wastes in a tropical environment as Nigeria. The Act defines the requirements for groundwater protection, surface water impoundment, land treatment, waste piles, landfills, and incinerators. It also describes the hazardous substances tracking programme with a comprehensive list of acutely hazardous chemical products and dangerous waste constituents. In addition, the Act also contains the requirements and procedures for inspection, enforcement and penalties.

Forestry Law CAP 51, 1994

A forestry Act 1958 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.

The Labour Act, (1990)

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

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

The Factories Act, 1990

The Factories Act 1990 (FA) is the primary law regulating the health, safety and welfare of workers in the country's factories. The law holds management and staff personally responsible for violations of the provisions in the Act.

With respect to safety, there are general provisions as to the securing, fixing, usage, maintenance and storage of prime movers, transmission machinery, other machinery, unfenced machinery, dangerous liquids, automated machines, hoists and lifts, chains, ropes and lifting tackle, cranes and other lifting machines, steam boilers, steam receivers and containers, and air receivers. There are, in addition to these, standards set for the training and supervision of inexperienced workers, safe access to any work place, first aid boxes, prevention of fire, and safety arrangements in case of fire.

The law requires that all accidents and industrial diseases be notified to the nearest inspector of factories and be investigated. The Act also prohibits the owner or occupier of a factory from making any deductions from the wages of any employee in respect of anything to be done or provided in pursuance of the Factory Act.

Land Use Act No6 (1978)

The Land Use Act of 1978 (LUA), the Constitution of 1999 and the Public Lands Acquisition Laws of the relevant states constitute the governing policy for land acquisition in Nigeria. As is the case with most national and state laws on compulsory acquisition of land in the public interest or for a public purpose, the legislation enables the State to acquire land (more precisely, to abrogate leases and other authorizations to occupy land). The Acts also specify the procedures the State must follow to clear the land, and define the compensatory measures the State must implement in order to compensate the people affected.

Under the LUA, there are two types of land rights (US AID, 2010) as follows:

Statutory occupancy rights: Individuals and entities can obtain a statutory right for occupancy of urban and non-urban land. Recipients of certificates of occupancy are obligated to pay the state for any unexhausted improvements (ie improvements with continuing value such as a building or irrigation system) on the land at the time the recipient takes possession and must pay rent fixed by the state. Rights are transferrable with the authorization of the state governor.

Customary right of occupancy: Local governments may grant customary rights of occupancy to land in any non-urban area to any person or organization for agricultural, residential, and other purposes, including grazing and other customary purposes ancillary to agricultural use. The term for customary rights (which is contained in the application form and not the legislation) is 50 years, and may be renewed for a second 50-year term. Recipients of customary rights of occupancy must pay annual tax on the land and cannot transfer any portion of the rights without approval of the governor (for sales of rights) or the local government (other transfers).

The LUA vests all land in the urban areas of each state under the control and management of the governor of the state. The governor of the state holds the land in trust for the people of the state and is solely responsible for the allocation of land in all urban areas to individuals who reside in the state and to organizations for residential, agricultural and commercial purposes. All other land in the state subject to conditions under the LUA is under the control and management of the local government. The act divests traditional owners of land and vests such land in the state governor for the benefit and use of all Nigerians. It provides the processes through which land may be acquired by the federal government.

On rural land where there are no formal title deeds and any land rights are customarily held, compensation for land acquisition is only provided for buildings, crops and other 'improvements' to the land as well as rent for the year the land was occupied. Payment is not paid for land itself since customary ownership is not recognised by government.

For community-owned land where ownership is not claimed by any one individual or family, the governor will determine who receives the compensation. This might be the community or the chief or a community leader who can make use of the money according to customary law. Alternatively, money can be paid into a community fund. The governor has the power to cancel the right that any person has to live on or make use of any piece of land, if the land is required for use in the interest of the public. This includes mining and oil pipelines. Rights to land cease with immediate effect upon receipt of notice from the governor.

National Forestry Action Plan 1997

The NFAP has succeeded in reviving the Forestry Sector and has provided individual and group training to both the formal and informal Forestry sector. Each state also has in place Forest Action Plan, which serves as guide for their Forestry development initiative. Full accomplishment of the NFAP objectives has been hampered by political instability in the country and ineffective political support.

National Energy Policy

The National Energy Policy establishes guidelines for the protection of the environment in the exploitation of Nigeria's fossil fuels. It also emphasizes the exploration of renewable and alternative energy sources, primarily solar, wind and biomass

Electric Power Sector Reform (EPSR) Act 2005

There had been different National regulatory acts or laws for the Power sector by successive governments in the country, e.g the Electricity Act Cap 106, the National Electric Power Authority (NEPA) Act, NEPA Amendment Decree No 29 of 1998, etc. These have now been replaced by the Electric Sector Reform (EPSR) Act 2005.

The basis of this Act is to enable persons other than the Authority, a state government or any of its agencies to be granted a licence. It also gives such a person the same rights and obligations as the Authority, a State Government or any of its agencies.

The Reform introduced the following new sub-sections:

S62 " (1)No person, except in accordance with a licence issued pursuant to this Act or denied to have been issued under section 98(2), shall construct, own or operate an undertaking other than an undertaking specified in subsection (2) of this section, or in any way engage in the business of : (a)electricity generation, excluding captive generation; (b) electricity transmission; (c) system operation; (d) electricity distribution; or trading in electricity

(2) Notwithstanding subsection (1) of this section, a person may construct, own or operate an undertaking for generating electricity not exceeding 1megawatt (MW) in aggregate at a site or an undertaking for distribution for electricity with a capacity not exceeding 100 kilowatts (KW) in aggregate at a site, or such other capacity as the Commission may determine from time to time, without a licence

Njgerian Electricity Regulatory Commission (Acquisition of Land and Access Rights for Electricity Projects) Regulations, 2012 (S.I.69)

The objectives of these Regulations are to provide a legal and regulatory framework for

(a) the acquisition of land and access rights for electricity projects in Nigeria;

(b) making provisions for the payment of compensation and resettlement of persons affected by the acquisition of their land for the establishment of electricity projects ; and

(c) the monitoring and evaluation of project designs of licensees to ensure compliance with environmental standards.

1.6.3 State Edicts and LGA Bye-Laws

The EIA Act No 86 of 1992 is the substantive law that regulates the siting of projects that impinge on environmental elements in Nigeria, and the State in which each project is located

has a major role to play in the overall process as a matter of law. The Nigerian Constitution allows States to make legislations, laws and edicts on the Environment and to establish State Environmental Protection Agencies (SEPA) which may participate in regulating the consequences of project development on the environment in their areas of jurisdiction. State Environmental Protection Agencies thus have the responsibility for environmental protection at the state level within their states. The functions of the SEPAs include:

- Routine liaison and ensuring effective harmonisation with the FMEnv in order to achieve the objectives of the National Policy on the Environment;
- Co-operate with FMEnv and other relevant National Directorates/Agencies in the promotion of environmental education;
- Be responsible for monitoring compliance with waste management standards;
- Monitor the implementation of the EIA and the Environmental Audit Report (EAR) guidelines and procedures on all developments policies and projects within the State.

Kaduna State Environmental Protection Agency, Edict No 1, 1998

The objectives are to achieve a sustainable development in the state and shall include the following:

a. Secure the quality of environment adequate for the health and well-being of the residents of the state.
b. Conserve and use the environment and its natural resources for the benefit of the state.
c. Minimize the impact of the physical development on the ecosystems of the state.
d. Raise public awareness and promote understanding of essential linkages between the environment and development within the state; and
e. Co-operate with the federal environmental protection agency and other States Environmental Protection Agencies to achieve effective prevention of abatement of trans-boundary movement of waste.

Plateau Environmental Protection and Sanitation Agency (PEPSA), Act 2000

The objectives are to;

- ❖ monitor house to house sanitation, inspection of premises (Residential, Commercial and industrial), street de-congestion, control of street trading/hawking, disposal of stray deaths (Human/animal) and control of stray animals.
- ❖ implement/enforce environmental regulations
- ❖ manage waste and pest control
- ❖ control illegal motor parks and street begging

1.6.4 International Standards, Treaties and Conventions

Global and Regional Treaties and Conventions are, in principle, binding in first instance on National Governments that accede to them. They are obliged to implement such arrangements through national legislation. At the international level, Nigeria is party to a number of Conventions that are relevant to the proposed development project. UNEP (1991) provides an overview of applicable, international Treaties and conventions. The more relevant ones are reviewed briefly below:

(i) *Vienna Convention for the Protection of the Ozone Layer, including the Montreal Protocol and the London Amendment*

The objectives of this Convention are to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the Ozone Layer and to adopt agreed measures to control human activities found to have adverse effects on the Ozone Layer.

(ii) *Convention on the Conservation of Migratory Species of Wild Animals or Bonn Convention*

The Bonn Convention's adopted in 1979 aims at the conservation and management of migratory species (including waterfowl and other wetland species) and promotion of measures for their conservation, including habitat conservation.

(iii) *UN Framework Convention on Climate Change 1992*

To achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

(iv) *Convention on Biological Diversity*

The objectives of this Convention, which was opened for signature at the 1992 Rio Earth Summit, are 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, including by appropriate access to genetic resources by appropriate transfer of relevant technologies.

(v) *Convention concerning the Protection of the World Cultural and Natural Heritage or World Heritage Convention*

This Convention defines cultural and natural heritage. The latter is defined as areas with outstanding universal value from the aesthetic and conservation points of view.

1.6.5 Other Relevant Guidelines and Standards

World Bank's Environmental and Social Safeguard Policies

The World Bank's environmental and social safeguard policies are a cornerstone of its support for programmes aimed at sustainable poverty reduction. The objective of these policies is to prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for lenders (including banks) and borrower staff in the identification, preparation, and implementation of programmes and projects. Safeguard policies have often provided a platform for the participation of stakeholders in the project design, and have been an important instrument for building a sense of project "ownership" among local populations. There are a total of ten environmental, social and legal Safeguard Policies of the World Bank, of which the most relevant are highlighted below:

- World Bank OP 4.01 for Environmental Assessment
- World Bank OP 4.04 for Natural Habitats
- World Bank OP 4.12 for Involuntary Resettlement
- World Bank OD 4.10 for Indigenous People
- World Bank OPN 4.11 for Physical Cultural Resources

OP 4.01 – Environmental Assessment

Environmental Assessment contains guidance on the World Bank requirements on various aspects of the EIA process. These include guidance on the categorization of projects during project screening, provisions for sector investing and financial intermediaries, exemptions for emergency situations, requirements for institutional capacity and requirements for public consultation and disclosure.

According to the World Bank OP 4.01, the proposed project is likely to be classified as a Category A project. Projects under this Category are likely to have significant adverse environmental impacts that are considered sensitive, diverse, or unprecedented and which may affect an area beyond the site or facilities. An EIA for a Category A project is required to identify and assess potential negative and positive environmental and social impacts, compare these with those of feasible alternatives (including the no project alternative), and recommend mitigation measures to reduce negative impacts and enhance benefits. The EIA process and this EIA report have been conducted and prepared in line with OP 4.01.

OP 4.04 - ***Natural Habitat***

This seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society.

OD 4.10 -Indigenous People

Indigenous People are particularly vulnerable if their lands and resources are transformed, encroached upon, or significantly degraded. Their languages, cultures, religions, spiritual beliefs, and institutions may also come under threat. In the study area, no distinct people from mainstream groups in national societies are often among the most marginalized and vulnerable segments of the population. Therefore, it is not applicable to this project.

OP 4.11 – Physical Cultural Resources

The World Bank recognises physical cultural resources (PCR) as valuable scientific and historical assets and an integral part of a people's cultural identity and practices. Thus development projects that are likely to have an impact on PCR must work to avoid or mitigate adverse impacts. In the event that PCR are impacted by project activities the developer is required to adhere to Nigerian legislation and, World Bank or any other international obligations. The following steps, which are integrated into the EIA process, will take account of the PCR in the area of interest: screening, developing terms of reference (ToR), collecting baseline data, impact assessment and formulating mitigating measures and a management plan. If the Project is identified to have adverse impacts on PCR, the proponent must identify appropriate measures for avoiding or mitigating these impacts as part of the EIA. These measures may range from full site protection to selective mitigation, including salvage and documentation, in cases where a portion or all of the physical cultural resources may be lost. The proponent is also required to develop a PCR management plan. In addition, OP4.12 requires the proponent to engage with project-affected groups, concerned government authorities, and relevant non-governmental organisations to document the presence and significance of PCR, assess potential impacts, and explore avoidance and mitigation options. The findings of the physical cultural resources component of the EIA are disclosed as part of, and in the same manner as, the EIA report.

OP 4.12 – Involuntary Resettlement

According to the World Bank's safeguard policy on Involuntary Resettlement, physical and economic dislocation resulting from World Bank funded developmental projects should be avoided or minimized as much as possible. Unavoidable displacement should involve the preparation and implementation of a RAP to address the direct economic and social impacts resulting from the resettlement. Under World Bank OP 4.12, the steps required for resettlement preparation and planning are as follows (World Bank, 2004):

- **Step 1. Land Acquisition Assessment:** to establish the extent, location and current use of the land required for the Project.

- **Step 2. Avoid/Minimise Resettlement:** seek alternative locations/routes for the Project.

- **Step 3. Household Census and Socioeconomic Survey:** an inventory of persons displaced by the project and associated assets (including physical structures and land based assets such as crops and grazing land). They are usually conducted in close coordination with local government officials so that the data can be validated.

- **Step 4. Legal Framework:** used as a basis for acceptance and enforcement of terms included in the RAP. It also enables eligibility criteria and entitlements to be decided based on relevant local and international requirements. This step defines the cut-off date for entitlements.

- **Step 5. Stakeholder Consultation:** consultation with the affected population in order to ensure that the resettlement plan is implemented fairly, meeting the needs of all concerned. It allows local communities to express their concerns and answer questions, and is the forum in which valuation and grievance procedures are discussed and agreed.

- **Step 6. Feasibility Study of Resettlement Sites:** determines the viability of residential and agricultural sites. It includes a host population capacity assessment to evaluate the availability of water, soil quality and topography; it also includes a needs assessment to ensure that the sites the needs of both the host and resettled communities.

- **Step 7: Feasibility of Income Improvement Measures / Livelihood Restoration and Capacity Development**: determines the technical, economic and financial feasibility of programmes proposed to restore the livelihoods of those economically affected by the Project and includes assessing training needs, vacancies and opportunities for job creation.

- **Step 8. Implementation:** involves setting up the working groups/institutional framework to manage resettlement, putting the grievance mechanism in place, moving and resettling affected persons, distributing compensation and managing livelihood restoration programmes.

1.6.6 Health, Safety, and Environment Policy Statement of TCN

It is the policy of TCN to conduct its business in a manner that promotes the safety of its employees and the public, and its facilities as well as protect the environment.

TCN activities will be organized, planned and executed in such a manner as to:

- Protect and promote the health and safety of its workforce as well as to conduct it activities in such a manner not to adversely affect any third party.
- Minimize the impact on the environment in which TCN operates.

This is realized by:

- Actively promoting the goal of zero accident & incident
- Complying with all applicable legal requirements and industry rules & regulations with regards to HSE
- Implementing a set of minimum standards in the area of health, safety & environment and asset Management
- Providing adequate training & support to our employees in such a way that the organisation is operated by highly qualified professionals
- Investing in infrastructure in such a way that the exposure to people and environment is avoided
- Promoting the involvement to HSE improvement as a shared concern by all our employees

1.7 STRUCTURE OF THE REPORT

The format of this report is essentially in line with the recommended format and guidelines by the Federal Ministry of Environment (FMEnv). Accordingly, the report is organised into the nine main chapters (1-9) and two others (10-11) as follows.

1. Chapter One: Introduction

This chapter provides background information about the proposed project and highlights objectives, scope of work for the environmental assessment as well as the applicable legal and administrative framework for the project.

2 Chapter Two: Project Justification

This chapter outlines the project justification, including the need; value / benefits of the project and project development options.

3. Chapter Three: Project and Process Description

This chapter describes the proposed project location, project activities and processes involved including construction & installation, project operation and maintenance and schedule.

4. Chapter Four: Description of the Existing Environmental

This chapter describes the existing (baseline) environmental conditions of the project area including the socio-economic and health status of the inhabitants in the area. Also included are records of consultations held with the stakeholders notably the elders and youths in the host communities.

5. Chapter Five: Potential and Associated Impacts
In this chapter, potential and associated environmental impacts of project activities are identified and evaluated.

6. Chapter Six: Impact Mitigations/Measures
This chapter proffers mitigation and ameliorative measures that would be adopted to eliminate or reduce to acceptable levels significant adverse impacts identified.

7. Chapter Seven: Environmental and Social Management Plan (ESMP)
This chapter presents the Environmental and Social Management Plan (ESMP) that will be adopted throughout the project life cycle. It also includes the Environmental Management System (EMS) plan that will ensure the effectiveness of the mitigation measures and the remediation plan after decommissioning.

8. Chapter Eight: Decommissioning Plan
This chapter briefly presents the details of decommissioning plan at the end of the project life cycle.

9. Chapter Nine: Conclusions
This chapter presents conclusions.

10. References
This section contains all the cited references and bibliographies referred to in the report.

11. Appendices
As much as possible, materials presented in the report are highlights, mostly the most important findings and results for clarity and to make the report easy reading and friendly. Other information sources, including some raw data are presented as appendices

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 NEED FOR THE PROJECT

The power generating and grid distribution capacity in Nigeria is currently about 3,500 megawatts (MW) distributed over about 4,700km of 330kV and 6,010km of 132kV transmission lines. Nigeria's current demand for electric power throughout the country is in the range of 10,000MW and it could grow to 25,000MW by 2025. The electricity supply is therefore very inadequate to support the current population of over 160 million people with an increasing electricity demand that is growing at an average rate of about 7 percent annually. Electricity supply is therefore characterized by frequent power failures and load shedding resulting in economic losses through loss of production and damaged equipment. To address this challenge, new power generating stations are being built in Nigeria. There is need for a complementary expansion of the current transmission line network in the country to cater for the needs of power evacuation from 330kv substation and distribution throughout the length and breadth of the country. The proposed 200km Jos – Kaduna 330kV DC Transmission line has been designed to supply electricity to the other parts of the country. There is no existing transmission line of a similar configuration suitable to perform the function of power evacuation and distribution as proposed and envisaged, hence the need for the present proposed project.

2.2 PROJECT OBJECTIVES

The objectives of the proposed 200km Jos – Kaduna 330kV D/C Transmission line and associated Substation Facilities are to:

- Enable the evacuation of power from 330kv Substation at Jos
- Provide a more efficient route for the transmission/distribution of power to consumers

2.3 PROJECT ALTERNATIVES

The following project alternatives were considered having regard to the objectives of the project, pertinent environmental and economic factors and community concerns:

(i) Do Nothing

This option would imply that the proposal to construct the 200km Jos – Kaduna 330kV D/C Transmission line will be cancelled. This will abort the entire scheme for the evacuation and utilization of power generated. Areas intended to benefit from the power transmission and supply will be denied this opportunity. The "Do nothing option is not an acceptable alternative given the great need for power generation and transmission in the country.

(ii) Different Transmission Capacity

An alternative transmission line capacity would have been the 132kV Double Circuit line, which is of a lower capacity than the 330 kV Double Circuit line proposed and will not be able to transmit the projected electricity supply envisaged.

(iii) Alternative Technologies such as Undergrounding and Direct Current Systems

Undergrounding as an alternative was rejected for the transmission line on the ground of taking much longer period for construction and greater costs involved. Additionally, the vast trenching activities through the expanse of land covered and the laying of underground cables will entail greater environmental consequences.

(iv) Alternative Starting / Ending Points: Corridors / Routes

There are no alternative starting/ending points as the 330kv substation from which power is to be derived has already been stationed at Jos and ending point at Mando in Kaduna. Any alternative routes between these points with different angle points will involve passing the transmission line through more built up areas, plantations and agricultural establishments.

The considered route for this project is the preferred route, taking into account such aspects as soil conditions, access, right-of-way acquisition costs, and avoidance of built up areas. This route is acceptable because of the following considerations:

- Avoidance of settlements as much as possible
- Avoidance of archaeological sites particularly shrines and burial grounds
- Avoidance of natural routes for the movement or migration of animals
- Avoidance of forest reserve areas
- Minimization of water, road, and railway crossings
- Avoidance of land areas with rock-outcrops or very shallow (< 2m deep) soils.
- Environmental friendliness.

2.4 Value / Benefit of the Project

The project will assist in the improvement of current availability of power supply, thereby enhancing local and national economic growth. This is consistent with the nation's priority for rapid development of reliable power supply.

2.5 Envisaged Sustainability

2.5.1 Economic and Commercial Sustainability

Over its estimated life span of at least 25 years and beyond, the transmission line is envisaged to be economically and commercially sustainable because it will make it possible to meet electrical demands of more customers including commercial bodies. .

2.5.2 Technical Sustainability

The proposed project is expected to be technically and environmentally sustainable because of the following:

- Proven transmission line construction technology and expertise are available within TCN and affiliated bodies
- Strict adherence to internationally accepted engineering design and construction standards as well as codes of practice at all stages of the project shall be adopted.
- Periodic inspection of facilities in accordance with the operational procedures developed through TCN's extensive experience;
- Management of the project by fully trained and qualified personnel who are conversant with the TCN's policy guidelines;

2.5.3 Environmental Sustainability

Incorporation of the recommendations of this EIA at the appropriate stages of the project development is expected to ensure that the proposed Transmission line project is environmentally sustainable. Strict adherence to the EMP shall ensure that every aspect of the proposed project is sustainable with minimum adverse impacts on the natural environment and its inhabitants.

CHAPTER THREE

PROJECT AND PROCESS DESCRIPTION

3.1 OVERVIEW OF THE PROJECT

The Federal Government of Nigeria through the Transmission Company of Nigeria (TCN), a subsidiary of the former Power Holding Company of Nigeria (PHCN) embarks on the construction of a 200km Jos – Kaduna 330kV Double Circuit (DC) Transmission Line and Associated Substation Facilities Project. This is in line with the decision of the government to increase the capacity of power transmission network and to strengthen the national grid system. The project will provide evacuation link for addition generating power and improve the voltage profile on Jos to Kaduna transmission line, thereby increase system reliability, stability and operational efficiency of the national grid network.

While the justification of the Power Transmission Line development project from its numerous socio-economic considerations cannot be overemphasized, the project in general involves activities and equipment that have environmental consequences. The design for construction and installation of facilities and equipment is based on best engineering practices.

This chapter documents the type of project, project description, installation facilities and equipment, construction materials, design basis, transmission line specifications, energy requirement and general project schedule.
The design and implementation offer a safe and efficiency of the overall components of the proposed project.

3.2 TYPE OF PROJECT

The project is transmission line construction project involving acquisition of land/ right of ways, clearing, installation of equipment at switchyards and erection of towers and mounting of associated transmission cable along approximately 200km transient. The line is to be equipped with 350mm2 “Bear” ACSR conductor, one optical ground wires (OPGW)

3.2.1 Project Location

The proposed 200km 330KV DC Transmission line and Associated Substation Facilities Project will be located in Plateau and Kaduna States, Nigeria. Figures 3.2.1 shows the one line sketch of the traverse line. The project shall originate from Kaduna (Regional Centre) Transmission Substation, traversing communities such as Rigachikun, Chukka farm, Kangimi, Panturawa, Barwa, Yaidi-Kauru, Pole-Wire and Danjaba in Kaduna State; Katako and Gurum in Plateau State. The line at both ends will terminate at the proposed 330kV line bays (to be located at the existing Transmission Substations) at Mando-Kaduna Regional Centre 330kV Substation and Jos 330/123kV substation.

3.2.2 Existing facilities at the project site

Kaduna Transmission Substation: 5, 330 / 132kV Transformers with the following capacities-

3x150MVA, 330/132kV
1x90MVA, 330/132kV
1x60MVA, 330/132kV
1x75MX Reactor.

There are also 4x60MVA 132/33kV at the 132kV feeder side.

Jos Transmission Substation: 2x 150MVA, 330/132kV Transformers and 2x60MVA, 132/33kV transformers at Jos Substation.

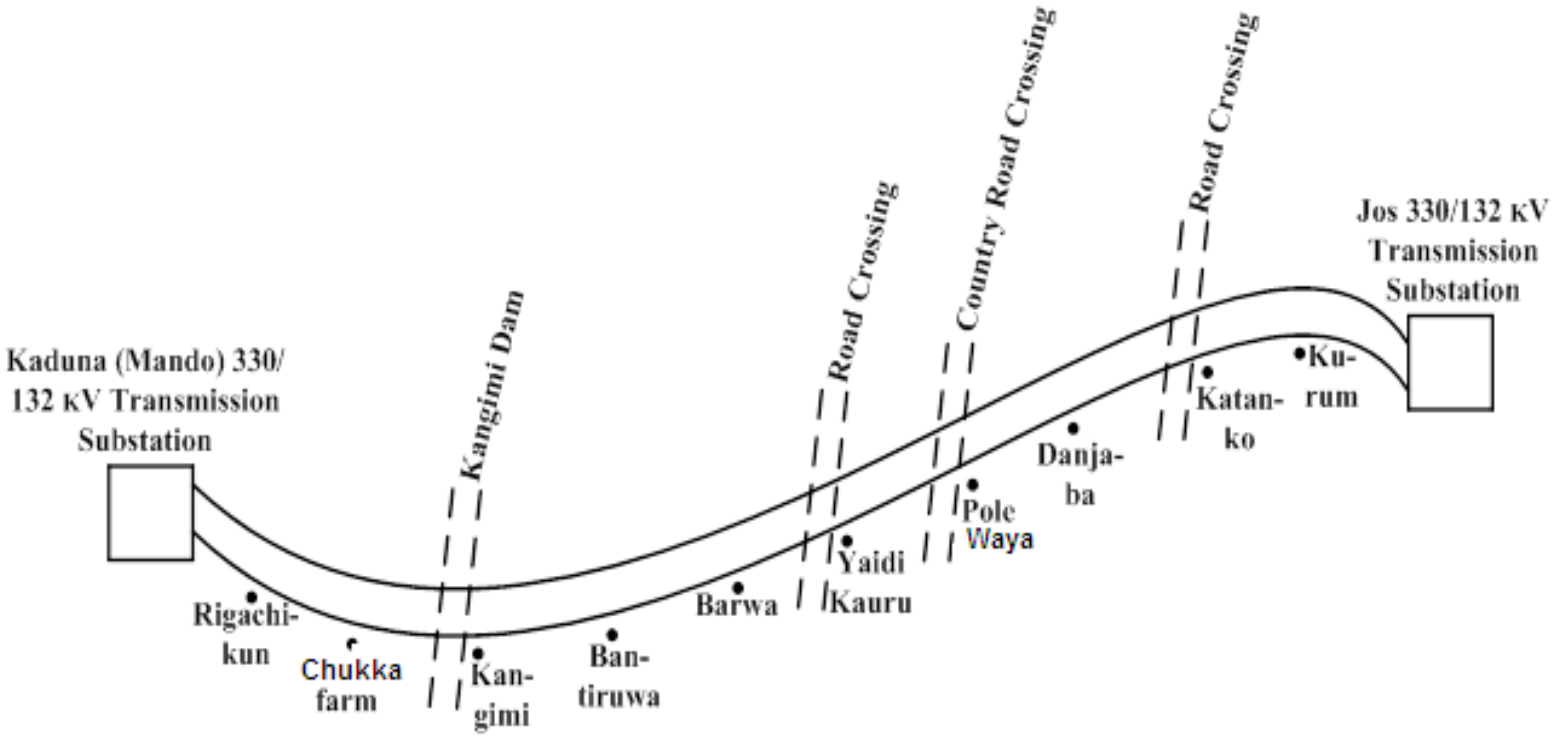

Figure 3.2.1: Sketch diagram of a proposed 200 km Jos-Kaduna 330 kV Double Circuit (DC) transmission line

3.3 PROJECT DESCRIPTION

The basic description/features of the facility, characteristics specifications, equipment overview, estimated emissions and performances etc of the project at the switchyard shall be presented in this section. Figures 3.2a show a typical Transmission substation with its various components of the Switchyard to be discussed in this chapter; Figures 3.3.1a, 3.3.1b, 3.3.1c and 3.3.1d show sectional views of the existing Kaduna Transmission substation while Figures 3.3.1e while 3.3.1f show sectional views of the Jos Transmission Substation.

Figure 3.3.1a: A typical transmission substation showing switchgears

Figure 3.3.1b: Sectional View of the Existing Kaduna-Mando Transmission Substation

Figure 3.3.1c: Sectional View of the Existing Kaduna-Mando Transmission Substation

Figure 3.3.1d: Sectional View of the Existing Kaduna-Mando Transmission Substation showing Bay for the proposed 330kV transmission line

Figure 3.3.1e: Sectional View of the Existing Jos Transmission Substation

Figure 3.3.1f: Sectional View of the Existing Jos Transmission Substation:

3.3.1 Design Concept

The overall goal in the design, and installation of facilities in the 200km Jos-Kaduna 330KV Double Circuit transmission line is to have a very efficient, reliable, durable and serviceable cost effective transmission line.

In order to achieve this goal, the following were carried out:

- Substation structures have been designed so that their strengths satisfy requirements under any of the head conditions specified in this technical specification;
- Structures have been designed based on loads, applied both to the structure itself and to the attached or supported accessories and equipment. These heads are unfactored loads.
- Equipment heading-equipment loads shall be the busbar connections traction the wind on the equipment, the earthquake induced head and any additional operating loads
- The dynamic forces exercised by the circuit breaker s at the time of closing and breaking is a good example of an operating head to be considered when calculating equipment loading
- The design strength of the structures have been calculated using the requirement of AISC
- Steel shall be free blisters, scales, laminations grease and other defects and suitable in all respects, for fabrication and hot-drip galvanizing
- All necessary attachment holes and brackets for mounting equipment and operating mechanisms grounding wire, buswork, incoming and outgoing transmission line conductors and overhead shield wires shall be included
- Tower structure steel, leg extensions tower foundation must meet design codes and standards to avoid defectiveness and breakdown

Quality Assurance – From International World Standard Organization

ISO9001- Quality System- model for Quality Assurance is Design, Development, Installation and Servicing

3.3.2 Project Design Criteria and Data

The project design criteria incorporate the local experience and general practice into consideration as exchanged and developed in Nigeria. Various international standards and codes were applied. The codes contain particulars and supply requirements, design and construction of power lines. The codes have been revised in the course of time in order to take advantage of the locally gained knowledge or practices.

3.3.2.1 Clearance

The clearance requirements for the temperature curve in metres are as follows:

Vertical clearances (in Metres)

Normal Ground	7.0
Road crossing, buildings, poles, structures, Walls and cable guard	9.0
Limited access motorways and dual carriage ways	10.0
Navigable waterways (‘at high level)	15.0
Pipelines (oil, gas, water)	10.0
Communication and power line wires	3.6
Cradle guard to top of railway track	9.0

Horizontal clearances

Nearest steel of transmission tower to edge of navigable waterways pipelines, bridges, highways pavement, railway (nearest rail, buildings on right of way and at crossing, to structure of line being crossed

Major highways	50.0
Railways	50.0
Country road	30.0
Farm lanes, dirt roads cart tracks	25.0
Canals	40.0
Buildings	50.0
Transmission & distribution lines 132kV and less	50.0
Gas pipe lines	10.0

Limiting tension of cable

The conductors will not exceed the following tension limit:

The phase conductors and shield wires will be erected with such sags that the tension at 35^{o}C will be less than 20% UTS (ultimate tensile strength) with no wind, and less than 40% UTS with a 130Km/h wind.

The shield wires will be erected at such a tension that, at 10^{o}C, the sag in the shield wire will be at least 10% less than the sag in the phase conductors

No building of other structure shall be erected under 330kV line or adjacent an electric line.

Safety factors:

Table 3.3.1: safety factors

Items	M
Live and earth conductors, based on ultimate tensile strength of the material	2.5
Mid-span joints and termination based on the ultimate tensile strength of the conductor.	0.95
Complete insulation units based upon the electro-mechanical strength of the material	0.5
Complete insulators and fittings, based upon electro-mechanical test, and elastic limit of metal	3.5
Stay wires and auxiliary materials based on ultimate tensile strength	2.0
Insulator metal fittings, including caps and pins, based on minimum failing load	3.5
Lattice steel supports.	2.0
Steel tubular poles based on the ultimate breaking strength in handling of the material	2.0
Foundation for supports against overturning lateral shearing, toe compression and uprooting under maximum simultaneous working loads based on soil bearing strength	2.5

Assumed maximum working conditions:

Table 3.3.2: Assumed Maximum working Conditions

Minimum ambient temperature of line and earth conductors	^{o}C	5
Maximum temperature of line and earth conductors	^{o}C	100
Average ambient temperature of overhead line conductors	^{o}C	35
Wind pressure per square metre on projected area of line and earth conductors and insulator sets -surface route -major river crossing	 kN kN	 415 622
Site altitude above sea level	Metres	0-300

330kV system parameters:

Table 3.3.3: 330kV system parameters

Nominal voltage	330kV
Highest voltage	362kV
Lighting impulse withstand level	650kV
Switching impulse withstand level	950kVp
Power Frequency withstand level	450/520kV
Frequency	50Hz
Altitude Above Sea level	0-300m
Basic insulation level	1135Vp
Short Circuit level for 1sec	31.5kA
Corona extinction voltage 230KVrms	230KVrms

3.3.3 Applicable Standards

The equipment or components supplied shall be in accordance with the standard specified below or later editions and / or amendments thereof.

Offers of item manufactured to any other internationally recognized standard or specifications equal to or better shall accompany an English version of such standard

a) IEC 61232- Aluminium clad steel wires for Electrical Purposes
b) IEC 60121-Recommendation for commercial annealed electrical conductor wire.
c) IEC 61089-Round wire concentric lay overhead electrical stranded conductors.
d) IEC 60889-Hard drawn aluminium wire for overhead line conductors.
e) IEC 61394-Characteristics of greases of aluminium, aluminium alloy and steel bare conductors.
f) IEC 61395-overhead electrical conductors- creep test procedures for stranded conductors.
g) IEC 270-Partial Discharge Measurements
h) BS 215-part 1 & 2 Aluminium stranded conductors, steel reinforced
i) BS 1559-Reets and drums for bare conductors
j) IEEE std. 524-1980 Guide to installation of overhead transmission line conductors.

Work Included

Work of this section consists of the design, supply and installation of conductor specified.

Terminology

Unless otherwise defined below, technical terminology is defined in IEC-50 (latest edition)

Sag

Sag of a length of conductor supported at each end only, shall mean the maximum vertical distance in the span measured between the conductor and the hypothetical straight line joining the two points of support.

Initial sag

Initial sag of a conductor shall mean the sag at the time of installation prior to being subjected to any loading or long term creep.

3.3.4 Application Code Standards

The proposed 330kV overhead transmission line was based primarily on TCN specifications and other standard/codes. In general the project will be designed in accordance with:

- Nigeria Government Legislation
- S.I.5 of 1996 Electricity Act. Electrical Installation Regulation
- S.I.6 of 1996 Electricity Supply Regulations
- Project Specification
- TCN specification and standard
- Design and engineering practice safety manuals, etc
- Industries codes and standards
- Contractors' codes and working standard

In the event of conflict between these, precedence will be in the order listed above with Nigerian legislation carrying the highest priority.
A list of applicable references codes and standards is presented below:

CONDUCTORS

IEC 888	Zinc-coated steel wires for stranded conductor
IEC 889	Hard-Drawn aluminium wire for overhead conductor
IEC 1089	Round wire concentric lay overhead electrical stranded conductors
IEEE Std.	Guide to the installation of overhead transmission line conductors 524 – 1980
BS 1559	Reet and Drums for Bare wire

SHEILD WIRES

IEC 888	Zinc-coated steel wires for stranded conductor
BS 1559	Reels and drums for Bare wire
IEEE Std. 514, 1980	Guide to the installation of overhead transmission line conductors

INSULATORS AND HARDWARE

IEC 60120	Dimensions Of Ball and Socket Couplings of String Insulator Units
IEC 60305	Characteristics of String Insulator of Ceramic Material of Glass for Overhead Lines With A Nominal Voltage Greater Than 1000v
IEC 60383	Test On Insulator of Ceramic Material of Glass for Overhead Lines with a National Voltage Greater than 1000V
IEC 60575	Thermal – Mechanical performance Test and mechanical performance TEST ON string Insulator Units
IEC 60591	Sampling Rules and Acceptance Criteria when applying statistical Control Methods for mechanical and Electromechanical Test on insulators of Ceramic Material for overhead lines with a Nominal voltages greater than 1000v
IEC 60507	Artificial Pollution Test on high-voltage insulators to be used on ac. systems
IEC 60437	Radio interference test on high-voltage insulators
IEC 60372	Locking Devices for all and socket coupling of string insulator units
IEC 61284	Overhead lines Requirement and test of fitting

LINE ACCESSORIES

IEC 61284	Fittings
IEC 61854	Spacers
IEC 61897	Dampers
ASTM AI 53	Specification for Zinc coating on iron and steel Hardware

GROUNDING SYSTEM

IEC 888	Zinc-coated steel wires for stranded conductor
ASTM A153	Specification for zinc coating on iron and steel Hardware
ASTM B498	Zinc-coated steel wire
ASTM A8193	Test for receptivity of Electrical conductor materials
IEE 80-1986	Guide for measuring Earth Resistivity, Ground impedance and Earth surface potentials of a Ground system
BS 18	Method for tensile Testing of Metals
BS 3289	Determination of Resistivity of Metalic Electrical Conductor Materials

3.4 SYSTEM PARAMETERS FOR 330KV TRANSMISSION LINE

Electrical:
Normal Voltage 330kV rms
Highest Voltage 362kV rms
Frequency-50Hz
System grounding effectively earthed system
Basic insulation level 1135 Vp switching impulse level 950KVp
Power frequency withstand Voltage (wet) 450Vrms
Short circuit level for Isec 31.5kA
RIV at 230 Vrms (UV at 1MHZ) 1000

3.5 SUBSTATIONS EQUIPMENT AND ITS ANCILLARIES

Kaduna Transmission Substation:
5, 330/132kV Transformers with the following capacities-
3x150MVA, 330/132kV
1x90MVA, 330/132kV
1x60MVA, 330/132kV
1x75MX Reactor.

Proposed line bay about 200sq located within the existing substation switchyard. Also, there are 4x60MVA 132/33kV at the 132kV feeder side.

Jos Transmission Substation:
2x 150MVA, 330/132kV Transformers and 2x60MVA, 132/33kV transformers at Jos Substation. Proposed line bay about 200sq located within the existing substation switchyard

3.5.1 Substation Power Transformers (Step-up)

High voltage power autotransformer/shunt will be used to receive power at a particular voltage of 15kV and to deliver power at a higher voltage of 330kV with frequency of 50Hz requires. The design criteria deploy codes and standards specification of IEC 60076 for power transformers and IEC 60289 Reactors. The present specification outlines from a technical point of view, the standards requirements applicable to the design, manufacture and testing of 150MVA, 90MVA and 60MVA transformer. The rating of the power transformer at a particular substation depends on the load demand trends and allocation from the primary substation source.

Power transformer foundations

The foundations for step-up transformer(s) are made of reinforced concrete. The oil containment basin is dimensioned for the amount of oil in the actual transformer. The basin is covered with course gravel supported on steel mesh or perforated steel sheet steel structure. For handling possible oil spill the outlet from the containment basin is s monitored with manually operated rain water and oily water valves. The rain water is led to the rain water system by opening the rain water valve. Possible oily water is load, by opening the oily water valve to the oily water sewage sump outside the containment area, from where the oily water is pumped to storage or treatment. The oily water pipes are plastic.

3.5.2 The High Voltage Current Transformer (CVT)

The current transformer is to single phase for outdoor installation. They will be provided with various cores, with metering and relaying accuracy. The transformers shall be designed, manufactured and tested taking into consideration the electrical characteristics given in the technical data schedules and following the standards indicated in the same.

The transformer shall be hermetically constructed, filled with oil or SF6 with metallic expansion diaphragm. The current transformer shall be composed of a seated housing for the cores and primary and secondary windings conductors, supported by a porcelain insulator and pedestal along with secondary leads, insulation and low voltage connection box.

Each current transformer shall have the contain accessories: Expansion chamber and diaphragm, oil level indicator or manometer, provision for oil drain/sampling valve or gas filling, low voltage terminal box

3.5.3 Switchyard foundations

The foundations for electrical equipment consists of footings and plinths. Foundation bolts supplied for fastening the equipment supporting structures. The switchyard area surface is course non dusty granular material. The fence posts and gate profiles are made of EN-AW 6063-T5 aluminium, alternatively galvanized steel, diameter 50 mm. The fence is about 2.5 meter high and with a barbed steel wire on top. There is a 4 m wide double swing vehicle gate in the entrance to the switchyard. There is also a smaller gate adjacent to the big gate.

3.5.4 Instrument Transformer

The codes and standards deployed in the design and manufacture of instrument transformer shall be the IEC 60044.

3.5.5 Communication/Control System

The need for putting in place, control circuits to enhance proper monitoring of system performance cannot be over emphasized.

The control circuits shall be designed taking into consideration the following points:

- Power supply to the operating mechanism motor shall be independent from the power supply used for the control and be protected by MCB

- The motor shall be protected by suitable thermal protection devices. The manufacturer will coordinate the device protection with upstream feeder protection.
- Protective tripping of the circuit breaker by protection relays of the selector switch Local/Remote
- An alarm contact shall be provided to signal a longer than usual rearming o fthe spring mechanism. The circuit should be realized by a limit switch and timing relay.
- AB position selector switch manual/local/remote shall be provided
- Provide a manual operating crank for each circuit breaker mechanism
- Provide push buttons "close-trip", "open/closed"
- The control panel should be a weather proof enclosure with lockable hinged doors and removable access panel used to support the incoming control, protection and power supply cables
- Provides heating element and thermostat long a 240V outlet (Nigerian standard type) and an interior light
- The terminal blocks should be phoenix UKS, Entrelec M4/6 type or equivalent with 20% of free terminal blocks. The terminal blocks will be installed on asymmetrical rails.

There shall be a communication room for effective Radio Communication between the technical officers in the substation with other substations in the transmission network. There is a communication wire at the top of the transmission lone tower linkage to the Radio room. Operational control panel showing various feeder areas and taking of hourly meter readings on the phase voltages and monitoring fault situations and loading level, the control and operation of the substation shall be possible from the feeder control; cubicle in the control room and from the load dispatch center (LDC) via telecoms systems. In addition, the substation shall be controlled via a station control unit (SCU).

3.6 CONDUCTORS

Unless otherwise stated terminology involved in the choice of conductors is defined in IEC-50. Conductors can be regarded as materials such as copper, aluminium. For the design/construction of overhead 330kkV transmission line project, aluminium conductor steel reinforced is recommended because of its lightness in weight and conductivity and cheapness when compared to copper which is vulnerable to power losses in a lossy transmission line. The length of the transmission line aluminium conductor covering proposed Jos- Kaduna 330kV is about 200km. Aluminium conductor steel reinforced and Optical Fibre Ground Wire (OFGW) will be considered mainly.

3.6.1 330kV Transmission Line Description

General

Overhead Lines are suspended from insulators which are themselves supported by toward or poles. The span between two towers is dependent upon the allowable sag in the line, and for sheet towers with very high voltage lines the span in normally 370-460m (1200-1500ft). Typical supporting structures are shown in Figures 3.6.1a and 3.6.1b.

There are two main types of tower:

a. those for straight runs in which the stress due to the weight of the line alone has to be withstood.

b. those for changes in route, called deviation towers; these withstand the resultant forces set up when the line changes direction.
When specifying towers and lines, wind loadings as well as extra forces due to a break in lines on one side of a tower; are taken into account. For lower voltages and distribution circuit wooden or reinforced concrete poles are used with conductor supported in horizontal formations.

The line conductors are insulated from the towers by insulation which take two basic forms, the **pin type** and **suspension type**. The pin type is used for lines up to 33KV while the suspension type is used for lines up to 400KV.

The main components for 330kV transmission are the following:

- Steel tower
- Conductors
- Shield wires
- Insulators and hardware
- Line accessories
- Cables and associated fittings for earthling

3.6.2 Towers

Tower types and Accessories:
The typical tower type to be used in the proposed construction are Vertical Standard Type, Tension/strain and Dead end Tower (Terminator)**.** Tower shall be self-supporting galvanized lattice steel structures of the vertical-type with vertical one overhead optical ground wire (OPGW)**.** Proposed outline of the tower are shown in the project drawings.

Towers shall be equipped with anti-climbing guard approx. 3m above the ground. Tower shall be provided with step bolts (M16 X 180, spaced 350mm) on one tower and maintenance.
Arial number plate at the tower peak every 10^{th} tower is to be provided. Danger as well as circuit and number plates are to fix the panel above the anti-climbing device. Phase plates (blue, yellow, red) shall be fixed to the respective cross arm peaks. All tower accessories are to be in accordance with the encoded drawings. To prevent against vandalism, stealing e.t.c. all bolts and nut below the cross arm shall be of the anti-vandalism type. The anti-vandalism bolts offered shall be of the "Huck-type" or similar

The wind is to be reduced accordingly for tangent with a line angle larger than 0^{o}. the line angle stated (incoming line/slacked span to the gantry) for the terminal tower shall be adjusted in accordance with the requirements at the substations, including provision of extra cross-arms if necessary for slacked spans with line angle above 45^{o}.

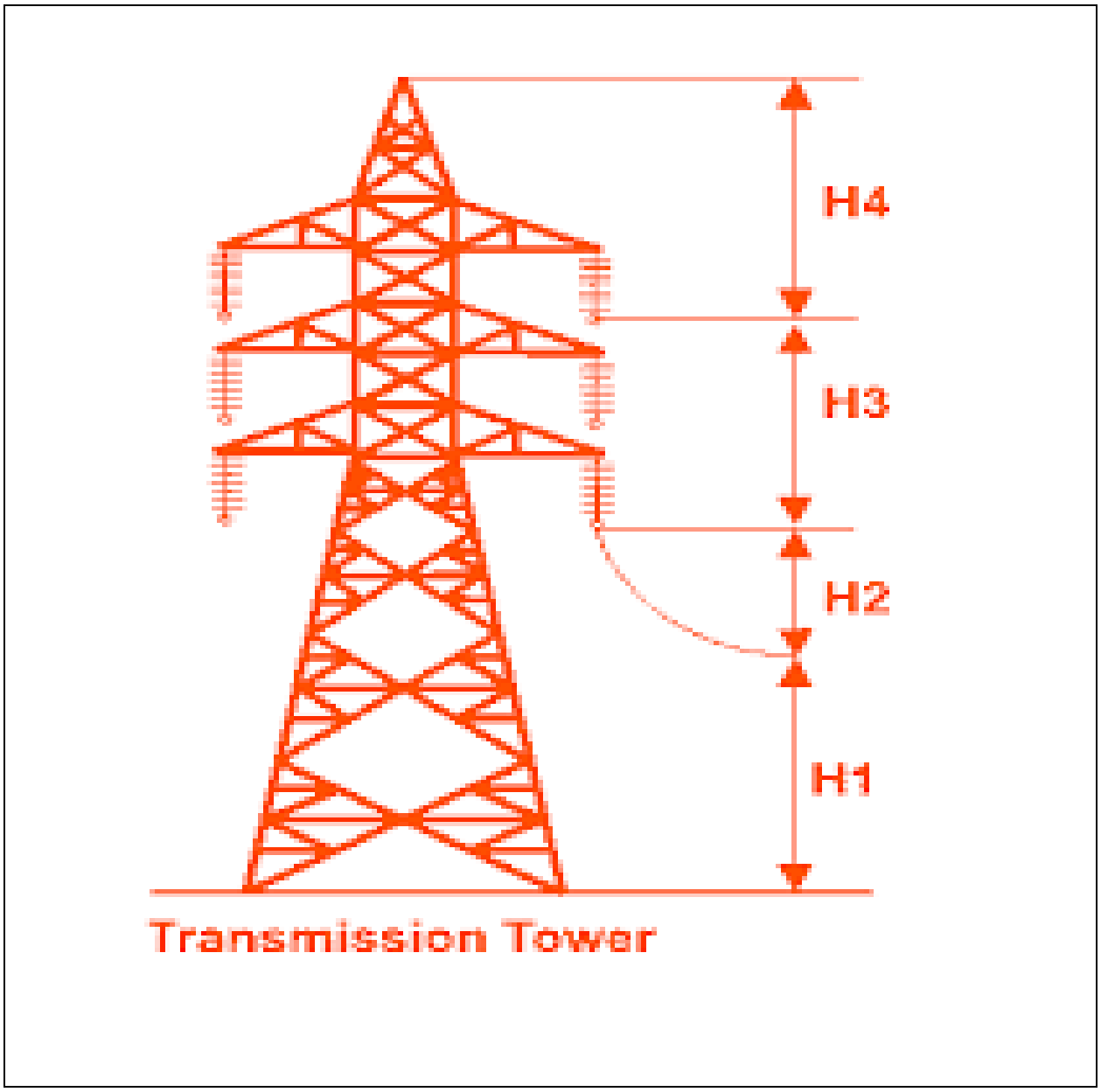

Figure 3.6.1a A Typical Tower arrangement for Double Circuit connection

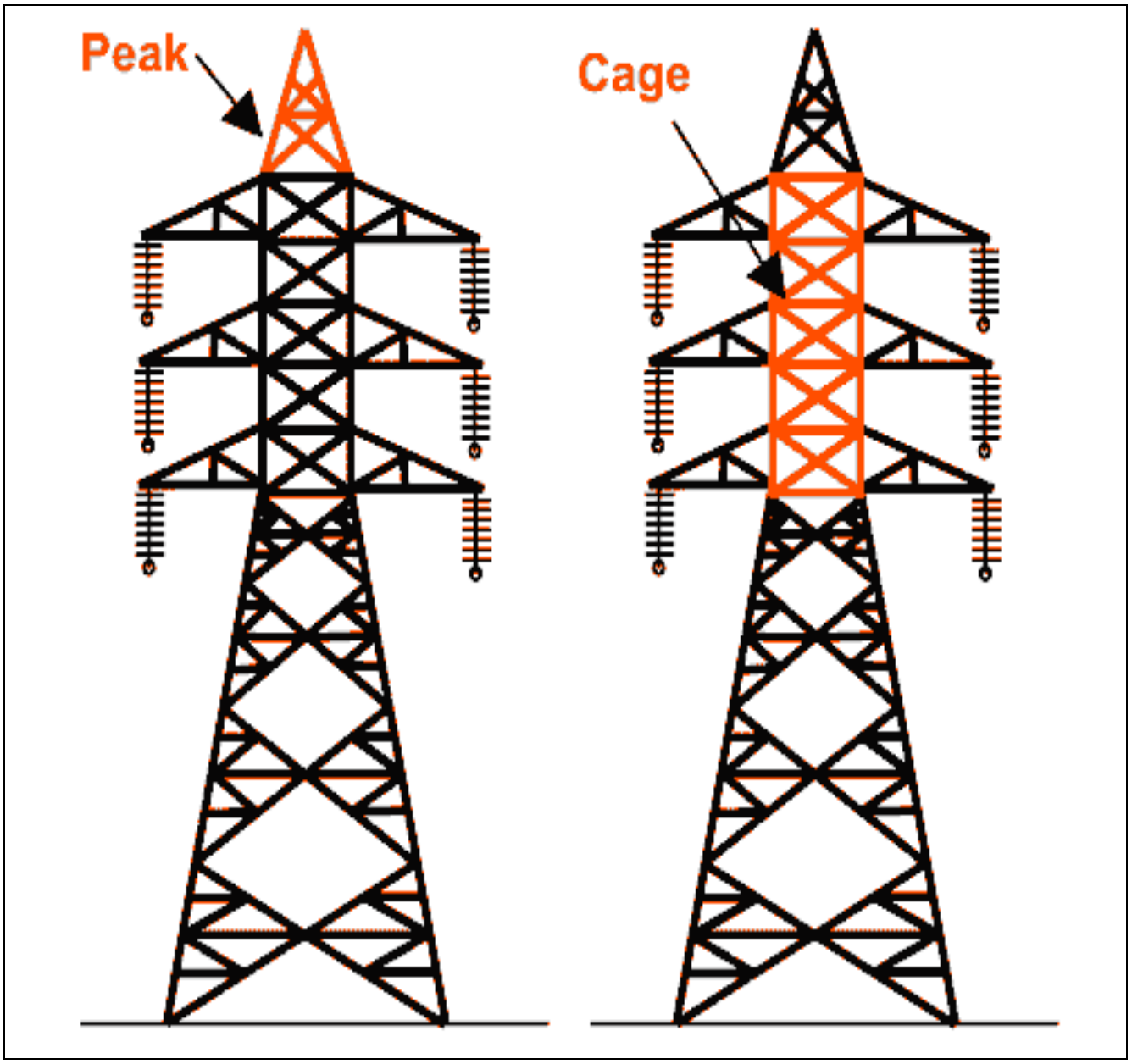

Figure 3.6.1b: A Typical Tower arrangement for Double Circuit showing High Voltage insulations arrangement

3.6.2.1 Requirement on line Sections

A line section as the distance between two tension towers and must not exceed 8km. Span and line angle limitations and other requirements appear from the proposed outline drawing of the towers. At crossing of transverse ravines in the ground, the maximum single span may be increased provided that the phase spacing are increased accordingly and towers, foundations and equipment are designed for this situation. Ruling span, maximum conductor and overhead ground wire tension shall be checked in each line section during the profiling of the line. At the important crossing such as main roads, HV power lines, railways or the like, towers on both sides of the crossing will be required to be provided with duplicate insulation sets. At crossing of

power lines, telephone and telegraph line as well as any navigable rivers the profile of the project 330kV line in the crossing span, stating exact clearance compiled with, shall also be submitted to the authorities concerned for final approval.

Where required by the authorities permanent cradle guards, designed to approved standard, shall be provided over railways, telephone and telegraphic lines. Line numbering shall be from Kaduna substation towards Jos substation.

3.6.2.2 Tower Foundation

The foundations will be suitable to resist uplift, overturning and vertical and horizontal forces. Foundations will also be able to withstand the stresses which may be imposed upon them under erection and stringing operations.

Foundation will be designed for all the specified towers types for good and poor soils, both in dry and fully submerged conditions, and for rock. Investigation of soil, at each tower site, will be conducted to provide the required data for the selection of the appropriate type of footing,. Parallel to these soil investigations, water analysis shall be carried out in location of standing water to ensure the application of the correct cement type and to provide adequate protection for all foundation element against soil of a corrosive nature.

3.6.2.3 Tower Erection and Accessories

Tower shall be erected at approved distances and all accessories shall be attached such as anti-climbing devices, cattle, birds and cradle guards; circuit plates (2 nos. for D/C towers), phase plates, danger plates, number plates, aerial identification signs, step bolts and ladders, etc. Towers painting shall be ensured as prescribed by the Engineer. Specification requirement for painting, if required for the project, shall be provided by the Engineer. Stub templates above the base shall be provided as necessary for ensuring correct position of the stubs during setting and correction of foundations.

3.6.2.4 Protective Embankment (Traffic and Flood)

Where any part of a tower base is located within 35m of the margin of a major road, and where there is no crash barrier or other obstruction between road and tower, or where a tower is located in an area regularly traversed by vehicle traffic, a low wall or other approved barrier, not less than 0.75 m high will be erected so that the tower will be protected from traffic impact. This will be sufficiently durable to withstand repeated collision from heavy traffic vehicles and so placed to prevent access of vehicle to the tower site, except from one direction, which will normally be the direction remote from the road.

Regarding flood embankments, where tower positions are such that damage could be caused to towers or foundations by occasional flooding, permanent embankment will be erected to protect the tower and its foundation from erosion or damage by water carried debris.

3.6.2.5 Protection of Foundation Steelwork

Tower leg will be protected by applying an approved coating to the tower steelwork for length of 0.5 m above and below the top of the concrete. This protective coating will be applied in addition to the galvanization

All grillage foundation steelwork will be galvanized and treated with a protective coating too.

3.6.3 Conductors

The conductors will be concentric-lay-stranded aluminium conductor, reinforced with a class A zinc coated steel wire and will have the following characteristics thereby meeting the required standards:

- Outside diameter mm 23.45
- Nominal aluminium area mm^2 350
- Cross-sectional area mm^2 381.7
- Minimum breaking strength kN 111
- Approximate weight Kg/m 1214
- Maximum dc. Resistance at 20^0 ohms/km 0.1093
- Sub conductor separation mm 450
- Current carrying capacity amps 685.85

Stranding

Aluminium (numbering & diameter in mm) 30×3.35 x3.00
Steel (numbering & diameter in mm) 7×3.357x3.00
The outmost layer will be right-handed. The steel core will be greased with approved greases in accordance with IEC 1089.

Stringing

Once sufficient towers have been erected, stringing operations can commence.
The first step is to develop a plan, the **'Stringing Plan'** which identifies the stringing sections to be pulled. Each stringing section will vary in length between a few kilometres up to about 10km. The stringing plan will also identify each stringing Site, including the location of mechanical equipment and lay-down area for the cable drums.

Before work is started, the stringing equipment is checked and serviced and delivered to site. The winches and tensioners will be capable of pulling a tension of approximately 5 tonne. The ACSR and GSW and OPGW drums, each weighing about 3 tonne are delivered to Site. Each cable drum will hold approximately 3 km of wire. The towers are fitted out in advance with pulley blocks (that temporarily support the conductor while it is passing over the tower). The pilot wire is drawn out, and then stringing operations commence. Several pulling operations are required in each section until all of the conductors and earth wires and optical ground wire is pulled. The stringing works is supervised and performed by specialists, supported by skilled labour, Unskilled labour may be used for loading and unloading of equipment only.

3.6.3.1 Conductors, Galvanized Steel & Optical Fibre Ground Wires and Optical Fibre Armoured Cable Applicable codes and standards

ASTM 398 Aluminium clad Alloy
ASTM 415 Aluminium clad steel wires

ASTM 502 Aluminium-clad steel core wire for aluminium conductors, aluminium-clad steel reinforced
ANSI/EIA 359 Standard colours for identification and coding
ANSI-EIA Series of standard related to fiber optic cables
BS 183 General purpose galvanized steel wire strand
BS 215 Aluminium conductors and aluminium conductors steel reinforced for overhead power transmission
IEC 60888 Zinc-coated steel wires for stranded conductors
IEC 60889 Hard-drawn aluminium wire concentric lay overhead line conductors
IEC 61394 ground wire concentric lay overhead electrical stranded conductors
IEE 1138 Standard construction of Composite Fiber Optic Ground Wire (OPGW)
ITU-TG 652 characteristics of a single-mode optical and cables
BS: 1559 Reels and drums for bare conductors
IEC 6043 Method of radio interference tests on high voltage insulators. British Standards specification (BS) and International Electro-technical Commission
(IEC) publication equivalent to above mentioned specification shall also apply
The contractor shall furnish 2 sets of latest Standards (BS/IEC/ASTM,etc) referred to/used in the design and control of transmission lines

3.6.3.2 Shield wire

The shield wire of the aerial line will be equipped with optical fibre cables that will be connected to suitable optical line terminal and multiplex equipment to form part of TCN'S overall communication transmission system.

3.6.3.3 Overhead ground wire optical fibre

Optical fibre can be regarded as a thin glass thread through which light can be transmitted and it is characterized with large bandwidth. The optical ground wire shall be of the self-supporting metallic type with 24 single mode fibre incorporated in the cable construction. The characteristics of optical fibres shall comply with the requirements of ITU-TG.652. Optical fibres shall be coloured coded. The fibre shall be loose tube buffered, with an excess length of at least 0.5 evenly distributed over the whole cable length and in such a way that is maintained over the lifetime of the cable. The fibres shall be protected from ingress of moisture and water by jelly filling of the tube. The tube is incorporated in the cable so that it will remain unaffected against loads, pressures, temperature or chemical attacks which may lead is deterioration of the performance of the fibres.

The composite overhead ground wire optical fibre (OPGW) will be used as a transmission medium for communication signal along a power transmission line. The OPGW will be composed of an optical fibre unit with the fibre cores embedded inside a metallic-tube, completely surrounded by a cluster of aluminium-clad steel ground wire conductor strands or a combination of aluminium-clad steel wires and aluminium alloy wires.

3.6.3.4 Steel shield wire

The shield wire provided will be concentric-lay-stranded galvanized steel cable.

3.6.3.5. Insulator and Hardware

The equipment for use with the conductor and the galvanized steel shield wire on the 330kV single circuit, shield wire and two conductors per phase transmission line will be: Insulators for conductor suspension, dead end and damper support assemblies. Hardware for attaching insulators to tower and for attaching conductors to insulators. Hardware for attaching galvanized steel wire to towers.

3.6.3.6 Optical Fibre Ground Wire (OFGW)

Optical fibre can be regarded as a thin glass thread through which light can be transmitted and it is characterized with large bandwidth. The optical ground wire shall be of the self-supporting metallic type with 24 single mode fibre incorporated in the cable construction. The characteristics of optical fibres shall comply with the requirements of ITU-TG.652. Optical fibres shall be coloured coded. The fibre shall be loose tube buffered, with an excess length of at least 0.5 evenly distributed over the whole cable length and in such a way that is maintained over the lifetime of the cable. The fibres shall be protected from ingress of moisture and water by jelly filling of the tube. The tube is incorporated in the cable so that it will remain unaffected against loads, pressures, temperature or chemical attacks which may lead is deterioration of the performance of the fibres. All optical fibres shall be delivered from the same manufacture. No factory splices shall be permitted.

3.6.4 Line Accessories

The conductors and (aluminium galvanized clad) steel shield wire accessories will have the following:

- Compression dead-end fittings
- Full tension splices
- Conductor repair sleeves
- Dampers
- Aircraft warning spheres(where necessary)
- Conductor Aircraft warning lights(where necessary)
- Bird reflectors (where necessary)

3.6.5 Compression Joints, Dead-End Terminations, Jumper Terminals and Repair Sleeve

The fittings for conductors shall be in accordance with the conductor manufacturer's recommendations. They shall be of compression type, of which the aluminium parts shall be of at least 99.5 percent purity. The electrical resistivity of each fitting under the test conditions specified in IEC 209 for ACSR conductor shall not be more than those of the conductor. Tension joints and dead-ends shall not permit slipping of or cause damage to a failure of the complete line conductor of any thereof, at a load less than 95% of the ultimate strength of the line conductor. All fittings shall be provided with approved joint compound, shall consist of as few parts as possible, and there shall be no longer of relative movement between individual layers of the conductor during assembly. External screwed caps or nuts shall be locked in an approved manner so that normal adjustment or removal of the caps for inspection shall not adversely affect either the locking device itself or any part of the fitting to which it is attached. Non-tension joints and jumper terminals shall not permit any slip or damage of the jumper connection at a load of less than 25 percent of the ultimate jumper connections can occur in service. Ensure the ends pf the compression fitting are so designed that the pressure gradually reduces to zero and stresses

from bending and vibration are at a minimum. The design of fittings and special tools to be used shall be such as to reduce to design a minimum the possibility of faulty assembly and erection. The bearing terminals shall be machined smooth and shall have adequate area such that the assembled joint may pass the electrical conductivity tests. Suspension Clamps-Non applicable (TS 4610) N due to being a part of suspension string fittings/sets

Spacer Dampers

Supply only spacer dampers for use on bundle conductors and spacers for use on jumpers. With a proven and successful service record. Spacer dampers shall be designed to maintain a sub-conductor spacing of four hundred and fifty millimetres (450mm), to minimize sub-span oscillation and to restrict Aeolian vibration to such levels that a strain of 150 micro inches/peak, as determined by the method in IEEE Committee Report 31TP65-156, is not exceeded. The system damping analysis will be performed to ensure damping system suitability to mitigate Aeolian vibration and sub span oscillation, etc. do not use rigid or semi-articulated spacer dampers. The spacer dampers shall be made of corrosion resistant materials and shape contoured to minimize corona. Bushings of rubber or other non-ferous materials shall be used in the clamp between the conductor surface and the spacer arm. The bushing material shall be ozone resistant, unaffected by the application or presence of grease in the conductor, semi-conducting, and suitable for the range of site ambient temperature. Clamps without bushings may be acceptable subject to submittal of substantial in service experience.

The spacer damper shall permit relative conductor transverse and longitudinal movement and rotational movement about the axis of the damper and shall be of such a design so as to promote the return of twisted bundles to their correct configuration. The connector shall maintain the recommended clamping force on the conductor after cold flow has occurred on the conductor such that its nominal diameter is reduced by one percent (1%). Submit theoretical, laboratory and field test data to show that the spacer damper design when installed at the recommended spacing will, based on the available meteorological, site, and conductor data, perform efficiently to control Aeolian and sub-conductor oscillations to within safe limits for the conductors. Provide a locking device on all threaded connections to ensure they shall not become loose from vibration. Component parts subject to maintenance shall be oriented to permit visual inspection from the ground. The spacer damper design and installation shall five hundred ampere (31.5kA) symmetrical fault without damage to either the spacers dampers or conductor. For jumper loops, ensure identical spacer requirements except control of Aeolian vibration and sub-conductor oscillation is not required.

3.7 330KV TRANSMISSION LINE SYSTEM PROTECTION

The design, construction and installation of a 330kV transmission line system is a very capital intensive project. The transmission line with all the associated gadgets on the Tower and substation switch yards needs system protection against, short circuit faults, corona discharge or lighting discharge, over voltage or current surges and sensitive earth fault. There are various measures that shall be put in place by design arrangement to contain excesses arising from the above stated threats.

For 330kV the 150MVA power transformer system, the protection takes electrical and mechanical dimension. For the mechanical protection buchhotz relays, over temperature protection, oil level relay, OLTC protection etc. For the electrical main protection scheme of the power transformer shall consist of a numerical low impedance differential protection and a high impedance restricted earth protection for each star connected transformer winding. The two protection scheme has their own current transformers.

3.7.1 Overcurrent and earth fault protection

For each winding of a power transformer, a three phase over current relay with instantaneous and normal IDMTL elements shall be provided for over current protection. These IDMTL elements shall comply with IEC 60253-3 codes and standards design.

3.7.2 Shunt Reactor Protection

Shunt reactors shall be protection with three phase low impedance differential relay and a high impedance restricted earth fault protection.

3.7.3 Busbar and Breaker Failure Protection

Each 330KV busbar shall be protected by numerical low impedance differential busbar protection. In case of a busbar fault, the protection shall trip and lock-out the incoming feeder of the faulty busbar on both sides of the transformer and trip and lock-out the bus coupling section breakers. The protection shall withstand short-circuit currents thermally and dynamically for 1 second.

3.7.4 Earthing System for Lightning protection

All relevant substation switch yard components such as high voltage MVA power autotransformers, feeders, system busbars, switch gear, tower etc. are poorly connected to ground potential (earth) to provide additional protection. During corona/lightning discharge surge arising from over voltage and current etc. The earth provision provides a low resistance path for diversion to earth.

Earthing or Grounding is the connection of electrical equipment to the general mass of earth by wire of negligible resistance. In other word earthing is the connection of conductor or frame of a device to the main body of the earth in such a manner that the resistance between the item and the earth is below prescribed limits. Earthing process often entails the burying of large assemblies of conducting rods in the earth and the use of connectors of large cross-sectional areas.

Generally power system earthing is provided with the following objectives:

- For the safety of personnel from electric shock.
- For the safety of the equipment and personnel against lightning and voltage surges providing the discharge path for surge arresters, gaps and other similar devices.
- For providing the ground connections for grounded neutral systems.
- For providing a means of positively discharging and de-energizing feeders or equipment before proceeding with maintenance on them.

The substation earthing/ grounding is in two parts: neutral (system) earthing and equipment earthing. Neutral earthing deals with earthing of the system neutral to ensure system security and protection, while equipment earthing deals with earthing of non-current carrying parts of the equipment to ensure safely of personnel and protection against lightning, open circuit and faults. The earth fault current from the equipment flows through the earthing system to the earth and is sensed by protection system and circuit breakers are opened. In a situation a rock of swampy soil is encountered, method of "deep well" technique will be employed.

3.8 INSULATORS

Insulators are glass insulators with ball and socket fittings, which prevent the passage of electric current. The insulators to be provided with the switches shall be designed and manufactured according to the electrical characteristics specified in the Technical Data Schedules. There are ceramics /Glass, Disc and Glass insulators. 330kV line tension string fittings and insulator strings shall be used for transmission line/cable installation. 330kV line tension string fittings and insulator strings shall be used for transmission line/cable installation. The 330KV suspension strings shall be single insulators (I) string assembly. The suspension string shall be used on 330KV strain towers, where necessary, to support jumpers loops. The glass insulator shell material shall be homogenous, without crystallization or internal defect and shall have been tempered to provide shock resistance. The surface shall be perfectly smooth without crystallization or internal defect and shall have been tempered to provide shock resistance. The surface shall be perfectly without imperfection that could cause a concentration of electrical field. Pins and caps shall be made of drop forged steel and malleable cast iron/spherical graphite iron/drop forged steel respectively, duly hot dip galvanized.

All ferrous parts shall be hot dip galvanized to give minimum average adherent coating of zinc equivalent to 600g/m2 and socket size shall be as per standards referred to in the Technical Data Schedule. Aluminium cement shall be used to bind the metallic parts with the insulator. The cement shall be not expansive with a limit of less than 0.12% the mechanical properties of the mortar shall be unvarying and ageing proof. Marking of insulators shall be performed as per requirements of standards mentioned in the Technical Data Schedule namely the name of the manufacturer, the month and year of manufacture, the tensile strength. In addition, the name of TCN shall also be marked of Identification of property. All insulators shall be interchangeable. All insulators shall be purchased with a locking pin made of stainless steel or phosphorus bronze. The suppliers shall include a spare quantity of 10% of locking pins. Where water environment is present, the insulators shall come with a corrosion retardation ring on the pin at cement line and made of 5 grams (minimum) pure zinc (99.5%purity minimum).

Suspension Clamps

The suspension clamp shall be armour grip suspension type (AGS). The AGS shall comprise retaining straps, support housing, elastomer inserts with aluminium reinforcement and AGS formed rod set Elastomeric cushion shall be resistant to the effect of temperature up to 75^{o}, ozone , UV radiation and other atmospheric contaminations. The physical properties of elastomer shall conform to approved standards. The clamps shall be able to take the longitudinal load capacity equivalent to 20% of corresponding conductors RTS.

The vertical breaking load of the clamp not be less than the strength of the insulators. The suspension clamps shall be designed for "electric losses" not exceeding 3 watts under operating current equal to conductor capacity at temperature indicated in the General Technical Requirement.

3.9 SIGNS AND ACCESSORIES

Transmission line signs and accessories shall mean anti-climbing devices, danger plates, line and tower number plates, phase identification plates, aerials tower number plates, cradles guards conductor and ground wire markers, circuit plates, anti bird device on the ground wire. Cradle Guards: cradle guards shall be designed to withstand the dynamic and static loads falling conductors and ground wires. Ensure specified clearances are maintained.

Ensure any rules and regulations stipulated by Railway Employer concerned are observed-
Paint: Submit for approval by the Engineer proposed tower paint and application procedure. Lighting: Submit for review by Engineer design, specifications and relevant calculations for tower and line lighting (where required). Marker Bells: Submit for approval by Engineer proposed installation scheme and technical specification for conductor marker bells.

3.10 TERMINATION BOXES

Termination boxes shall be installed inside the substation buildings, normally in the telecommunication or control room, to connect the incoming and outgoing fibre optic underground cable with telecommunication equipment. The termination boxes shall offer enough space to contain at least 24OFAC fibres and 24 fibres from the telecommunication equipment inclusive reserve length. In those substations which are connected via T-off connection, termination boxes which allow to connect 48 fibres shall be installed. An extra stripped off length of approximately 1.5 m of the fibres shall be left inside the termination box for repeat splices. It is required that the termination panel is protected against environmental influences, especially dust, by a suitable housing. The connection of the installed telecommunication equipment to the optical fibres of the underground cable inside the termination box is not within the responsibility of the OPGW contractor. The installation works of OFAC and telecommunication equipment must be coordinated with the telecommunication contractor. A name plate shall be fixed on the front of the box door.

3.11 SAFETY, SECURITY AND CONTINGENCY

Safety procedures demands that the operating staff adheres to all safety procedures. To stay at the working environment, erect and maintain fences around all open excavations, and other area where necessary to ensure safety and security. Maintain security checks and surveillance in all areas where work is being carried out and in all areas where plant and contractors equipment is stored. Ensure at any stage of construction that the works and plant are made secure when left unattended.

Install and maintain adequate lighting to provide sufficient light at all areas where work is being carried out during darkness (where approved) and all areas where light is required for security

reasons. Provide and maintain properly constructed tanks for the storage of fuels, oils and other hazardous materials. Locate such tanks at a safe distance from all work and living places, buildings, storage areas and vehicles parks. Prevent any fuel or oil or other hazardous or polluting substance from entering any stream, river or water course.
Provide all staff and workmen with safety helmets, goggles, gloves, safety booths, life jackets and ropes, fall arrestor and other protective clothing and equipment as may be required in carrying out the various types of work. More so it is expected that adequate health insurance would be provided for workers as may be contained in TCN health policy.
All the above mentioned equipment shall be made available at all times for the employer, his representatives and visitors.

3.12 STATION FIRE EXTINGUISHERS AND COMMUNICATION EQUIPMENT

Fire outbreak is not predictable at power station where current carrying equipment are in use. Where fire fighting equipment are lacking, it becomes extremely impossible to control fire when it breaks out. The primary requirement of the communications system is to provide a secure channel between the various switches and the substation. The communication channel also needed to allow remote connection to the switchgear intelligent electronic devices for the use of engineers and maintenance by the personnel. In case of emergency the communication equipment are very useful to salvage circumstance.

3.13 FIRST AID FACILITIES

By World Health Organization (WHO) standard on health and hazard management, first aid facilities shall be provided to ensure wellness of any accident victim and reduce the risk of hazards in the working environment.

- Provide and maintain first aid facilities at all places where applicable such as power substation switch yards, workshops, offices, stores accommodations, maintenance facilities etc. are situated and ensure that personnel trained in first aid are available in an emergency at all such places.
- Ensure the maintenance of a high standard of sanitation throughout the camp areas and elsewhere on the site.
- Provide sanitary conveniences for the use of all persons engaged on the site at such locations as may be necessary. At the main working sites, sanitary conveniences to be in accordance with the applicable Government regulations.
- Provide sanitary conveniences for the use of all persons engaged on the site at such locations as may be necessary. At the main working sites, sanitary conveniences to be in accordance with the applicable Government regulations.

3.14 FAULT LOCALIZATION/MAINTENANCE

Any construction and installation such as the 330kV transmission line will definitely develop faults and requires an efficient and effective fault localization method. Fault locator facility is to be provided. The line protection relay panel shall include a fault locator for locator shall provide the lines. The fault locator shall provide visual information to the operator by means of an LCD and or print out of the following:-

- ❖ Location of the fault in km or percent length of the line length

- ❖ Pre-fault and fault voltage and currents, including their magnitudes and phase angles
- ❖ Date and time of fault occurrence and magnitude of fault resistance. It shall be possible to communicate the fault records to the SCU-Station control unit serial interface.

For required software and hardware for evacuation of data from the relay to a PC and for fault-evaluation with a PC shall be supplied. PC - Personal Computer.
The fault locator range shall be at least 2.5 to 75 ohms for 1A rated current input

3.15 STEEL STRUCTURES AND EQUIPMENT SUPPORTS DESIGN

Substation structures shall be lattice or solid profile type fabrication from either steel W or C profiles or hollow structural sections. The design of the substation structures shall conform to the requirements of the applicable AISC "Manual od steel construction of ASCE 10-90 or equivalent and the requirements of this Technical Specification. Manual and ASCE 10-90 shall be replaced by the values given in this section Technical Specification.

3.16 RIGHT OF WAY AND ACCESS ROADS

Access to the right-of way is available by means of roads and tracks. The contractors shall make his own arrangement for access to the right –to way where required.

3.17 CONSTRUCTION PHASE

Based on the final route choice, definition of tower foundations, equipment and other engineering activities, and before starting the construction phase, the following preliminary activities will be performed:

- Land survey to fix tower location
- Clearing of right of way and
- Access to site

Once the above mentioned activities end, the construction phase will be performed as follows

- Excavation of foundation
- Erection of towers
- Grounding installation
- Installation of insulators and fittings
- Conductors stringing
- Stringing of aluminium clad-steel shield wire
- Clean up, final inspection and testing

3.17.1 Preliminary Activities

Land survey and tower location

Final survey of the route and the preparation of the line profile and plan will be performed to establish a true tangent line between angle points and to locate all the towers with an accuracy of plus or minus 0.3m. the maximum allowed lateral offset of a tangent tower from true centre line is 0.1 metre.

Clearing of Right-of-way

The clearing will consist of the removal and disposal of trees and other vegetation houses and huts, bam, cattle-sheds, etc. within a total width of 30 m, i.e 15 m on each of the centre of transmission line.
No vegetation will be left under the transmission line except trees or crops with

- A maximum height above the ground of not more than 3 meters if within the area of 15 m on either side of the transmission line centre line, or
- A minimum mature height above the ground of not more than 30 m if outside the area of 30 m on either side of the transmission line centre line.

Access to site

Construction of the necessary 3 meters wide access road is also part of the right of way clearing process. During construction, road and trucks used jointly with the landowners will remain usable at all times. All opening made in fences or walls of private properties will be equipped with locking doors or gates accessible to landowners and workers.

All necessary access permits as well as those required for the construction of the transmission line within the right of way will be obtained from local landowners and the agencies involved. This will be accomplished through the proper evaluation and payment of adequate compensation for all damaged structure, including economic losses due to the inability to cultivate land for agriculture.

The road or access path will, wherever possible, lie within the transmission line right of way and existing routes and caused minimum disturbance to the natural surroundings.

3.17.2 Erection Activities

Excavation for foundations will include all the excavation required for the installation of foundations, levelling around the individual tower foundations, and grading or preparation for construction at the tower site. Where necessary, adequate drainage will be provided around the tower site. Generally, excavated material will be laid aside to be for backfill and embankment at the tower site from which it was excavated and the excess material will be spread evenly around the site after completion of the foundation backfilling; unstable material and surplus material will be removed.

Erection of Tower

The towers and accessories will be erected in accordance with the approved detail shop and construction drawings. Tower will be complete with all members in place and bolts, including step bolts, securely tightened before any stringing work is started.

The tower may be erected by assembling in sections on the ground and hoisting or lifting successive sections in to place, or they may be erected in place on footings by installing individual members. At the end, the tower sign and anti-climbing devices on the tower will be installed.

Grounding installation

All towers will be permanently and effectively earthed.

The following resistance within 1.5km to the substation (excluding the counterpoise connecting the last 4 tower) will be 10 ohms or less.

Over the last eight (8) tower of the route in to any substation and all eight (8) tower will be connected together by a continuous counterpoise galvanized steel conductor. The counterpoise will be laid at the same level as the earthling around the towers.

Various component installations

The following components will be installed in accordance with the manufacturer's recommendations:

- Insulator
- Suspension and Dead-End accessories
- Compression Dead-End Fitting and joints for Conductor
- Compression Dead-End Fittings and joints for Galvanized steel shield wire
- Vibration Damper
- Reflectors

Conductors Stringing

After the conductors stringing and sagging operations, the conductors will be clamped-in accordance to the agreed procedure. Tension clamps will be installed and properly anchored prior to clamping-in at suspension strings. In order to make future adjustments possible, approximately one half of the available length adjustment of tumbuckles will remain after anchoring

Stringing of Aluminium clad steel Shield wire

The operations of stringing, sagging and clipping in of the aluminium clad steel shield wire are similar to those for the conductors.

Clean-up and Restoration

- **Clean-up**

All point, building, equipment, rubbish, concrete forms and other materials will be removed from the vicinity of the work. Unused materials will be incinerated or disposed of at places with will not be unsightly or objectionable to the inhabitants of the area.

- **Restoration**

The following will be restored

- All irrigation facilities to the condition existing before arrival on site;
- Natural drainage in area where temporary facilities have been made for construction purposes;
- Any fences, gate, etc.., which have been damaged during construction;
- Access roads to their original condition

3.17.3 Final Inspection

A final inspection of the completed work, prior to tests or completion will be carried out. During this inspection, all defects will immediately be remedied, and in particular, the inspection will ensure the following:

- Backfilling of the excavations, levelling around foundations, drainage requirements for footing on sloping ground, disposal of excess earth, etc., have to be completed.
- Concrete protruding above ground is correctly shaped, finished and sealed
- Bitumen painting has been correctly applied
- Towers are true to line and are vertically acceptable
- Tower accessories and signs are completely and correctly fitted

- Tower framework is free of all foreign matter
- Scratches or like damage to galvanizing has been carefully repaired
- Insulators are free from conspicuous foreign material, and all units are undamaged
- Conductors, aluminium clad steel shield wire and OPGW fitting have been erected in accordance with the drawings and are complete, and the line conductor, aluminium clad steel shield wires and OPGW are correctly clamped
- All conductors stringing pulleys, hooks and other equipment have been removed from the line.
- All bolts, nuts and cotter pins, washers and split pins on all fittings are properly fitted, tightened and locked
- Conductors, aluminium clad steel shield wires and OPGW are clean, without strand damage and free of foliage, loose wires, etc.
- The sag of all cables is in accordance with sagging documents, and clearance is correct.

3.17.4 Test on completion

All the test demonstrates that the transmission line is complete and ready to operate will be arranged and carried out. Commissioning test such as checking the behaviour of insulators, insulation, loss of charge, etc., using the appropriate equipment will be performed and documented.

The line's electric parameters such as insulation, resistance to AC and DC current and, the line phase-to-phase, phase-to-ground reactance and impedance, etc., will be measured and documented.

CHAPTER FOUR

DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 OVERVIEW

This chapter presents information on the existing environmental conditions in the project area and details of the materials and methods of baseline data collection for the different studies carried out for the project EIA. The scope of environmental components and the main indicator parameters used to characterize them are highlighted in Chapter five. The main source of information was through the field survey in which a strong team of experts (scientists, engineers and technologists) obtained site specific data and/or collected samples for determination as detailed below for the respective studies. Information on the existing environment makes it possible to determine the sensitivity of the environment and can be used as a benchmark against which subsequent changes in the environment can be determined and/or evaluated later through monitoring.

Data on the existing environment was also obtained from literature review sources mainly from the previous reports of Environmental Impact Assessment study in the study area. The environmental data gathering for the proposed project covered wet season while secondary was obtained for dry season in which TCN got waiver for one season data gathering in order to expedite the process. However, gaps in environmental baseline information of the area were identified, and fieldwork activities designed to acquire additional data to fill these gaps.

The field sampling / measurements during the wet season were carried out for about two weeks from October 17, 2016 adopting a multi-disciplinary approach. The Federal Ministry of Environment and International Finance Corporation Guidelines and Standards were strictly adhered to in the course of field sampling and measurements. The environmental components covered include topography, climate/Meteorology, air quality and noise, soil, vegetation, animal ecology, wildlife, water quality and hydrobiology. Others were geology/geophysics/hydrogeology, socio-economics, health status assessment and waste management. The selected sampling points for each study were geo-referenced using Global Positioning System (GPS) handset. The locations of some of the sampling points are shown in Figure 4.1.1.

The Quality Assurance/quality Control (QA/QC) procedures covered all aspects of the study, including sample collection, handling, laboratory analyses, data coding and manipulation, statistical analyses, presentation and communication of results. Chain of custody procedures including sample handling, transportation, logging and cross-checking in the laboratory were also implemented. All analyses were carried out in FMEnv accredited laboratory (Obafemi Awolowo University, Ile-Ife Central Laboratory- appendix 3). The methods of analyses used in this study were those specified in Federal Ministry of Environment Guidelines and other internationally accepted analytical procedures, in order to ensure the reliability and integrity of the data obtained. The procedures for the laboratory analyses are in Appendix 2.

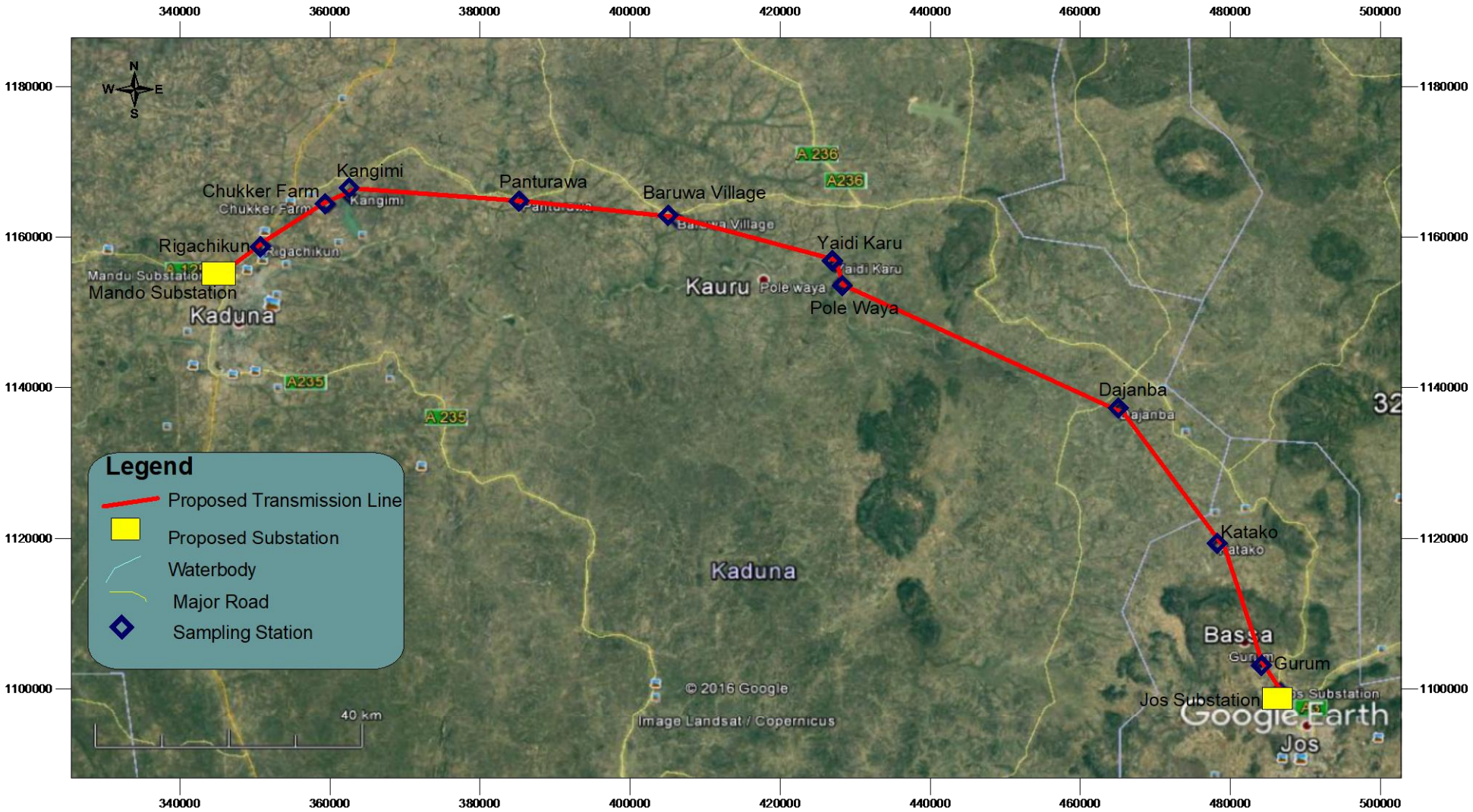

Figure 4.1.1: Sampling Locations along Proposed Transmission line

4.2 BASELINE DATA ACQUISITION

4.2.1 CLIMATE AND METEOROLOGY

4.2.1.1 Methodology

Information on the climate and meteorology of the project area is based largely on data on Jos and Kaduna, the two principal towns in the area which incidentally are also state capitals and among the few towns in the country with longterm meteorological data records dating over seventy years back. The major literature sources on the two towns include the works of Papadakis (1962) and Ojo (1977) both on the climates of West Africa. The information obtained from these literature sources has been complemented with recent data obtained from the Nigerian Meteorological Department (NIMET) as well as from the site specific data obtained from direct mearesuments during the EIA study fieldwork.

4.2.1.2 Results and Discussions

Jos, the capital of Plateau State in the North Central region of Nigeria is one of the few towns in the country with a meteorological station predating the amalgamation of the two protectorates that formed Nigeria. The agro meteorological station was originally located on latitude $09^0 52^1$N and longitude $008^0 54^1$E on an altitude of about 1290m (≈4220ft) above the mean sea level (amsl), being one of the highest of such stations in the country. Following the classification scheme of Papadakis (1962), Jos Climate Code is 1.73 i.e. Moist Monsoon climate typical of frostless highlands (*Tierra Templada*). This climate is characterised by cool nights with average daily minimum temperature of all months of the annual cycle below 20^0C (68^0F).

The establishment of a meteorological station in Kaduna (capital of Kaduna State in North Central Region of Nigeria) dates back to early 1930s, then located on latitude $10^0 36^1$N and longitude $007^0 27^1$E on an altitude of about 650m (≈2120ft) amsl. The climate of Kaduna is classified as Hot Equatorial Tropical with moist dry Monsoon characterised by five months of humid months (climate code = 1.483 of Papadakis, *op. cit.*).

Temperature

Table 4.2.1.1 compares the long term (LT) and recent time (RT) monthly temperature regimes in both Jos and Kaduna. Extreme temperatures occurred in the range of 10.0 – 33.4^0C in Jos and 14.4 – 36.6^0C in Kaduna. The monthly minimum temperature in Jos occurred in the range of 10.0 – 18.9^0C (i.e. generally less than 20^0C) while in Kaduna it was generally higher (14.4 – 22.0^0C). Similarly, the range of maximum temperature in Kaduna (27.7 – 36.6^0C) was also generally higher than in Jos (24.4 – 31.2^0C). In both locations however, minimum temperature attains a peak mostly in April whereas maximum temperature attains a leak mostly in March. In Jos, whereas recent time mean minimum temperature (16.4 ± 1.6^0C) is higher than the longterm values (14.8 ± 2.4^0C), the inverse is the case for the mean maximum temperature, i.e. the recent time mean maximum value (27.7 ± 2.4^0C) is lower than the longterm value (28.6 ± 2.7^0C). On the other hand, in Kaduna, for both minimum and maximum temperature, the annual mean values were generally higher in recent time (2012 - 2015) compared to long term values, suggesting a general increase in temperature in recent time (confirming occurrence global warming).

Table 4.2.1.1: Comparison of Long Term (LT) and Recent Term (RT) monthly temperature in Jos and Kaduna.

Month	JOS				KADUNA			
	Min. Temp (^{0}C)		Max. Temp (^{0}C)		Min. Temp (^{0}C)		Max. Temp (^{0}C)	
	LT	RT	LT	RT	LT	RT	LT	RT
January	10.0	13.6	29.3	28.0	15.1	14.6	31.7	32.7
February	13.6	15.4	31.7	30.6	16.8	18.6	33.7	36.0
March	15.5	18.0	33.4	31.2	19.8	20.9	34.8	36.3
April	17.2	18.9	31.4	30.5	21.7	22.0	34.5	36.6
May	17.6	18.0	29.9	28.4	21.1	21.7	31.9	35.0
June	16.6	17.2	26.9	26.6	19.9	20.8	30.1	30.9
July	16.3	17.1	25.5	24.2	19.6	20.2	27.7	29.8
August	15.9	16.4	24.4	23.8	19.5	20.3	29.1	29.1
September	15.8	16.8	26.2	25.7	19.3	20.2	29.6	29.9
October	15.4	16.6	28.3	27.7	18.8	19.3	31.4	33.4
November	12.8	15.6	28.6	28.5	15.7	16.6	32.9	34.0
December	11.1	13.7	28.6	27.7	14.4	15.0	32.0	32.3
Mean	14.8	16.4	28.6	27.7	18.5	19.2	31.6	33.0
S.D.	2.4	1.6	2.7	2.4	2.4	2.5	2.2	2.7
Median	15.7	16.7	28.6	27.9	19.4	20.2	31.8	33.1

LT = Long term
RT = Recent term (2012 - 2015)

Wind Regime

Like in most parts of Nigeria, the wind patterns in Jos and Kaduna are determined largely by the occurrence of the moist maritime winds from the south and the dry cool continental winds originating from the Sahara Desert. The seasonal pattern of the prevailing winds and wind types (by speed) are presented in Table 4.2.1.2. In Jos the order of prevailing winds over the annual cycle is E>W>SE>NE comprising of E>W>SE>NE in the dry season (November - April) and E>W>SE>NE in the rainy season (May - October). For both seasons, the dominant wind type is light breeze (6 – 10km/hr) followed by fresh breeze (11 – 15km/hr) and strong breeze (15 – 20km/hr) with the percentage occurrence of 56.5%, 30.4% and 13.1% in the dry season and 86.9%, 15.1% and 0.0% in the rainy season. In Kaduna, the frequency of prevailing winds is E>NE>S>W>N in the dry season and SW>W>E>NE in the rainy season respectively. The wind types are limited only to light air (1-5km/hr) and light breeze 37.5% and 62.5% in the dry season and 62.5% and 37.5% in the rainy season respectively.

The monthly mean wind speeds in the two towns over the annual cycle are compared in Table 4.2.1.3. The ANOVA statistics confirm that wind speed is significantly higher ($P \leq 0.05$) in Jos than in Kaduna with the overall annual range and mean values of 2.9 – 9.4km (mean±sd = 5.07±1.31km/hr) in Kaduna and 0.0 – 20.0km/hr (10.31±2.73km/hr) in Jos. Thus, the average wind speed in Jos is double that of Kaduna ($P<0.05$).

Table 4.2.1.2: Seasonal variations in wind direction and wind speed in Jos and Kaduna

Location	Season wind direction order	% frequency of wind types			
		Light Air	Light Breeze	Fresh Breeze	Strong Breeze
JOS	DS E>W>SE>NE	0.0	56.5	30.4	13.1
	RS W>E>NE>SE	0.0	86.9	13.1	0.0
	Annual E>W>SE>NE	0.0	71.7	21.7	6.6
KADUNA	DS E>NE>SW>N	37.5	62.5	0.0	0.0
	RS SW>W>E>NE	62.5	37.5	0.0	0.0
	Annual E>SW>W>NE	50.0	50.0	0.0	0.0

DS = Dry Season (November – April) RS = Rainy Season (May - October)

Table 4.2.1.3: Monthly variation for Wind Speed in Jos and Kaduna

Month	Kaduna		Jos		Anova	
	Min-Max.	Mean± S.D.	Min-Max.	Mean± S.D.	F	P
January	5.6-9.4	6.8±1.77	10.1-13.2	11.275±1.39	15.78	0.007346
Feburary	4.8-6.4	5.65±0.82	9.9-10.6	10.175±0.31	106.9	4.78E-05
March	4.1-7	5.25±1.27	10-16.1	12.15±2.79	20.33	0.004065
April	4.5-6.2	5.13±0.76	10.4-12	11.3±0.67	149.2	1.83E-05
May	3.8-5.6	5.05±0.85	9.9-11.2	10.58±0.62	109.1	4.52E-05
June	5.4-6.1	5.78±0.33	9.4-11.2	10.45±0.86	103.4	5.27E-05
July	4.7-5.9	5.1±0.54	9.9-20	12.73±4.86	9.708	2.07E-02
August	3.8-5.4	4.63±0.66	9-11.1	10.23±1.01	86.81	8.66E-05
September	2.9-4.6	3.65±0.71	7.2-9.2	8.48±0.89	70.59	1.55E-04
October	2.9-3.3	3.08±0.17	6-9.6	7.95±1.54	39.84	7.38E-04
November	3.7-5.3	4.23±0.75	6.6-10	9±1.62	28.42	1.78E-03
December	5.4-7.4	6.53±0.98	0-15.1	9.48±6.67	0.7667	4.15E-01

Relative Humidity (RH)

The monthly range and mean±sd values of % relative humidity (RH) in Jos and Kaduna over one annual cycle are compared statistically in Table 4.2.1.4. The range and mean values in Jos (range = 0.0 – 92.0% mean±sd = 62.2±25.7%) are higher (F = 2.01, P=0.16) than those of Kaduna (19.0 – 84.0%, mean±sd = 55.1±23.0%). The monthly mean values increase steadily from January through to a peak in August and thereafter decrease to December. The mean values for the two towns are significantly different (P≤0.05) from May to september being muvh higher in Jos than in Kaduna. As obvious from Table 4.2.1.5, the Humidity Index (HI) in Jos is in the range of 0.00 – 5.21 (median = 7.7) as opposed to 0.00 – 4.31 (median = 3.3) in Kaduna.

Table 4.2.1.4: Monthly variation for in Relative Humidity (%) in Jos and Kaduna

Month	Kaduna		Jos		Anova	
	Min-Max.	Mean± S.D.	Min-Max.	Mean± S.D.	F	P
January	23-30	26.5±4.04	24-37	31.75±5.74	2.24	0.19
February	23-29	26.75±2.87	26-36	30±4.54	1.46	0.27
March	19-40	31±8.83	23-47	39±11.11	1.27	0.3
April	28-59	50.5±15.02	35-74	63.5±19.02	1.15	0.32
May	61-71	67.75±4.57	72-82	78±4.89	9.36	0.02
June	74-77	75.5±1.29	81-87	85.25±2.87	38.34	0.0008
July	78-81	79.5±1.29	88-92	89.75±1.71	91.69	7.41E-05
August	82-84	83±0.82	91-92	91.25±0.5	297	2.45E-06
September	79-82	80.75±1.26	82-88	85.75±2.63	11.76	0.01397
October	64-75	69.5±5.80	72-79	76±3.16	3.87	0.09671
November	38-46	41±3.83	45-55	50±4.76	8.679	0.02575
December	27-33	29.75±2.5	0-37	26±17.45	0.1809	0.6854

Table 4.2.1.5: Monthly variation in Humidity Index in Jos and Kaduna

Town	J	F	M	A	M	J	J	A	S	O	N	D
Jos	0.01	0.04	0.14	0.54	1.93	2.73	4.63	5.21	2.84	1.00	0.18	0.02
Kaduna	0.00	0.01	0.06	0.33	1.16	1.72	3.04	4.31	3.06	1.00	0.27	0.00

Rainfall

The likelihood of the onset and cessation of rainy season in Jos and Kaduna are given in Table 4.2.1.6. Generally, the onset of the rains is about one week earlier in Jos than in Kaduna while the cessation is also about one week later in Jos than in Kaduna. On the average, the rainy season covers 185 days in Jos as opposed to 173 days in Kaduna. Information is provided in Table 4.2.1.7 on the number of rainy days per month for both Jos and Kaduna. On the average, there is rain at least every other day in Jos from May to September as well as from June to September in Kaduna. However, based on maximum recorded values per month, rains occur almost from July to September in Jos and from August to September in Kaduna (Table 4.2.1.7). The diurnal distribution of rain over the hours of the day on percent probability of rainfall over the 24 hours of the day is in the range of 2 – 28% over the annual cycle (Ojo, 1977). The probability increases steadily from 10% to over 20% between the hours of 14 – 20 GMT hr (2 – 10pm local time) from July to September (Ojo, *op cit.*).

Based on available long term records (Akintola, 1986) the annual rainfall values recorded over the period 1931 – 1983 in Kaduna show a minimum of 899.6mm (in 1939) and a maximum of 1654.3mm (1983). Comparable values in Jos over the period 1922 – 1983 have a minimum of 948.6mm (1961) and a maximum of 1729.4mm (1948). This shows that although the extreme annual rainfall values in Jos and Kaduna are comparable, the values for Jos are generally higher than that of Kaduna. The descriptive statistics of monthly rainfall over the annual cycle for both Jos and Kaduna are presented in Table 4.2.8. In Kaduna, the monthly mean rain amount increases steadily from January (0.22±0.27mm) through to a peak in August (293.3±11.6mm) of the year. Similarly in Jos, the rain amount increases from January (1.8±0.7mm) through the months to a peak in July (348.1±36.8mm) and then decreases to the end of the year (Table 4.2.8b). Based on longterm records (Ojo, 1977) the rainfall pattern in Jos is positively correlated to that of Kaduna (r=0.60), Yola (0.46), Kotangora (0.50), Zaria (0.46), Port Harcourt (0.46), Calabar (0.30) and Forcados (0.34).

The longterm frequency distribution of rain intensities over the annual cycle in Jos and Kaduna are shown in Table 4.2.1.9a&b. Rain events during the dry season and early rain season are mostly as drizzle and light rains while over the period of July – October rains occur as heavy and very heavy events both in Jos and in Kaduna. Information in Table 4.2.1.10 reveals that whereas monthly and annual total rainfall in recent time is less than the long term value in Jos, the reverse is the case in Kaduna where the recent time values are much more than the long term values suggesting that the impact of climate change on the two towns are different.

Table: 4.2.1.6: Onset and Cessation of Rainy Season in Jos and Kaduna

RAINFALL REGIME	**JOS**	**KADUNA**
Onset of Rain		
Expected	April 5	April 20
Early	March 31	April 5
Late	April 30	May 5
CESSATION OF RAIN		
Expected	October 16	October 10
Early	October 1	October 25
Late	October 31	October 25
Duration (days)	185	173

Source: Akintola (1986)

Table 4.2.1.7: Longterm number of rainy days in Jos and Kaduna

Location	Statistics	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
JOS	Mean	0.3	0.3	3.1	7.9	15.2	17.5	23.8	31.1	18.8	6.5	0.4	0.2
	Min.	0	0	0	1	7	10	19	15	9	0	0	0
	Max.	4	3	8	16	22	22	29	30	28	18	3	2
KADUNA	Mean	0.1	0.3	0.2	5.3	12.1	15.7	18.0	21.5	21.2	7.9	0.6	0.0
	Min.	0	0	0	0	6	10	8	13	17	1	0	0
	Max.	10	3	3	13	21	21	24	28	27	22	4	0

Table 4.2.1.8a: Statistical Analysis of Longterm monthly rainfall (mm) in Kaduna 1931 – 1983

Month	Min	Max	Mean	s.e.m	Median	Mode	Skewness	Kurtosis
Jan.	0.00	14.50	0.27	0.27	0.14	0.00	7.00	47.06
Feb.	0.00	50.80	3.13	1.43	0.03	0.00	3.70	12.34
Mar.	0.00	84.84	12.60	2.74	3.60	0.00	2.55	5.26
Apr.	0.00	232.66	54.54	7.28	37.30	0.25	232.66	1.24
May	14.51	309.88	133.53	8.57	122.40	14.51	0.417	-0.27
June	45.30	275.90	168.10	6.43	172.47	142.49	-0.22	0.39
July	85.80	354.00	218.03	8.08	221.99	157.73	0.01	-0.28
Aug.	42.00	466.85	293.28	11.66	299.99	209.30	-0.32	0.07
Sep.	22.85	466.60	254.86	12.66	262.38	22.85	-0.10	-0.18
Oct.	0.00	255.81	72.49	9.24	43.43	23.60	1.22	0.44
Nov.	0.00	42.10	3.50	1.20	0.00	0.00	2.77	7.16
Dec.	0.00	33.78	0.66	0.62	0.00	0.00	6.99	47.00

s.e.m = standard error of mean

Table 4.2.1.8b: Statistical Analysis of Longterm monthly rainfall (mm) in Jos 1916 – 1983.

Month	Min	Max	Mean	s.e.m	Median	Mode	Skewness	Kurtosis
Jan.	0.00	34.29	1.79	0.73	0.03	0.00	4.01	17.07
Feb.	0.00	66.04	2.25	1.13	0.00	0.00	6.22	41.04
Mar.	0.00	112.52	20.32	3.24	70.68	0.00	1.91	3.60
Apr.	0.00	995.00	105.56	15.98	81.50	97.28	5.78	38.07
May	35.05	1913.00	212.67	29.28	169.94	159.00	6.55	45.53
June	105.16	2063.00	241.22	30.75	201.31	105.10	6.97	49.56
July	67.56	2494.00	348.11	36.76	310.00	277.33	6.64	46.57
Aug.	121.29	2946.0	325.37	43.86	282.21	311.9	7.15	51.39
Sep.	80.80	1907.00	246.35	28.48	211.59	193.80	6.63	46.36
Oct.	0.00	412.00	53.43	8.97	30.24	0.00	3.27	12.26
Nov.	0.00	45.47	3.33	1.21	0.02	0.00	3.32	101.68
Dec.	0.00	34.00	1.35	0.68	0.01	0.37	4.59	22.11

s.e.m = standard error of mean

Table 4.2.1.9a: Longterm frequency distribution of monthly rainfall (mm) in Jos

SN	Class Interval (mm)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	0	82	79	19	0	0	0	-	-	-	4	76	86
2	1-5	18	21	72	19	0	0	-	-	-	39	24	14
3	6-10	-	-	9	60	10	3	-	-	2	46	-	-
4	11-15	-	-	-	19	38	22	-	2	9	10	-	-
5	16-20	-	-	-	2	47	67	9	18	61	1	-	-
6	21-25	-	-	-	-	5	8	69	58	26	-	-	-
7	26-30	-	-	-	-	-	-	22	22	2	-	-	-

Source Akintola (1986)

Table 4.2.1.9b: Longterm frequency distribution of monthly rainfall (mm) in Kaduna

SN	Class Interval (mm)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	0	90	80	28	2	30	3	-	-	-	-	-	-
2	1-5	10	20	72	48	52	50	-	-	-	38	70	5
3	6-10	-	-	-	48	15	42	5	5	42	32	30	95
4	11-15	-	-	-	2	3	5	15	35	50	20	-	-
5	16-20	-	-	-	-	-	-	60	47	8	7	-	-
6	21-25	-	-	-	-	-	-	20	13	-	3	-	-
7	26-30												

Source Akintola (1986)

Table 4.2.1.10: Comparison of Longterm and Recent term variations in monthly rainfall (mm) in Jos and Kaduna

Location	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
JOS	LT	1.8	2.3	20.3	105.6	212.7	241.2	348.1	325.4	246.4	53.4	3.3	1.4	1561.7
	RT	0.0	10.6	9.5	123.1	181.5	197.6	328.7	196.7	179.7	55.6	0.0	0.0	0.0
KADUNA	LT	0.3	3.2	12.6	54.6	133.5	168.1	218.0	293.3	254.9	72.5	3.5	0.7	1214.2
	RT	0.0	0.0	21.9	91.7	113.0	182.4	272.8	420.3	391.3	86.7	0.0	0.0	1585.1

LT = Longterm (2030 - 1984) RT = Recent term = (2012 - 2015)

Evapotranspiration (EPP)

The longterm records of potential evapotranspiration (PET) and Humidity Index (HI) in Jos and Kaduna are presented in Table 4.2.1.11. In general, PET was higher in Kaduna than in Jos all through the 12 months of the annual cycle with annual values of 1563mm in Jos and 1920mm in Kaduna. The pattern of monthly variation is the same in the two towns. This pattern is characterised with a peak in February followed by a steady decrease through to a minimum in August at the peak of rainfall.

Humidity Index followed the inverse pattern of evapotranspiration but directly correlated to rainfall in both towns. Monthly values rose from a minimum in January steadily through the months to a peak in August with a total annual value of 19.26 in Jos and 14.91 in Kaduna. The relationship between PET and HI shows that the annual regime in both towns is characterised by a pre-humid period of January to April, a humid period of May to September and a post humid period of October to December in both Jos and Kaduna.

Table 4.2.1.11: Longterm Potential Evaporation Transpiration and Humid Index (PET) In Jos and Kaduna

Town	Parameter	J	F	M	A	M	J	J	A	S	O	N	D	Total
JOS	PET (mm)	180	199	197	154	112	83	58	54	76	116	164	170	1563
	HI	0.01	0.04	0.14	0.54	1.93	2.73	4.62	5.21	2.84	1.00	0.18	0.02	19.26
KADUNA	PET (mm)	224	248	241	191	126	99	69	68	95	135	207	217	1920
	HI	0.00	0.01	0.06	0.33	1.16	1.72	3.04	4.31	3.06	1.00	0.27	0.00	14.91

PET = Potential Evapotranspiration HI = Humidity Index

4.2.2 Air Quality

4.2.2.1 Methodology

Ambient air was sampled for the purpose of analyzing for the common atmospheric pollutants *in situ* along the ROW using portable gas and particulate analyzers at sampling points established at each sampling station along the proposed transmission line. Sampling locations and coordinates are given in Table 4.2.2.1.

Table 4.2.2.1: Sampling Coordinates for Air Pollutants & Noise Measurements

S/N	Sampling Station	Co-ordinate (Datum Minna, Zone 32)	
		Easting	Northing
1.	Mando Substation	0326286	1171052
2.	Pole Waya	0418482	1168438
3.	Yaidi Karu	0417590	1171366
4.	Baruwa Village	0394124	1178560
5.	Panturawa	0371052	1181566
6.	Rigachikun	0332574	1174821
7.	Chukker Farm	0342072	1181461
8.	Kangimi	0345400	1182756
9.	Dajanba	0459722	1147940
10.	Katako	0474324	1126609
11.	Gurum	0480195	1108411
12.	Jos Substation	0483331	1103902

The concentrations of carbon monoxide (CO), oxides of nitrogen (NOx), Sulphur dioxide (SO_2), Non Methane Hydrocarbon (NMHC), and Hydrogen Sulphide (H_2S) in the ambient ambient air were measured using RAE multi gas analyzer made in U.S.A. Suspended Particulate Matter (SPM) was determined with PPM 1055 handheld aerosol monitor. Twelve (12) locations were identified and established for the air quality measurement. The measurements were carried out at heights of 1.6m above ground level. The measurements were carried out over the one-hour averaging period at all sampling locations.

4.2.2.2 Results and Discussions

A summary of the findings of the ambient air quality measurements taken for the study area is presented in Table 4.2.2.2 with due reference to FMEnv standards.

Table 4.2.2.2: Air Quality Characteristics of the Study Area

Sampling Station	TSP	SO_2	NO_2	CO	H_2S	NMHC
	$\mu g.m^{-3}$	ppm				
Mando Substation	96.00	0.05	<0.01	<1.00	<0.1	<0.1
Pole Waya	105.00	0.01	<0.01	<1.00	<0.1	<0.1
Yaidi Karu	124.00	0.02	<0.01	1.00	<0.1	<0.1
Baruwa Village	93.00	0.01	<0.01	1.00	<0.1	<0.1
Panturawa	42.00	<0.01	<0.01	<1.00	<0.1	<0.1
Rigachikun	154.00	0.02	<0.01	2.00	<0.1	<0.1
Chukka Farm	99.00	<0.01	<0.01	<1.00	<0.1	<0.1
Kangimi	58.00	<0.01	<0.01	<1.00	<0.1	<0.1
Dajanba	58.00	<0.01	<0.01	<1.00	<0.1	<0.1
Katako	51.00	0.01	<0.01	<1.00	<0.1	<0.1
Gurum	86.00	0.01	<0.01	<1.00	<0.1	<0.1
Jos Substation	78.00	0.02	<0.01	1.00	<0.1	<0.1
[b] Range of EIAs Baseline data for Dry Season (2014)	**221-323**	**0.002-0.032**	**0.021-0.055**	**0.1-0.90**	**0.001-0.002**	

Source: EIA Wet Season Field Survey, 2016 & [b]EIA for Abiba Solar Project, 2014

Table 4.2.2.3: Regulatory Standards for Ambient Air Quality

S/N	Contaminant	Averaging Period	Maximum Concentration (μg/m^3)		
			WHO	FMENV[a]	World Bank[b]
1.	CO	1 – Hr			30,000 (26.2ppm)
2.	NO_2	24 – Hr		75 – 113 (0.04-0.06ppm)	150
		1 – Hr	200 (0.11ppm)		
3.	SO_2	1 – Hr	125	260(0.1ppm)	
		24 – Hr		26(0.01ppm)	
4.	TSP	1 – Hr		600	
		24 – Hr		250	80

[a]Source: FME (1991); [b]Source: World Bank (1998)

Total Suspended Particulate TSP

TSP concentrations obtained ranged from 42 to 154μg/m^3 during wet season field survey while dry season concentrations obtained from previous study ranged from 221 to 323 μg/m^3. The measured values along the transmission line and substations were below FMEnv maximum allowable levels of 600μg.m^{-3} and previous EIA studies around the project area.

Sulphur Dioxide (SO_2)

The levels of SO_2 were between 0.010 and 0.040ppm during survey and below the FMEnv limits of 0.10ppm. Anthropogenic contribution to SO_2 load was apparently insignificant at the proposed transmission line ROW.

Nitrogen dioxide (NO_2)

The NO_2 concentrations were insignificant at all sampling locations during wet season. The secondary values obtained for the dry seasons ranged from 0.021-0.055ppm (Table 4.2.2.2). Therefore, the concentrations at all sampling location for wet and dry season are below limit of 0.11ppm (Table 4.2.2.3).

Carbon Monoxide (CO)

As expected, low concentrations were measured at all sampling stations due to a very short life span property of CO to be suspended in the air for long period. The concentrations measured and obtained from the previous study ranged from 0.1 to 2ppm which are still within the standard limit of 26ppm (Table 4.2.2.3). Therefore, there was no significant seasonal variation.

Hydrogen Sulphide (H_2S)

The levels of H_2S measured were less than 0.1ppm. The predominant source of ambient H_2S is the anaerobic degradation of wastes. Although there are no standards set for H_2S, the low levels obtained for the dry season should not attract any precautionary measures.

Non-Methane Hydrocarbon (NMHC)

The measured concentrations during wet season were below 0.1ppm and below the results obtained from previous study for the dry season (Tables 4.2.2.2 and 4.2.2.3).

4.2.3 Noise Level Measurements

4.2.3.1 Methodology

Noise level measurements were carried out using an CEL-24X sound level meter with data logger from Casella Instruments, UK, for the continuous measurements (short period- one-hour averaging period). The equipment was calibrated before and after usage. The same sampling locations and rationale for site selection reported for Air Quality were used as noise measurement. Measurements were made at a height of approximately 1.2 m above the ground level (See Table 4.2.2.1).

4.2.3.2 Results and Discussions

The noise levels (Table 4.2.3.1) measured varied from 37.10 to 66.60dB (A) in the period of survey. The highest noise level was recorded at Rigachikun while lowest noise level was recorded at Chukka farm (remote area). The main sources of noise in the study area are vehicular movement and human conversation. The results indicate that the average noise levels recorded at the different receptors along the proposed transmission line ROW were below the maximum allowable Laeq (Hourly 85 dB (A)) limit of FMEnv and within the range value of previous EIA study in the study area.

Table 4.2.3.1: Noise Level of the Study Area

Sampling Station	**Noise Level L_{Aeq}(dBA)**
Mando Substation	55.10
Pole Waya	41.50
Yaidi Karu	56.40
Baruwa Village	48.20
Panturawa	42.10
Rigachikun	66.60
Chukker Farm	37.10
Kangimi	34.50
Dajanba	51.20
Katako	39.70
Gurum	44.0
Jos Substation	53.3
[b] **Range of EIAs Baseline data for Dry Season (2014)**	**50.8-67.00**
Standards	**85.00**

Source: EIA Wet Season Field Survey, 2016 & [b]EIA for Abiba Solar Project, 2014

4.2.4 GEOLOGICAL AND GEOPHYSICAL INVESTIGATIONS

4.2.4.1 Methodology

Geological/Hydrogeological Investigation

The literature on the geology and hydrogeology of the study area were reviewed. Direct observation of outcrop and superficial deposits in areas around the sampled localities was made.

Geophysical Investigation

The geophysical investigation involved the electrical resistivity method. A low frequency electric current (I) was passed into the ground through a pair of current electrodes while the resulting potential difference (ΔV) was measured across another pair of potential electrodes located within the current electrode pair. The VES technique involved the Schlumberger array. The inter-electrode spacing (AB/2) was varied from 1 m to 100 m with a maximum spread length of 200 m. The apparent resistivity values were calculated from the equation:

$$\rho_a = \pi \frac{RL^2}{2l}$$

where ρ_a is the apparent resistivity

R is the ground resistance (note R=ΔV/I)

ΔV is the potential difference

I is the energizing current

L (AB/2) is half the current-current electrode spacing

l is half the potential-potential electrode spacing; and

π is a constant (22/7).

Nine (9) VES stations were occupied along the proposed transmission line and one (1) sounding station each was occupied at the substation in Jos and Kaduna respectively, resulting to a total of eleven (11) sounding stations as shown in Figure 4.2.4.1. The description and geographical co-ordinates of the VES stations are shown in Table 4.2.4.1. Plate 4.2.4.1 shows geophysical team on site.

Data Presentation

The VES data are presented as depth sounding curves obtained by plotting the apparent resistivity values against the electrode spacings on bi-log graph papers.

Preliminary quantitative interpretation of the VES curves involved segment-by-segment matching of the sounding curves starting with 2-Layer model curves starting from small electrode spacing and progressing gradually to large spacing. The partial curve matching interpretation results (layer resistivities and thicknesses) were used as starting model parameters in a 1-D computer assisted forward modeling involving WinResist software. The VES interpretation results are presented in Table 4.2.4.2.

Figure 4.2.4.1: Geophysical Team on Site

Table 4.2.4.1: Description of VES Stations and Geographical Coordinates

Test Point (VES)	Co-ordinates				Elevation (m)	Town/ Village	Existing Tower
	UTM (Zone 32)		Geographic				
	Easting (m)	Northing (m)	Latitude	Longitude			
1	326286	1171052	10º 35' 26"	7º 24' 44"	629	Kaduna	Sub-station
2	418482	1168438	10º 34' 12"	8º 15' 18"	673	Pole-waya	225
3	417590	1171366	10º 35' 47"	8º 11' 31"	658	Yadi-Kauru	208
4	394129	1178560	10º 39' 40"	8º 01' 55"	694	Barwa	165
5	371052	1181566	10º 41' 15"	7º 49' 15"	658	Pariturawh	112
6	332575	1174823	10º 37' 30"	7º 28' 10"	618	Rigachikum	19
7	342072	1181461	10º 41' 08"	7º 33' 22"	626	Chukker Farm	45
8	483331	1103902	9º 59' 14"	8º 50' 52"	1160	Jos	Sub-station
9	480195	1108411	10º 01' 41"	8º 49' 09"	1156	Gurum	437
10	474324	1126609	10º 11' 33"	8º 45' 56"	860	Katako	393
11	459722	1147940	10º 22' 08"	8º 37' 55"	782	Damjaba	333

Table 4.2.4.2: VES Interpretation Results

VES No.	DEPTH (m) $d_1/d_2/d_3/\ldots\ldots/d_{n-1}$	RESISTIVITY (ohm-m) $\rho_1/\rho_2/\rho_3/\ldots\ldots/\rho_n$
1	1.3/11.8/101.9	426/796/108/∞
2	2.0/8.2/11.1/18.4	348/142/2427/16/∞
3	1.8/9.4	65/130/1150
4	1.3/25.9	346/73/∞
5	0.6/1.4/9.1/28.8	203/2048/195/25/∞
6	0.9/1.6/5.3/20.1/137.2	112/387/151/405/227/∞
7	1.1/13.6	231/57/∞
8	0.8/1.9/6.4/33.8/53.4	254/368/49/122/33/∞
9	0.9/10.7/45.9	1152/154/117/∞
10	0.9/7.2	227/73/∞
11	1.0/6.4/13.3	288/137/22/1252

The interpretation results are used to generate the geoelectric section.

4.2.4.2 Results and Discussion

Geology of the Project Area

The Proposed Jos - Kaduna Transmission Line is underlain by the Jurassic young granitic rocks at the Jos axis and undifferentiated Precambrian Basement Complex rocks at the Kaduna ends (Figure 4.2.4.1). The lithological units along the transmission line are contained in Table 4.2.4.3.

Table 4.2.4.3: The Geology beneath the Proposed Jos - Kaduna Transmission Line

VES	Site Description	Lithological Unit
1	Mando (Kaduna) Substation	Migmatite
2	Pole-wire	Migmatite
3	Yadi-Kauru	Migmatite
4	Barwa	Migmatite
5	Panturawa	Granite
6	Rigachikum	Migmatite
7	Chukker Farm	Granite
8	Jos Substation	Granite
9	Gurum	Quartzite
10	Katako	Granite
11	Damjaba	Granite

(Sources of Geological Information: Direct Observation around the VES Stations)

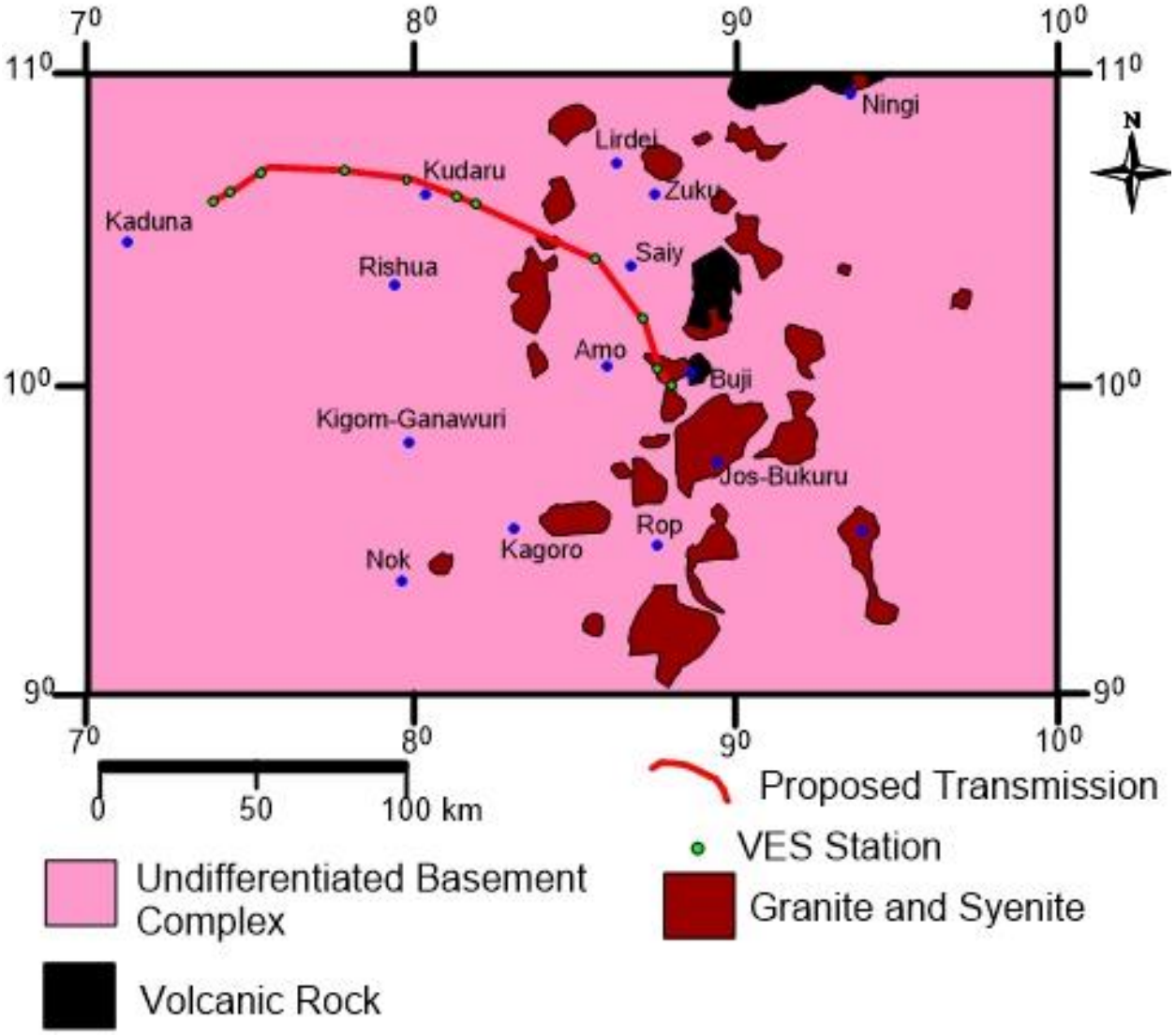

Figure 4.2.4.2: Generalized Geological Map of the Study Area (Adapted from Turner, 1989)

Hydrogeological Characteristics

The groundwater is contained in the fractured Basement and the weathered layer columns. Groundwater yield is dependent on the degree of fracturing and weathering. It is highest where groundwater flow is assisted by fractures.

Recharges and Discharges

The major source of aquifer recharge in the project area is surface precipitation (rainfall). The moderately annual average rainfall over the area ensures adequate groundwater recharge. Other sources include lateral water movement from streams and rivers and basal groundwater flow. Discharge sources include groundwater abstraction from boreholes and hand dug wells located within the project area and evapo-transpiration.

Geophysical (Geoelectric) Characteristics

General Features of the VES Curves:

The VES curves, within the limits of the electrode spread, are the H, A, QH, KH, HKH and KHKH type.

Geoelectric Parameters and Geoelectric/Stratigraphic Sections:

Figure 3 displays the geoelectric section along the proposed transmission line. The subsurface sequence and the geoelectric characteristics are the following:

1st Layer: Topsoil: Clay/Sandy Clay/Clayey Sand/Laterite.
Resistivity: 65 - 1152 ohm-m; Thickness: 0.9 – 1.9 m

2nd Layer: Weathered Layer: This is composed of Clay/Sandy clay/Clayey Sand/laterite, but predominantly Sandy clay.
Resistivity: 49 - 796 ohm-m; Thickness: 4.4 – 24.6 m

3rd Layer: Fractured Basement
Resistivity: 16 - 227 ohm-m; Thickness: 6.9 – 117.1 m

4th Layer: Fresh Basement
Resistivity: 1150 - ∞ ohm-m; Rockhead at: 6.4 – 25.9 m

Groundwater Quality

In the study area, the weathered basement and the fractured basement rocks are generally known to host fresh water.

Soil Resistivity and Corrosivity Evaluation

Low electrical resistivities arising from reduced aeration, increased electrolyte saturation or high concentration of dissolved salts in soils are indicative of good conducting path. Such low resistivity media are known to precipitate severe corrosion. Based on Baeckmann and Schwenk, 1975; Agunloye, 1984 and the British Standard BS – 1377, soil resistivity can be classified in terms of the degree of soils corrosivity as shown in Table 4.2.4.4.

Table 4.2.4.4: Classification of Soil Resistivity in terms of its Corrosivity

Soil Resistivity (ohm-m)	Soil Corrosivity
Up to 10	Very Strongly Corrosive (VSC)
10 – 30	Very Corrosive (VC)
30 – 60	Moderately Corrosive (MC)
60 – 180	Slightly Corrosive (SC)
180 and above	Practically Non-Corrosive (PNC)

The subsoil resistivity within the depth range of 0 – 2 m within which the base of the transmission line towers could be founded varies from 60 – 700 ohm-m (Figure 4.2.4.3). Based on Table 4.2.4.3 above, soils with layer resistivity values within this range are slightly corrosive to practically non-corrosive. Metal structures embedded within transmission line tower foundation may not be under significant threat of corrosion.

Electrical System Earthing

Heavy electrical transformers (high voltage substations) require to be properly earthed. The earthing medium must have high electrical conductivity or low electrical resistivity. Clays are usually good earthing media and are characterized by layer resistivity values in the 1 - 100 ohm-m range. The sub-soils (up to 4.0 m) within which transformers could be earthed have resistivity values varying from 75 – 680 ohm-m typical of sandy clay/clayey sand and laterite. The proposed transmission line is generally underlain by high resistivity sub-soils at upper 4 m, hence they are generally poor earthing media. The conductivity of the sub-soils along the transmission line may need to be enhanced with clay or brine (salt) to make them good earthing materials.

Subsoil Engineering Characteristics

The Basement bedrock constitutes the competent bedrock in the subsurface sequence delineated beneath the proposed transmission line. The low permeability clayey weathered layer Formation constitute the incompetent overburden since the topsoil is generally thin. Depths to the competent Basement bedrock vary from 6.4 – 25.9 m. There is high risk of settlement of transmission line tower foundation unless the foundations (platforms) of the towers are anchored on friction piles.

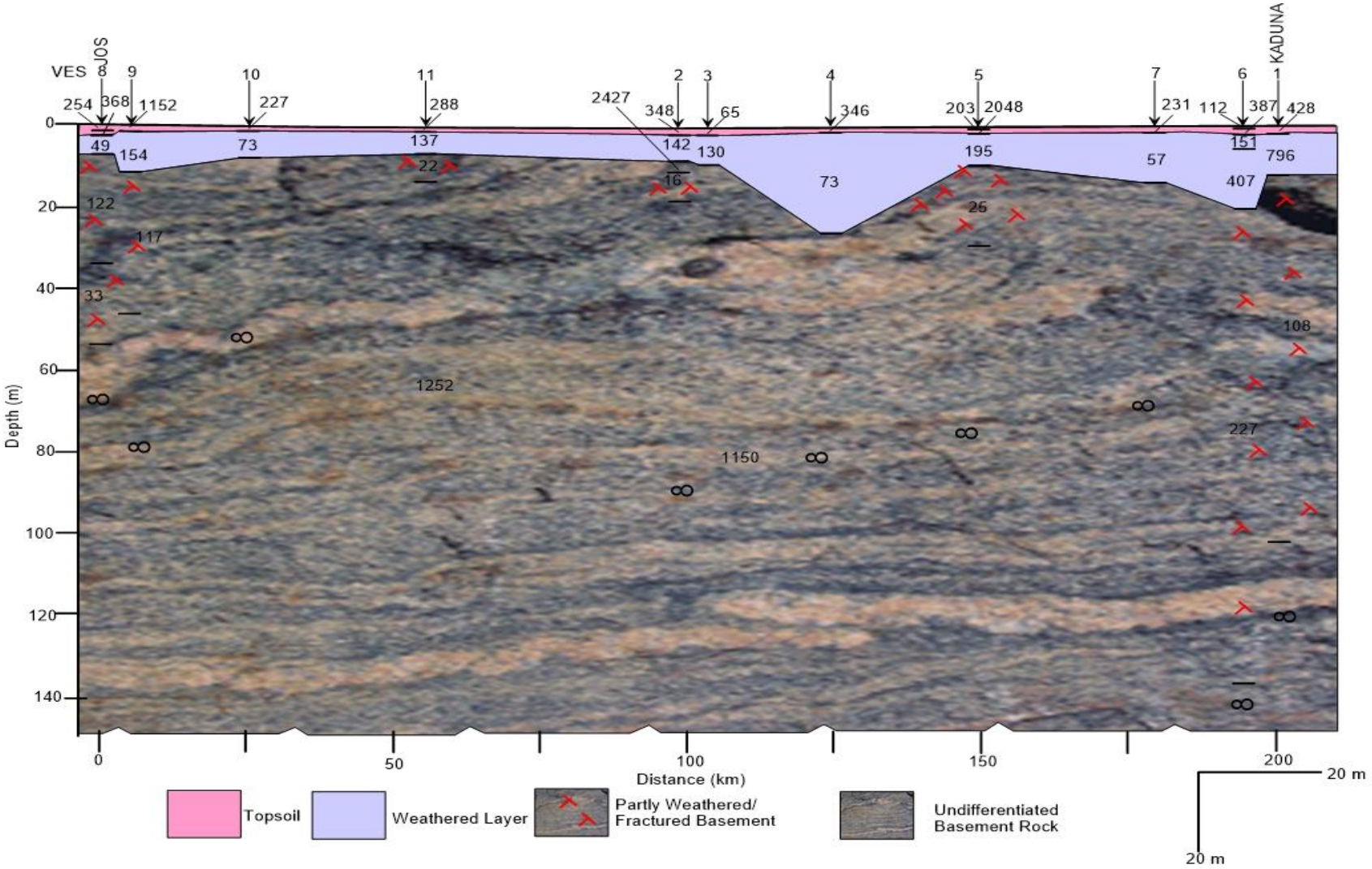

Figure 4.2.4.3: Geoelctric Section along the Proposed 200km Jos – Kaduna Transmission Line

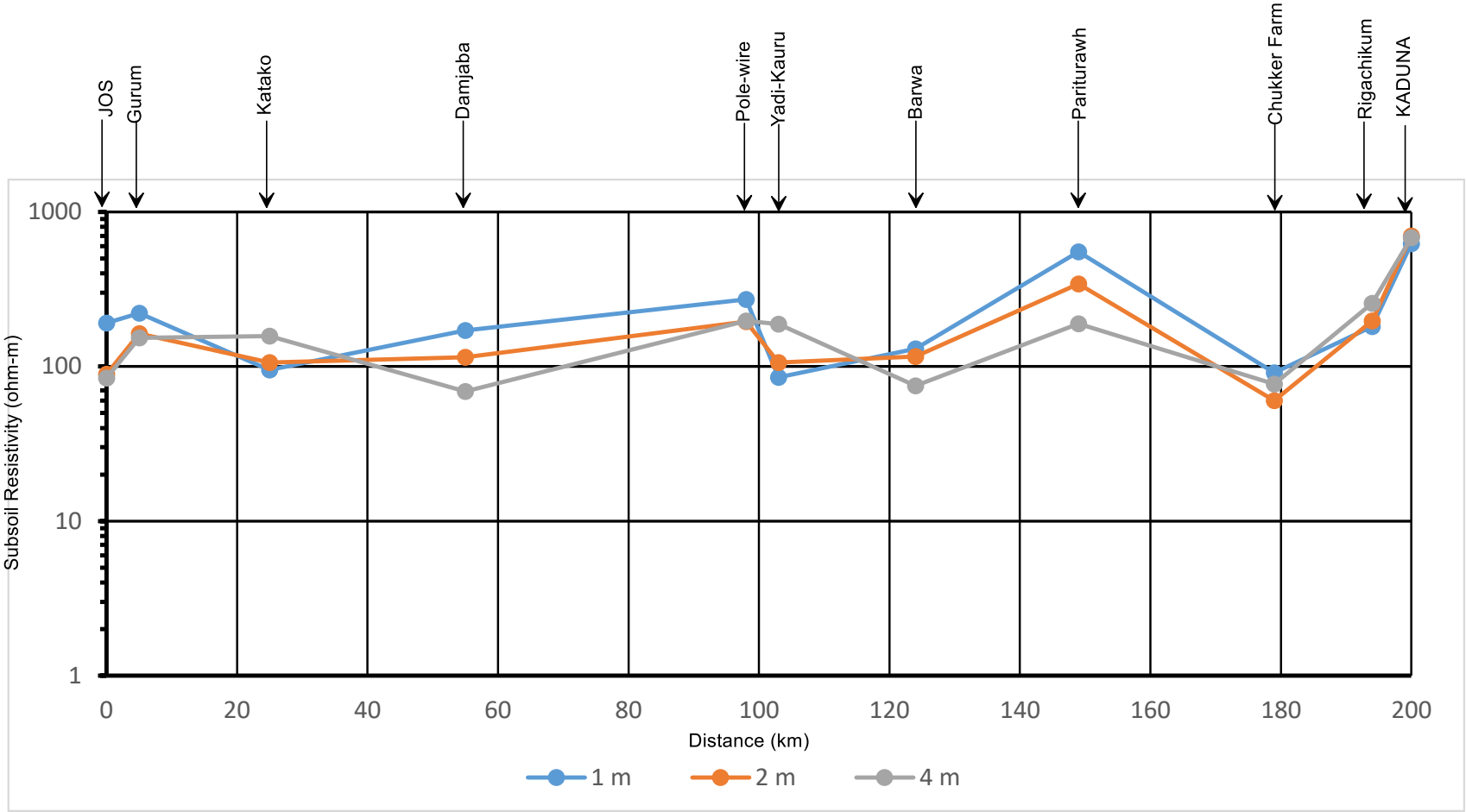

Figure 4.2.4.4: Subsoil Resistivity along the Proposed 200km Jos – Kaduna Transmission Line

4.2.5 SOIL AND LAND USE STUDIES

4.2.5.1 Methodology

Soil samples were taken at about 20 km interval along the route while direct observations of soil formation were made at 10 km interval along ROW of proposed transmission line. The survey map of the proposed transmission route was obtained from TCN and the sampling stations were guided by the existing transmission line that is parallel to the one proposed in this project. The location co-ordinates were obtained using GPS receivers (so as to pin point the exact locations as we moved along the route). The geographical co-ordinates for the sampling points from Kaduna to Jos substation are presented in Table 4.2.5.1.

At each soil sampling location, representative soil samples were collected at two depths (0-15, 15-50 cm), representing the topsoil and subsoil depths, respectively. The sub-soil boundary represents the control section on which the classification of the soil can be based. Soil samples were collected from each genetic horizon within the depth chosen or to the water table or lithic contact for shallow soils according to the FAO guideline for soil profile description (FAO, 1977). To ensure the collection of representative soil samples, 10 core soil samples taken within 5 -10 m radius of the sampling location were composited in plastic bucket, and thoroughly homogenized before sub-sampling for laboratory analysis. In all, there were twelve (12) soil sampling and observation locations. Although Kangimi location was close to the sampling location at Choker Farm, nevertheless, the terrain was given an observation (without soil sampling) because the proposed line will cross a river that is relatively big (see the section on surface and groundwater quality for more information) and the water used to irrigate a farmland in the riparian zone. The soil sampling locations were geo-referenced on the field using handheld GPS. The environment at each observation point was also briefly described in terms of vegetation; land use and erosion (see Plate 2.2). Soil samples collected were for the following:

- Physico-chemical characterization;
- Heavy metals determination;
- Organics

Table 4.2.5.1: Description of soil sampling and observation stations

No	Sample Name	Site Description	Coordinates	
			N	E
1	Mando (Kaduna) Substation	Adjacent existing Substation Facility	$10^0$35.452	$007^0$26.640
2	Chukker Farm	Arable farmland on hill wash & oil pipeline crossing a river	$10^0$41.113	$008^0$33.310
3	Riga Chikun	Urban farmland beside the National Teacher Institute	$10^0$37.543	$008^0$28.177
4	Panturawa	Arable farmland	$10^0$41.226	$008^0$49.210
5	Barwa	Arable farmland	$10^0$39.664	$008^0$01.912
6	Yadi-Kauru	Arable farmland	$10^0$35.790	$008^0$11.437
7	Pole Waya Community	Arable farmland	$10^0$34.209	$008^0$15.236
8	Danjaba	Arable farmland	$10^0$23.137	$008^0$37.884
9	Katako	Arable farmland within a rural settlement	$10^0$11.596	$008^0$45.861
10	Gurum	Arable farmland with medium fallow	$10^0$01.785	$008^0$49.087
11	Jos Substation	Adjacent existing Substation Facility	$09^0$59.156	$008^0$50.739
12	Kangimi	Irrigated arable farming near a relatively big river crossed by an existing line	$10^0$41.854	$007^0$35.089

Plate 4.2.5.1: Collection of soil sample using auger at a sampling location

4.2.5.2 Results and Discussions

The approximately 200 km Kaduna – Jos Transmission line and Associated Substation Facilities Project, involving 300 KV DC Transmission Line and Associated Substation Facility Project, passes through a terrain belonging to the rock in the basement complex category. Except for the locations of the substations in Kaduna and Jos metropolis the terrain is predominantly arable farmlands with small settlements and villages. The whole transects covered various geomorphic units. Soil investigation is essential for the Environmental and Social Management Plan for the transmission project because it is a receptor for all waste and related discharges. It is known to have limited capacity for waste storage, filtration and purification through decomposition. It also varies in the capacity to anchor and chemically interact with structures built or buried in it. Hence the necessity to study the capacity of the soil vis-a-vis the type of waste amongst other.

The physical and chemical properties of the soils of the proposed transmission route are presented in Table 4.2.5.2. The corridor passed through a long strength of agricultural land used principally for arable agriculture making the soil to be predisposed to some degrees of erosion especially in areas with steep slope.

Physical Properties

In general, the soils ranged in texture from sandy loam to sandy clay in the topsoil (top 15cm of soil profile) and from sandy loam to clay loam at the lower (15 cm – 30 cm) soil depths with the sand fraction varying from 37% - 69% and generally decreased with depth in the profile. The percentage silt content varied from 16%-48% while the clay content varied from 13% - 39%. The soil reaction was mainly in the acidic range and may limit the production of most arable crops. The ECEC of the soil is between 2 and 11 cmol kg^{-1} of soil confirming the soil to be moderately fertile and in the presence of no major limitation should be able to support most arable crops. The exchangeable cation sites of the soil are dominated by basic cations (Ca, Mg and K) with base saturation ranging from 72% to 96%. The organic matter and available phosphorus contents of the soil is just moderately adequate for most crops implying that regular application of fertilizers are required to sustain crop productivity.

Soil Heavy Metals

The soils heavy metals contents presented in Table 4.2.5.3 shows that the values are within the permitted ranges for either agricultural or urban soils. The soil Cd was between 0.01 $\mu g\ g^{-1}$ and 0.34 $\mu g\ g^{-1}$. The Cr, Ni and Zn contents of the soil show levels not much different from the background levels for these elements. A slightly elevated content of Pb was however recorded in Gurum both the surface and subsurface soil layers. These are however below the unsafe levels for soil Pb.

Table 4.2.5.2: Physico-chemical properties of soil along the Jos– Kaduna Transmission Line

Depth	pH in CaCl2	Soil Particle Size			Texture	OC	P	Exchangeable bases				Exch. Acidity		CEC	BS
		Sand	Silt	Clay				Ca	Mg	K	Na	Al	H		
cm		%				%	ppm	cmol kg^{-1}							%
Katako (31N 0474189 1126791)															
0-15	4	39	42	19	L	1.72	4.6	7.25	1.10	0.34	0.30	0.30	0.40	9.68	92.77
15-50	4.4	37	33	30	CL	0.55	4.71	9.95	1.78	0.41	0.27	0.20	0.30	12.91	96.13
Chukker farm (31N 0451354 1181209)															
0-15	4.6	45	32	23	L	0.55	7.97	7.95	1.70	0.41	0.21	0.30	0.40	10.97	93.62
15-50	5	41	38	21	L	0.94	8.86	5.88	1.12	0.75	0.21	0.10	0.50	8.55	92.99
Danjaba (31N 0459651 1148072)															
0-15	5.1	61	26	13	SL	0.55	6.62	4.93	0.71	0.39	0.19	0.40	0.20	6.82	91.20
15-50	5.3	55	26	19	SL	0.59	5.61	6.55	0.85	0.31	0.16	0.30	0.20	8.37	94.02
NTI (31N 0441987 1174645)															
0-15	5.6	51	24	25	SCL	0.43	8.86	7.65	0.65	0.67	0.23	0.30	0.30	9.79	93.87
15-50	5	41	24	35	CL	0.35	7.97	4.22	0.69	0.50	0.19	0.40	0.40	6.39	87.48
Barwa (31N 0394114 1178670)															
0-15	5	39	48	13	L	0.43	6.84	2.49	0.72	0.54	0.21	0.10	0.30	4.35	90.82
15-50	5.2	59	22	19	SL	0.59	8.41	3.09	1.11	0.91	0.25	0.10	0.30	5.75	93.05
Pole Waya Com (31N 0418378 1168549)															
0-15	4.9	53	34	13	SL	0.35	5.72	2.61	0.60	0.52	0.21	0.20	0.30	4.43	88.71
15-50	4.8	31	38	31	CL	0.12	5.72	3.90	1.26	0.50	0.19	0.10	0.20	6.14	95.12
Kaduna (Mando) Substation (31N 0331591 1171158)															
0-15	5.3	59	26	15	SL	0.59	8.08	4.23	0.62	0.63	0.20	0.20	0.30	6.18	91.91
15-50	5.6	57	22	21	SCL	0.35	7.85	3.71	0.49	0.44	0.17	0.10	0.30	5.20	92.31
Yadi Kauru (31N 04114459 1171480)															
0-15	5.2	67	18	15	SL	0.43	7.52	3.82	0.47	0.37	0.17	0.30	0.20	5.32	90.60
15-50	4.8	61	19	20	SL	0.39	5.83	3.30	0.43	0.49	0.18	0.30	0.20	4.89	89.78
Jos Substation (31N 0483083 1103861)															
0-15	5.4	69	18	13	SL	2.46	6.84	4.48	0.62	0.52	0.26	0.30	0.20	6.37	92.16
15-50	4.6	61	20	19	SL	0.43	6.17	2.84	0.51	0.21	0.18	0.30	0.20	4.22	88.16
Panturuwa (31N 0480334 1181388)															
0-15	4.2	39	24	37	CL	0.27	8.98	1.61	0.82	0.14	0.15	0.30	0.30	3.32	81.94
15-50	4.5	57	26	17	SL	0.23	7.52	0.71	0.45	0.21	0.20	0.30	0.30	2.17	72.31
Gurum (31N 0480069 1108707)															
0-15	4.2	45	16	39	SC	0.59	8.08	2.56	0.60	0.24	0.14	0.20	0.40	4.14	85.51
15-50	4.4	53	16	31	SCL	0.78	10.99	2.95	1.44	0.36	0.16	0.50	0.30	5.72	86.01

L = Loam, CL = Clay loam, SL = Sandy loam, SCL = Sandy clay loam, SC = Sandy clay

Table 4.2.5.3: Heavy metals contents of the Jos-Kaduna Transmission Line

Depth	Cd	Cr	Pb	Ni	Zn
Katako (31N 0474189 1126791)					
0-15	0.29	1.54	3.72	2.2	0.28
15-50	0.05	0.42	1.97	1.93	0.16
Chukker farm (31N 0451354 1181209)					
0-15	0.06	2.61	2.72	2.58	0.14
15-50	0.18	1.03	2.16	1.82	0.34
Danjaba (31N 0459651 1148072)					
0-15	0.04	2.97	0.81	2.57	0.27
15-50	0.01	0.99	0.91	2.08	0.66
NTI (31N 0441987 1174645)					
0-15	0.19	0.69	1.02	2.43	0.6
15-50	0.03	0.67	1.7	2.89	0.58
Barwa (31N 0394114 1178670)					
0-15	0.1	1.21	0.74	3.47	0.13
15-50	0.12	1.02	1.45	2.27	0.31
Pole Waya Com (31N 0418378 1168549)					
0-15	0.08	1	2.18	1.67	0.26
15-50	0.16	1.73	2.46	2.93	0.13
Mando (Kaduna) Substation (31N 0331591 1171158)					
0-15	0.24	0.59	4.28	3.75	1.3
15-50	0.22	0.76	4.02	3.66	0.29
Yadi Kaura (31N 04114459 1171480)					
0-15	0.29	1.06	3.1	3.51	0.72
15-50	0.17	1.29	2.91	3.22	0.47
Jos Substation (31N 0483083 1103861)					
0-15	0.19	1	5.96	3.22	1.13
15-50	0.3	0.99	3.56	2.03	1.67
Panturuwa (31N 0480334 1181388)					
0-15	0.21	0.79	3.67	3.21	1.52
15-50	0.28	0.67	1.62	1.95	0.19
Gurum (31N 0480069 1108707)					
0-15	0.3	0.61	7.03	0.27	0.23
15-50	0.22	0.56	5.81	1.36	0.32

Table 4.2.5.4: The distribution of bacteria and fungi in the soils along the Jos-Kaduna Transmission Line

Soil Depth (cm)	Microbial population (CFU g^{-1})			
	THB	HDB	THF	HDF
Chukker farm (31N 0451354 1181209)				
0-15	3.0×10^7	7.4×10^6	2.2×10^4	2.1×10^2
Barwa (31N 0394114 1178670)				
0-15	3.8×10^7	3.6×10^6	2.5×10^4	1.9×10^3
Mando (Kaduna) Substation (31N 0331591 1171158)				
0-15	2.6×10^7	2.2×10^6	4.5×10^3	2.6×10^2
Jos Substation (31N 0483083 1103861)				
0-15	3.1×10^7	1.2×10^6	4.2×10^4	3.2×10^2
Panturuwa (31N 0480334 1181388)				
0-15	2.2×10^7	1.9×10^6	3.8×10^6	4.1×10^3
Gurum (31N 0480069 1108707)				
0-15	1.7×10^7	1.1×10^7	2.4×10^6	2.8×10^3

Soil Microbiology

The high population of the heterotrophic bacteria and fungi (Table 4.2.5.3) is a further indicator that the soils along the transmission corridor has not been much contaminated. Moreover, the higher population of soil bacteria compared to fungi is typical of uncontaminated soils. The population of hydrocarbon degraders in the soil are much lower than the heterotrophs. This is a further confirmation of low level or non-contamination of the soils by hydrocarbon from extraneous sources.

Land use

The predominant land uses encountered in the non-built up areas studied were bush fallowing and arable crop farming. The primary use of land in the communities along the proposed transmission line is for agriculture making up about 80% of the land area. Most of the land area were cultivated to surface-feeding arable crops such as Maize (*Zea mays*), followed by cassava (*Manihot esculenta*), yam (Dioscorea spp), cowpea *(Vigna unguiculata)*, groundnuts *(Arachis hypogeal)* and sorghum (*Sorghum bicolor)*. in a descending order. There were several mixed farms consisting of either maize/cassava, maize/soybean or maize/cowpea planted in relays. The built-up areas constitute about 5% of the total land area studied.

4.2.6 Terrestrial Vegetation

4.2.6.1 Methodology

Plant species composition, density and habitat conditions were studied in detail using the Quadrat and Belt Transect Methods. Sampling was carried out along transects at the site. The lengths of the transects varied depending on the real extent of the vegetation being studied. Systematic samples were collected at regular intervals of Twenty (20) kilometres and a plot measuring 20m x 25 m (that is 500m^2) was used for sampling at every sampling point. The name and co-ordinates of each sampling point were recorded. All plants within each quadrat were systematically evaluated with plants, identified to species level and the number of individuals of each species enumerated. Specimens of plant species that could not be readily identified on the field were collected and pressed in a plant press and taken to IFE Herbarium (Obafemi Awolowo University) for proper identification. The number of strata in the vegetation was noted and the dominant species recorded. The height of trees was measured with measuring tape and Haga altimeter. Where counting of individuals was not possible e.g. in situations where there are creeping plants, cover was measured according to Greig-Smith (1983).

4.2.6.2 Results and Discussions

The vegetation along proposed 200km Jos - Kaduna Transmission Line ROW on the basis of structure and species composition has been classified as Northern Guinea Savanna made up of mixtures of trees, shrubs, herbs and grasses. The species nomenclature is in accordance with Hutchinson and Dalziel of Flora of West Tropical Africa (Hutchinson and Dalziel, 1954-1972). On the basis of density, proportion of plant species and their distribution, the major types of vegetation were revealed. Plates 4.2.6.1- 4.2.6.5 show few of the typical vegetation types encountered in the project area.

Floristic Composition, Distribution, Density and Diversity of Vegetation

The floristic composition of the vegetation along the proposed transmission line corridor is diverse in species even over a relatively homogenous area. A total of 41 plant species belonging to 17 families/sub-families and comprising trees/shrubs, herbs and grasses were recorded within the proposed project area during the sampling. The families/sub-families that had high frequency of occurrence of plant species include Caesalpiniaceae, Ochnaceae, Mimosaceae, Rubiaceae, Annonaceae, Combretaceae, Verbenaceae, Ulmaceae, Loganiaceae, Euphorbiaceae, Sapotaceae, Meliaceae.

Plant species with frequencies of occurrence of 50% and above (abundant) within this vegetational zones along the proposed transmission corridor (200 km) includes: The *Afzelia africana, Isoberliana doka, I.dalzielii, Monotes kerstingii and Uapaca togoensis* were the most abundant and dominant trees which were mainly sapplings in most of the areas sampled along the transmission route. Other common woody species encountered along the route include: *Daniella oliverii*, Vitex *doniana*, *Vitellaria paradoxa, Piliostigma thonningii, Terminalia spp, Anogeisus leicarpus, Burkea africana, Indigofera pulchra, Parkia biglobosa, Mangifera indica and Combretum spp . Ageratum conyzoides* was the dominant herb while others were *Sida acuta, Tridax procumbens, Aspilia africana, Waltheria indica, Euphorbia heterophylla, E. Hirta* and *Hyptis artrorubens. Andropogon gayanus, Hyparrhenia, Schizachyrium sanguenium* and *Pennisetum polystachion* are the major grasses.

Trees of the family Caesalpiniaceae (e.g *Afzelia africana, Isoberliana doka, I.dalzielii Piliostigma thonningii*) and Ochnaceae (*Monotes kerstingii)* are particularly common in the study area. The legumes thus accounted for a greater proportion of the trees. This is similar to the observations of Hopkins (1974) and Sanford (1982). Within the study area the dominant trees were thus *Afzelia africana, Piliostigma thonningii* (Caesalpiniaceae), *Monotes kerstingii* (Ochnaceae), and *Vitex doniana* (Verbenaceae) and these form an association. Of the smaller trees and shrubs, species of *Piliostigma thonningii, and Annona senegalensis* are common. The herbaceous genera encountered belong mainly to the families Fabaceae, Euphorbiaceae, Cleomaceae and Asteraceae. The commonest monocotyledonous plants belonged to the families Poaceae, Araceae and Cyperaceae.

The results of the mean plant density and diversity, as well as biomass of the herbaceous layer are presented in Table 4.2.6.1**.** Within the study area (savanna woodland vegetation) mean tree and shrub density were 255/ha, the herbs have low biomass in the savanna woodland except within vegetation in the weedy farmland.

Plant species diversity is high in this savanna woodland vegetations, but stem girth measurements at breast height are smaller in this savanna woodland.

Table 4.2.6.1: Plant density, diversity and biomass of vegetation within the study area

S/N	Vegetation Type	Mean Plant Density		Biomass of herbaceous layer (kg/ha)	Species Diversity Index
		Trees and Shrubs (No/ha)	Herbaceous layer (No/m^2)		
1	Savanna Woodland	255	985	2250	0.450
2	Crop/Farmland	73	15	1525	0.410
3	Grassland	14	88	789	0.155

Structures and Physiognomy

The vegetation is typically savanna woodland and farmland. In this savanna woodland, the trees and shrubs form a canopy, which is generally light. In terms of its vertical structure, the savanna woodland profile shows a tree stratum, 8-12 m high with a generally high canopy, but open in most part along the route. Below this tree stratum and indistinctly differentiated from it, is a shrub stratum also with an irregular canopy 2-5m high. Finally is the herb stratum, dominating the ground cover and consisting mainly of grasses growing up to about 1.0-3.0 m high. About 65% of the plant species are Phanerophytes, whereas about 15% are Hemicryptophytes (mainly grasses), 12% Crytophytes (including geophytes) and 8% Therophytes (annual plants). No Epiphytes and Chamaephytes were encountered. Within the woody plants, very tall ones (Megaphanerophytes) were absent. Most of the Phanerophytes here were deciduous and shed their leaves during the dry season.

Table 4.2.6.2: Comparative Features of the Vegetation Types found in the Study Area

Vegetation Types	Coordinate and Station	Dominant plant species	Density of Woody species	Species diversity	Maximum tree height
Farmland	10^0 35.452'N; 007^0 26.640'E (Mando - Kaduna Sub station)	*Psidium guajava, Terminalia catapa, Citrus spp, Tridax procumbens, Calotropis procera, Sida acuta,Waltheria indica,Ageratum conyzoides, Abelmoscus esculentus*	Low	Medium	4m
Farmland	10^0 34.209'N; 008^0 15.236'E (Pole Wire)	*Sorghum bicolor, Vigna unguiculata, Soybean, Oryza sativa, Abelmoscus esculentus, Capscum spp, Zea mays*	Medium	Medium	4m
Farmland	10^0 35.790'N; 008^0 11.437'E (Yadi-Kauru)	*Zea mays,Sida acuta, Cassia spp, Ageratum conyzoides, Aspilia africana, Euphorbia spp*	low	Very low	3m
Farmland + Fallowland	10^0 39.654'N; 008^0 01.955'E (Barwa)	*Capsicum* spp, *Sorghum bicolor*, Soybean, *Vigna unguiculata, Ageratum conyzoides, Abelmoscus esculentus,Penisetum spp*	Medium	Low	4m
Farmland	10^0 41.226'N; 008^0 49.210'E (Pariturawh)	*Oryza sativa, Abelmoscus esculentus, Penisetum spp, Zea mays, , Capsicum spp, Potato,*	Low	low	8m
Fallowland	10^0 37.543'N; 008^0 28.177'E (Rigachikun)	*Ricinus communis, Mangifera indica,Gmelina arboreus,Ageratum conyzoides, Sida acuta, Abelmoscus esculentus, Euphorbia spp, Hyptis spp,*	Very low	Medium	5m
Fallowland	10^0 41.048'N; 008^0 33.261'E (CHUKKER Farm)	*Afzelia africana, Isoberliana doka, I.dalzielii, Monotes kerstingii , Uapaca spp, Waltheria indica, Indigofera spp, Lantana camara*	High	High	7m
Fallowland (Grassland)	09^0 59. 165' N; 008^0 50.714' (Jos Substation)	*Psidium guajava, Vigna*	Very low	Very low	4m

		unguiculata, Ageratum conyzoides, Ipomea spp, Tithonia diversifolia, Andropogon gayanus, Hyparrhenia, Schizachyrium sanguenium and *Pennisetum polystachion*.			
Fallowland	10^0 01.692'N; 008^0 49.085'E (Gurum)	*Lantana camara, Acacia hockii, Mangifera* indica, Terminalia catapa, Harungana madagascariensis, *Piliostigma thonningii, Sida acuta, Tridax procumbens, Aspilia africana, Waltheria indica, Euphorbia spp,*	High	High	8m
Farmland	10^0 11.574'N; 008^0 45.888'E (Katako)	*Musa spp, Oryza sativa, Sorghum bicolor, Tomatoes,*	Low	Low	3m
Fallowland	10^0 23.158'N; 008^0 37.879'E (Danjaba)	*Ageratum conyzoides, Waltheria indica, Euphorbia spp, Hyparrhenia, Schizachyrium sanguenium* and *Pennisetum polystachion*.	Low	Medium	3m

Morphology of the Plants

Most of the trees and shrubs have very thick (usually more than 1cm thick) and corky barks / trunks that are twisted and gnarled as a result of the frequent fires in the savanna area which have regulated their growth. Most of the grasses are perennial and grow in tufts with bare grounds between them during the dry season but close-up during the wet season. The outer portions of these tufts appear to protect the inner parts from fire; thus enabling these grasses,

most of which have their surviving buds at the ground level (Hemicryptophytes), to survive the burning during the dry season. Growing on the bare ground between the perennial grass tufts during the dry season were occasional Geophytes. Most of the herbs, both grasses and forbs, possess fibrous root system.

Economic Plants

A checklist of the common economic plants within the study area is presented in Table 4.2.6.3. The density of the economic plants in the study area is about 180/ha. More than 50% of the total number of economic plants per hectare of land area is legumes of the sub-families Mimosaceae and Caesalpiniaceae. The economic importance of these plants vary and they include their uses as fuel, timber, dyes, vegetable, edible fruits and seed trees, medicinal and religious plants and sponge. The economic trees include *Vernonia amygdalina, Psidium guajava, Terminalia catapa, Calotropis procera* and *Vitex doniana*. The study area thus has a diversity of plants that are economically important.

Agriculture

About 13 crop plants belonging to 9 families are cultivated in farms (Table 4.2.6.4). The system of farming practiced in the area is mainly land rotation and bush fallowing with mixed cropping. The crops include melon, okra, corn, rice, plantain, cowpea, soybean, sweet potato, pepper, tomato, Citrus and green leafy vegetables. In most cases, crop plants density was high and farm sizes were large, covering many hectares. Most of these crops were planted on ridges or mounds. The farms were weeded regularly using the hoe to reduce competition from weeds.

Table 4.2.6.3: Checklist of Common Economic Trees/Plants in the Study Area

S/N	Scientific Name	Family/Sub family	Common Name	Uses/Economic Importance	Density (No./ha)
1	*Piliostigma thonningii*	Caesalpiniaceae	Thonning's piliostigm	Dye yielding, Religions purposes	35
2	*Daniellia oliveri*	Caesalpinaceae	African copaiba balsam	Timber, fuel wood	30
3	*Vitex doniana*	Verbanaceae	Black plum Yoruba: orinla	Fuel wood, Edible fruits	12
5	*Anacardium occidentalale*	Anacardiaceae	Cashew	Edible fruit, Medicinal	10
6	*Mangifera indica*	Anacardiaceae	Mango	Edible fruit, Medicinal	8
7	*Tectonia grandis*	Verbanaceae	Teak	Used as poles for high/low tension electric lines	18
8	*Luffa aegyptica*	Cucurbitaceae	Loofah, Loofah gourd	Sponge	22
9	*Celtis integcifolia*	Ulmaceae	Hausa:	Fuel wood,	13

			zuwo	Edible fruits	
10	*Citrus aurantium*	Rutaceae	Orange	Edible fruit	5

Table 4.2.6.4: Checklist of Crops Plants in Farms Encountered along the Transmission Line ROW.

S/N	Scientific Name	Family/Sub family	Common Name	Uses/Economic Importance	Density (No./ha)
1	*Zea mays*	Poaceae	Maize/Corn	Grains	10,000
2	*Ipomoea batatas*	Convolvulaceae	Sweet potato	Root tuber	2,500
3	*Vigna unguiculata*	Fabaceae	Cowpea	Grain legume	20,000
4	*Sorghum bicolor*	Poaceae	Sorghum	Grains	2,500
5	*Capsicum annum*	Solanaceae	Pepper	Spice	5,000
6	*Lycopersicon esculentum*	Solanaceae	Tomato	Fruit vegetable	5,000
7	*Glycine max*	Fabaceae	Soybean	Grains	10,000
8	*Abelmoscus esculentus*	Malvaceae	Okra	Edible fruit	5,000
9	*Musa paradisiaca*	Musaceae	Plantain	Edible fruit	5,000
10	*Citrullus lanatus*	Cucurbitaceae	Melon	Fruit Vegetable	1,500

Plant Pathology

Generally plants along the transmission line corridor were generally healthy with no obvious signs of stress except some few scattered pathological problems like chlorotic and necrotic leaf spot, which were, in some cases, associated with the tropical red ants (*Oecophylla sp*) (Table 4.2.6.5). Leaf spots were the dominant disease symptoms on the foliage of unhealthy plants. Most of the leaf spot diseases were caused by *Cercospora spp*. The disease severity indices revealed that the few diseases encountered were of very light to moderate infection and are common and comparable in nature and intensity to those on plant species all over the savanna zone of the country. There were no devastation insect or animal pests observed in the study area. The appearance and the state of health of the plant communities and of the commonest species were quite normal. There was no evidence of endemic vegetation problems. None of the diseases was unusual either in its nature or severity.

Table 4.2.6.5: Plant pathological conditions (disease symptoms and Causative Organisms of representative plant species along the proposed Transmission Line ROW.

Plants Sampled	Pathological Condition	Causative organisms
Musa paradisiaca	Sigatoka (leaf spots)	Mycosphaerella musicola
Musa paradisiaca	Moko	*Pseudomonas solanacearum*
Zea mays	Bacterial stripe	*Pseudomonas andropogoni*
Zea mays	Stem borers	Weevils
Vigna unguiculata	Leaf spot	*Cercospora sp*

Plate 4.2.6.1: Farmland of Okra at Kaduna Sub-station

Plate 4.2.6.2: Farmland at Pole Wire along the route showing the dominant crops (Sorghum, Cowpea, harvested maize)

Plate 4.6.2.3: Fallowland showing savanna woody species at Gurum along the route

Plate 4.6.2.4: Farmland of Sorghum and Soybean at Baruwa along the Route

Plate 4.6.2.5: Farmland of *Capsicum* (pepper) and *Sorghum bicolor* at Panturawa along the Route

4.2.7 WATER QUALITY

4.2.7.1 Methodology

In the present study, the choice of investigated water quality parameters was guided by the recommendations of the Nigerian environmental regulatory bodies (FEPA, 1991; DPR, 1992; EGASPIN, 2004) in relation to the type and scope of the project involved. The list of selected parameters broadly includes: hydro-physical parameters (temperature, colour, turbidity, transparency and depth); general chemical parameters (pH, conductivity, TDS, Alkalinity, Acidity, Hardness), major anions and cations, organic carbon and nutrient compounds, oxygen parameters, trace/ heavy metals.

The adopted study methodology comprised field *in situ* determinations (of prevailing conditions and parameters without holding time) and collection of samples for detailed laboratory analysis. Twelve (12) sampling locations/stations were selected for the water quality study. They comprised six locations on the surface waterbodies around (majorly streams and rivers) and six samples from the underground water sources (boreholes and hand-dug wells). The grid co-ordinates and description of the selected sampling stations were measured using a portable global positioning system (GPS) set (Table 4.2.7.1). The stations were carefully selected very close to the proposed Transmission Line as well as being representative of the different existing waterbodies in the area. At each sampling station information on prevailing weather condition and water use activities was recorded. Ambient air temperature and water temperature were measured using mercury in glass bulb thermometer. Each waterbody was sampled and immediately its pH, conductivity, TDS measured using a meter (PCE-PHD1 multi-parameters meter previously standardized). Surface water bodies were sampled directly from the surface using a 5L capacity plastic sampling bottle. Samples from underground sources were collected using a polythene fetcher from the various well water sources and from supply taps in the case of boreholes. Separate samples were collected for some parameters or group of parameters, notably, dissolved oxygen, (DO) Biochemical oxygen demand (BOD_5), heavy metals, organic and nutrient compounds. Sample for DO determination was fixed immediately after collection (using Winkler's reagents) for later determination at the field base station. All samples were adequately labelled and preserved as applicable. The field work was conducted over the period of 18^{th} – 21^{st} October, 2016. Table 4.2.7.2 presents the date and time of sampling at the selected sampling stations.

4.2.7.2 Results and Discussions

Groundwater quality

Temperatures was moderately high in the area with air temperature ranging from 26.0 to 34.5 ^oC with an average of 30.5 ± 1.1 ^oC and water temperatures in the range of 23.9 – 28.2 ^oC; (mean value = 26.1 ± 0.6 ^oC). All the underground water samples from the area were imparted with varying degrees of colour all having apparent colour range (31.33 – 72.63 Pt-Co) and mean value (45.85 ± 5.80 Pt-Co) greater than the NIS (2007) maximum permitted levels of colour for drinking water. Turbidity values (range = 12.32 – 18.00 NTU; mean = 15.72 ± 0.81 NTU) were also greater than the maximum permitted levels for drinking water. The pH of the underground water samples in the area ranged from moderately acidic (5.78) to moderately alkaline (8.00) and on the average neural (6.87 ± 0.33). All of them had their conductivity values less than 1,000 μScm^{-1} and Total Dissolved Solids (TDS) less than 500 mgL^{-1} indicating they are all of freshwater sources. They are all soft (hardness < 60 $mgCaCO_3L^{-1}$) and well buffered waterbodies except for Station 5 which is poorly buffered (a well water in Barwa Community, Kaduna State) with alkalinity value less than 20

$mgCaCO_3L^{-1}$. On the average, the cationic hierarchy of the underground water sources in the area was in the order: $Ca^{2+} > K^+ > Mg^{2+} > Na^+$ whereas, the hierarchy of the anions is in the order: $HCO_3^- > Cl^- > SO_4^{2-}$ (Table 4.2.7.3).

There is no evidence of organic pollution in the area as indicated by the low values of the nutrient compounds. The values of the BOD_5 in the underground water samples showed that the quality of the underground water sources varied from being very clean in Station 1 ($BOD_5 < 1.0\ mgL^{-1}$); clean in Stations 2, 4 and 10 ($BOD_5 < 2.0\ mgL^{-1}$); doubtful in Station 5 ($BOD_5 < 5.0\ mgL^{-1}$) to being of bad quality in Station 9 (i.e. $BOD_5 > 5.0\ mgL^{-1}$) as suggested by Key (1956). No evidence of inorganic pollution in the underground water sources from the area as most of the heavy/trace metals contents of the underground water samples were within the prescribed limit of the drinking water standards as prescribed by NIS (2007) and the Canadian Drinking Water Quality (2008), except for cadmium (Cd) with slightly elevated levels in all the water samples as presented in Table 4.2.7.4. Sources of cadmium may include: natural emissions (e.g. volcanism and from soils) as well as anthropogenic emissions from industries and fuel combustions (Wetzel, 2001).

Surface water quality

Air temperatures around the surface waterbodies in the area ranged from 26.6 to 33.7 ^oC with an average of 31.5 ± 1.0 ^oC and the surface water temperatures (range = 23.9 – 28.2 ^oC; mean value = 26.1 ± 0.6 ^oC). The depth at the sampling point of the surface waterbodies in the area were shallow with most stations transparent to the bottom except in Stations 3 and 12 where the depth (0.55m; 0.67m) were greater than the transparency (0.10m; 0.42m) respectively. All the surface water samples from the area were imparted with varying degrees of colour all having apparent colour range (53.42 – 310.79 Pt-Co) and mean value (112.11 ± 40.35 Pt-Co), all greater than the NIS (2007) maximum permitted levels of colour for drinking water. Turbidity values (range = 7.28 – 62.52 NTU; mean = 19.10 ± 8.74 NTU) were also greater than the NIS (2007) maximum permitted levels of 5.0 NTU for drinking water. The pH ranged from slightly alkaline (7.52) to strongly alkaline (8.90) and on the average neural (8.06 ± 0.27). All of the surface water sources in the area had their conductivity values less than 1,000 μScm^{-1} and Total Dissolved Solids (TDS) less than 500 mgL^{-1} indicating they are all of freshwater sources. They are all well buffered and soft with average alkalinity of 38.7 ± 10.3 $mgCaCO_3L^{-1}$ and total hardness of 28 ± 7 $mgCaCO_3L^{-1}$ respectively. Total hardness is solely of carbonate hardness, i.e. none of the water sources sampled had permanent hardness (non-carbonate hardness = 0.00 $mgCaCO_3L^{-1}$ in all the water samples).

On the average, the cationic hierarchy of the surface water sources from the area is in the order: $Ca^{2+} > Mg^{2+} > K^+ > Na^+$ whereas, the hierarchy of the anions is in the order: $HCO_3^- > Cl^- > SO_4^{2-}$ (Table 4.2.7.2). There is no evidence of organic pollution in the surface water samples from the area with most of the water samples having BOD_5 less than 3.0 mgL^{-1}except that of Station 11 ($BOD_5 = 3.4\ mgL^{-1}$). Also, Dissolved Oxygen (%Saturation) were mostly far greater than 50% in most of the water samples except for Station 3 (DO %Saturation = 38.9%). The value of DO %Saturation in Station 11 indicated that the stream sampled (at Gurum village, Plateau State) was super-saturated (i.e. DO %Saturation > 100%) as at the time of this study. There was no evidence of inorganic pollution in the surface water sources in the area as most of the heavy/trace metals contents of the surface water sampled were within the prescribed limit of the drinking water standards as prescribed by NIS (2007) and the Canadian Drinking Water Quality (2008), except for cadmium (Cd) with slightly elevated levels in Stations 3, 6 and 8 (Table 4.2.7.4). According to Wetzel (2001), cadmium occurs in natural freshwaters and usually in high concentrations in rivers as much of the

cadmium is associated with particles (> 0.2 µm) or complexes with dissolved organic macromolecules. As a result, cadmium availability is often much higher in freshwater than would anticipated simply on the basis of inorganic solution chemistry and solubilities. Also, that, sources of cadmium may also include: natural emissions (e.g. volcanism and from soils) as well as anthropogenic emissions from industries and fuel combustions (Wetzel, 2001).

4.2.8 HYDROBIOLOGY STUDIES

4.2.8.1 Methodology

It is a common knowledge that the occurrence and distribution of aquatic organisms are greatly influenced by water quality; hence water quality and Hydrobiology are often treated together in most environmental studies. Thus, in the present study, the Hydrobiology studies involved the surface water sampling stations only as presented in Table 4.2.8.1. The Hydrobiology aspect of the study broadly encompassed aquatic invertebrate biodiversity, their community structure and functioning. The main biota involved were: Phytoplankton flora, zooplankton fauna, benthic macro invertebrates and microbiology. The assessment of community metabolism was based on the determination of primary photosynthetic productivity and respiration rate.

Quantitative plankton samples for both phytoplankton and zooplankton were collected at each of the surface water bodies by passing 30 L volume of the water sample through fine meshed (50 µm) plankton net to a concentrate volume of 30 ml. The concentrate sample was preserved in 5% formalin solution for later examination in the laboratory under a compound microscope. Samples were also collected for primary productivity by the white and black oxygen evolution method (Vollenweider, 1974). Sediment samples were collected from shallow shoreline in each station using a shovel of known surface area. Sediment samples were collected for the determination of physico-chemical characteristics and for the occurrence of benthic macro invertebrates. Samples for macro invertebrates were sieved through a 1 mm mesh sized sieve using the water from the station. All recorded invertebrates animals were carefully picked using a camel hair brush and preserved in10 % formalin solution in a labelled specimen bottle. Samples for microbiology were collected in pre-sterilized universal bottles and kept in an ice chest with ice cubes for transportation to the laboratory base for the commencement of analysis. Table 4.2.8.1 is the description of the sampled waterbodies and specific the water quality/hydrobiology studies carried out on them during the period of the investigation. Plates 4.2.8.1a-b cover some of the selected sampling stations and sampling activities at the stations.

Table 4.2.7.1: Grid Location and Site Description of Water Quality and Hydrobiology Sampling Stations

SN	Station	Location and Grid Coordinate				+Altitude (m)	Site Description
		Latitude (N)	Longitude (E)	Northing	Easting		
1	Station 1	09°02.566'	007°26.559'	0328825	0999946	463 ± 3	Borehole I, at TCN Kaduna Sub-Station Sampled at the Kitchen, Kaduna State
2	Station 2	09°02.566'	007°26.559'	0328825	0999946	463 ± 3	Borehole II, at TCN Kaduna Sub-Station Sampled at the tap beside the Car Park
3	Station 3	10°33.841'	008°16.052'	0419866	1167867	654 ± 3	Stream at Angwan-Salawu Village (Angwan-Salawu River), Kaduna
4	Station 4	10°34.456'	008°15.074'	0418084	1169007	661 ± 3	Well water at the Seriki's House at Pole-waya Village, Kaduna State
5	Station 5	10°39.990'	008°01.156'	0392737	1179275	692 ± 3	Well water at Tsauni compound in Barwa Community, Kaduna State
6	Station 6	10°35.710'	007°24.971'	0326725	1171661	661 ± 2	Stream behind TCN Kaduna Sub-Station, Kaduna State
7	Station 7	10°41.109'	007°23.259'	0341887	1181538	623 ± 2	Stream down the RUBICON POLO CLUB, Chukker Farm, Kaduna State
8	Station 8	10°41.844'	007°35.140'	0345326	1182875	614 ± 3	River Galma at Sabon Gari Dam Area, Via Fodio Fish Farm, Kaduna State
9	Station 9	09°59.235'	008°50.653'	0482927	1104008	1172 ± 7	Well water behind TCN Jos Sub-Station, Plateau State
10	Station 10	09°59.280'	008°50.814'	0483220	1104089	1158 ± 7	Borehole at Jos Electricity Dis. Co. in front of TCN Jos Sub-Station, Plateau State
11	Station 11	10°01.784'	008°49.029'	0479961	1108706	1148 ± 2	Stream at Gurum Village, Plateau State
12	Station 12	10°13.063'	008°45.403'	0473356	1129494	823 ± 2	River Lungu at Lungu Village, Via Jengre, Plateau State.

Table 2: Sample code, sample time and site grid coordinate of Water Quality and Hydrobiology Sampling Stations

S/N	Station	Water Type/Source	Site grid coordinate		+Altitude (m)	Sampling Date	Sampling Time
			Northing	Easting			
1	Station 1	Underground water/Borehole	0328825	0999946	463 ± 3	18/10/2016	4:30 p.m.
2	Station 2	Underground water/Borehole	0328825	0999946	463 ± 3	18/10/2016	4:40 p.m.
3	Station 3	Surface water/Stream	0419866	1167867	654 ± 3	19/10/2016	1:30 p.m.
4	Station 4	Underground water/Well	0418084	1169007	661 ± 3	19/10/2016	2:10 p.m.
5	Station 5	Underground water/Well	0392737	1179275	692 ± 3	19/10/2016	4:56 p.m.
6	Station 6	Surface water/Stream	0326725	1171661	661 ± 2	20/10/2016	9:45 a.m.
7	Station 7	Surface water/Stream	0341887	1181538	623 ± 2	20/10/2016	12:25 p.m.
8	Station 8	Surface water/River	0345326	1182875	614 ± 3	20/10/2016	12:25 p.m.
9	Station 9	Underground water/Well	0482927	1104008	1172 ± 7	21/10/2016	9:15 a.m.
10	Station 10	Underground water/Borehole	0483220	1104089	1158 ± 7	21/10/2016	9:45 a.m.
11	Station 11	Surface water/Stream	0479961	1108706	1148 ± 2	21/10/2016	10:50 a.m.
12	Station 12	Surface water/River	0473356	1129494	823 ± 2	21/10/2016	1:45 p.m.

+ = above mean sea level (amsl).

Table 4.2.7.3: Results of Physico-Chemical Parameters of water samples from the Underground waterbodies from the study area

S/N	Parameter	Unit	Stream/River								Drinking water quality standard	Health Impact (NIS, 2007)
			St. 1	St. 2	St. 4	St. 5	St. 9	St. 10	Range	Mean±S.E.		
Hydro-physical parameters												
1	Ambient Air Temperature	(°C)	26.0	30.2	34.5	30.9	31.1	30.3	26.0 - 34.5	30.5 ± 1.1	Ambient^{+}	None
2	Water Temperature	(°C)	23.9	26.1	28.2	26.6	26.1	25.6	23.9 - 28.2	26.1 ± 0.6	Ambient^{+}	None
5	Apparent colour	(Pt-Co)	41.26	31.33	47.66	38.70	72.63	43.50	31.33 - 72.63	45.85 ± 5.80	15 (TCU)$^{+}$	None
6	True colour	(Pt-Co)	2.82	2.80	3.97	3.66	3.31	2.29	2.29 - 3.97	3.14 ± 0.25	15 (TCU) $^{+}$	None
7	Turbidity	(NTU)	16.88	18	12.32	14.65	16.51	15.95	12.32 - 18.00	15.72 ± 0.81	5.0^{+}	None
General chemical parameters												
8	pH		6.67	5.78	6.74	6.43	7.60	8.00	5.78 - 8.00	6.87 ± 0.33	6.5 – 8.5^{+}	None
9	Conductivity	(μScm^{-1})	46.5	44.4	57.6	42.5	64.3	176.4	42.5 - 176.4	72.0 ± 21.2	1500*	None
10	TDS	(mg/L)	31.0	29.5	38.4	28.5	43.2	117.4	28.5 - 117.4	48.0 ± 14.1	1000*	None
11	Total Alkalinity	($mgCaCO_3/L$)	40	42	44	10	48	78	10 - 78	44 ± 9	200*	None
12	Acidity	($mgCaCO_3/L$)	10	34	12	8	16	16	8 - 34	16 ± 4	NS	None
13	Total hardness	($mgCaCO_3/L$)	16.77	13.08	18.81	15.12	20.59	52.65	13.08 - 52.65	22.84 ± 6.06	150^{+}	None
14	Non-carbonate hardness	($mgCaCO_3/L$)	0.00	0.00	0.00	5.12	0.00	0.00	0.0 - 5.12	0.85 ± 0.85	150^{+}	None
15	Sodium ion (Na^{+})	(mg/L)	1.00	1.00	1.00	1.40	1.20	1.00	1.00 - 1.40	1.10 ± 0.07	200^{+}	None
16	Potassium ion (K^{+})	(mg/L)	1.50	1.60	1.70	1.50	1.50	1.40	1.40 - 1.70	1.53 ± 0.04	NS	-
17	Calcium ion (Ca^{2+})	(mg/L)	5.35	3.88	3.88	2.4	5.35	20.85	2.40 - 20.85	6.95 ± 2.82	75*	None
18	Magnesium ion (Mg^{2+})	(mg/L)	0.83	0.83	2.22	2.22	1.76	0.13	0.13 - 2.22	1.33 ± 0.35	30*	Consumer acceptability
19	Chloride (Cl^{-})	(mg/L)	0.65	3.01	3.8	2.22	1.43	6.96	0.65 - 6.96	3.01 ± 0.91	250^{+}	None
20	Sulphate (SO_4^{2-})	(mg/L)	1.39	1.31	1.04	1.12	0.79	1.02	0.79 - 1.39	1.11 ± 0.09	100^{+}	None
21	Bicarbonate (HCO_3^{-})	(mg/L)	48.0	50.4	52.8	12.0	57.6	93.6	12.00 - 93.60	52.40 ± 10.61	100*	None
Oxygen parameters and Nutrient compounds												
22	Dissolved Oxygen (DO)	(mg/L)	2.4	3.4	5.6	6.5	4.0	5.4	2.4 - 6.5	4.6 ± 0.6	7.5*	-
23	Dissolved Oxygen (DO % Saturation)	(%)	20.1	42.7	72.5	82.2	50.2	67.2	20.1 – 82.2	55.8 ± 9.3	-	-
24	Biochemical Oxygen Demand (BOD_5)	(mg/L)	0.2	1.6	1.4	3.5	12.0	1.2	0.2 - 12.0	3.3 ± 1.8	6.0*	-
25	Chemical Oxygen Demand (COD)	(mg/L)	8.35	3.48	11.83	7.65	15.3	6.56	3.48 - 15.30	8.86 ± 1.70	10*	Cancer
26	Total Organic Carbon (TOC)	(mg/L)	3.13	1.3	4.43	2.87	5.74	2.35	1.30 - 5.74	3.30 ± 0.64	5.0^{+}	Cancer
27	Organic Matter	(mg/L)	5.39	2.25	7.64	4.94	9.89	4.05	2.25 - 9.89	5.69 ± 1.10	-	Cancer
28	Nitrate (NO_3^{-})	(mg/L)	0.36	0.88	1.92	2.44	0.88	0.88	0.36 - 2.44	1.23 ± 0.32	50^{+}	Cyanosis, and asphyxia (blue-baby syndrome) in

												infants under 3 months
Heavy Metals/Trace Elements												
29	Cadmium (Cd)	(mg/L)	0.016	0.008	0.012	0.008	0.007	0.006	0.006 - 0.016	0.010 ± 0.002	0.005**	Toxic to the kidney
30	Chromium (Cr)	(mg/L)	0.004	0.003	0.002	0.003	0.004	0.000	0.000 - 0.004	0.003 ± 0.001	0.05^{+}	Cancer
31	Copper (Cu)	(mg/L)	0.011	0.010	0.006	0.005	0.017	0.002	0.002 - 0.017	0.009 ± 0.002	1.0^{+}	Gastrointestinal disorder
32	Iron (Fe)	(mg/L)	0.000	0.000	0.080	0.000	0.040	0.000	0.000 - 0.080	0.020 ± 0.014	0.3^{+}	None
33	Manganese (Mn)	(mg/L)	0.020	0.020	0.010	0.010	0.060	0.050	0.010 - 0.060	0.028 ± 0.009	0.2^{+}	Neurological disorder
34	Nickel (Ni)	(mg/L)	0.021	0.016	0.008	0.000	0.006	0.003	0.000 - 0.021	0.009 ± 0.003	0.2^{+}	Possibly carcinogenic
35	Lead (Pb)	(mg/L)	0.009	0.010	0.000	0.010	0.006	0.007	0.000 - 0.010	0.007 ± 0.002	0.05**	Cancer, interface with Vit. D metabolism, affect mental development in infants, toxic to the Central and Peripheral Nervous System
36	Zinc (Zn)	(mg/L)	0.000	0.012	0.000	0.000	0.000	0.000	0.000 - 0.012	0.002 ± 0.002	3.0^{+}	None

ND = Not detectable; NA = Not applicable; ND = Not determined*
*$^{+}$ = NIS, 2007 (Maximum permitted); * = WHO, 2004; ** = Canadian Drinking Water Quality, 2008*

Table 4.2.7.4: Results of Physico-Chemical Parameters of water samples from the Surface waterbodies from the study area

S/N	Parameter	Unit	Stream/River								Drinking water quality standard	Health Impact (NIS, 2007)
			St. 3	St. 6	St. 7	St. 8	St. 11	St. 12	Range	Mean±S.E.		
Hydro-physical parameters												
1	Ambient Air Temperature	(°C)	33.3	26.6	31.9	31.4	31.9	33.7	26.6 - 33.7	31.5 ± 1.0	Ambient^{+}	None
2	Water Temperature	(°C)	33.2	25.9	29.0	33.0	29.0	32.5	25.9 - 33.2	30.4 ± 1.2	Ambient^{+}	None
3	Depth (Total)	(m)	0.55	0.40	0.15	0.44	0.21	0.67	0.15 - 0.67	0.40 ± 0.08	-	-
4	Transparency	(m)	0.10	0.40	0.15	0.44	0.21	0.42	0.10 - 0.44	0.29 ± 0.06	-	-
5	Apparent colour	(Pt-Co)	310.79	53.42	59.50	96.32	63.34	89.27	53.42 - 310.79	112.11 ± 40.35	15 (TCU)$^{+}$	None
6	True colour	(Pt-Co)	15.09	3.02	5.05	5.13	3.88	3.51	3.02 - 15.09	5.95 ± 1.86	15 (TCU)$^{+}$	None
7	Turbidity	(NTU)	62.52	14.37	7.28	10.45	11.66	8.31	7.28 - 62.52	19.10 ± 8.74	5.0^{+}	None
General chemical parameters												
8	pH		7.52	7.65	7.58	7.83	8.90	8.89	7.52 - 8.90	8.06 ± 0.27	6.5 – 8.5^{+}	None
9	Conductivity	(μScm^{-1})	150.0	52.0	77.6	47.2	92.1	55.8	47.20 - 150.00	79.12 ± 15.80	1500*	None
10	TDS	(mg/L)	100.0	34.5	51.6	31.4	61.2	37.2	31.4 - 100.0	52.7 ± 10.5	1000*	None
11	Total Alkalinity	($mgCaCO_3/L$)	88	22	24	28	42	28	22.0 - 88.0	38.7 ± 10.3	200*	None
12	Acidity	($mgCaCO_3/L$)	14	4	6	6	8	6	4 - 14	7 ± 1	NS	None
13	Total hardness	($mgCaCO_3/L$)	61.01	21.54	21.68	19.76	28.86	13.14	13 - 61	28 ± 7	150^{+}	None
14	Non-carbonate hardness	($mgCaCO_3/L$)	0.00	0.00	0.00	0.00	0.00	0.00	0.00 - 0.00	0.00 ± 0.00	150^{+}	None
15	Sodium ion (Na^{+})	(mg/L)	1.10	1.10	1.30	1.10	1.20	1.30	1.10 - 1.30	1.18 ± 0.04	200^{+}	None
16	Potassium ion (K^{+})	(mg/L)	1.80	1.80	1.30	1.40	1.60	1.70	1.30 - 1.80	1.60 ± 0.09	NS	-
17	Calcium ion (Ca^{2+})	(mg/L)	12.73	5.35	3.88	3.88	9.04	3.14	3.14 - 12.73	6.34 ± 1.54	75*	None
18	Magnesium ion (Mg^{2+})	(mg/L)	7.12	1.99	2.92	2.46	1.52	1.29	1.29 - 7.12	2.88 ± 0.88	30*	Consumer acceptability
19	Chloride (Cl^{-})	(mg/L)	3.80	2.22	6.96	3.80	3.01	0.64	0.64 - 6.96	3.41 ± 0.86	250^{+}	None
20	Sulphate (SO_4^{2-})	(mg/L)	0.13	0.67	0.79	0.34	1.31	1.14	0.13 - 1.31	0.73 ± 0.18	100^{+}	None
21	Bicarbonate (HCO_3^{-})	(mg/L)	105.6	26.4	28.8	33.6	50.4	33.6	26.4 - 105.6	46.4 ± 12.3	100*	None
Oxygen parameters and Nutrient compounds												
22	Dissolved Oxygen (DO)	(mg/L)	2.8	6.8	6.8	6.8	9.4	7.0	2.8 - 9.4	6.6 ± 0.9	7.5*	-
23	Dissolved Oxygen (DO % Saturation)	(%)	38.9	85.0	89.0	94.2	123.0	96.3	38.9 – 123.0	87.7 ± 11.2	-	-
24	Biochemical Oxygen Demand (BOD_5)	(mg/L)	2.0	2.8	0.7	1.6	3.4	2.8	0.7 - 3.4	2.2 ± 0.4	6.0*	-
25	Chemical Oxygen Demand (COD)	(mg/L)	7.65	10.43	8.35	15.99	1.43	3.48	1.43 - 15.99	7.89 ± 2.11	10*	Cancer

26	Total Organic Carbon (TOC)	(mg/L)	2.87	3.91	3.13	5.99	0.52	3.13	0.52 - 5.99	3.26 ± 0.72	5.0^{+}	Cancer
27	Organic Matter	(mg/L)	4.94	6.34	5.39	10.34	0.9	5.39	0.90 - 10.34	5.55 ± 1.23	-	Cancer
28	Nitrate (NO_3^-)	(mg/L)	4.26	0.88	1.4	1.14	1.14	1.4	0.88 - 4.26	1.70 ± 0.52	50^{+}	Cyanosis, and asphyxia (blue-baby syndrome) in infants under 3 months
Heavy Metals/Trace Elements												
29	Cadmium (Cd)	(mg/L)	0.013	0.010	0.004	0.008	0.004	0.002	0.002 - 0.013	0.007 ± 0.002	0.005**	Toxic to the kidney
30	Chromium (Cr)	(mg/L)	0.008	0.001	0.002	0.003	0.000	0.000	0.000 - 0.008	0.002 ± 0.001	0.05^{+}	Cancer
31	Copper (Cu)	(mg/L)	0.022	0.006	0.008	0.016	0.004	0.002	0.002 - 0.022	0.010 ± 0.003	1.0^{+}	Gastrointestinal disorder
32	Iron (Fe)	(mg/L)	9.900	0.000	0.540	2.180	0.850	1.000	0.000 - 9.900	2.412 ± 1.526	0.3^{+}	None
33	Manganese (Mn)	(mg/L)	0.400	0.000	0.020	0.040	0.050	0.040	0.000 - 0.400	0.092 ± 0.062	0.2^{+}	Neurological disorder
34	Nickel (Ni)	(mg/L)	0.000	0.000	0.000	0.014	0.000	0.001	0.000 - 0.014	0.003 ± 0.002	0.2^{+}	Possibly carcinogenic
35	Lead (Pb)	(mg/L)	0.000	0.004	0.002	0.004	0.005	0.004	0.000 - 0.005	0.003 ± 0.001	0.05**	Cancer, interface with Vit. D metabolism, affect mental development in infants, toxic to the Central and Peripheral Nervous System
36	Zinc (Zn)	(mg/L)	0.000	0.000	0.000	0.000	0.000	0.000	0.000 - 0.000	0.000 ± 0.000	3.0^{+}	None

ND = Not detectable; NA = Not applicable; ND = Not determined*

*$^{+}$ = NIS, 2007 (Maximum permitted); * = WHO, 2004; ** = Canadian Drinking Water Quality, 2008*

4.2.8.2 Results and Discussions

Sediment physico-chemical quality

Sediment textures of the sediment samples from the surface waterbodies in the area were essentially silty-sand (Stations 3, 7, 8 and 11) and sand (Stations 6 and 12). Aqueous sediment pH ranged from moderately acidic (pH = 5.8) in Station 7 to neutral (pH = 6.6) in Station 6 with an overall average value of 6.3 ± 0.1 (slightly acidic). The pH in neural salt ($CaCl_2$) was in the range of strong acid (pH = 5.1) in Station 7 and slightly acidic (pH = 6.1) in Station 12 with an average value of 5.8 ± 0.2 (i.e. moderately acidic) (Table 4.2.8.2).

The sediments in the area were with low nutrients values: For instance, sulphate (SO_4^{2-}) (range = 0.08 – 1.16 mg/kg), available phosphorus (range = 1.58 – 5.62 mg/kg), total nitrogen (range = 0.48 – 1.48 %) and organic carbon (range = 4.66 – 14.32 %). There is no evidence of organic pollution in the sediment samples from the area. Most of the trace/heavy metals analysed from the sediment samples from the area were below the Geochemical Background Levels (GBL) (i.e. average for the earth crust of the elements) except for silver (Ag) and mercury (Hg) with slightly elevated values in the sediment samples both having moderate contamination (i.e. their contamination factors (C_f) = $1 \leq C_f \leq 3$). This is also an indication of little or no inorganic pollution/contamination of the sediment samples from the area (Table 4.2.8.2).

Phytoplankton flora and primary productivity

The checklist and outline classification of the phytoplankton flora in the area is as presented in Table 4.2.8.3. A total of 33 species of phytoplankton were recorded from the surface water samples from the area. They belong to four major groups: Bacillariophyta (seven species), Charophyta (21 species), Chlorophyta (three species) and Ochrophyta (two species). On the whole, phytoplankton occurrence was in the dominance order of Charophyta > Bacillariophyta > Chlorophyta > Ochrophyta. The total abundance of phytoplankton in net samples (4422 Org/m^3) was lower than that of the total plankton samples (215000 Org/m^3). Also, most of the species identified in both analyses (i.e. net and total plankton analyses) occurred lowest in net plankton samples. However, the phytoplankton composition of the net plankton analysis was richer and more diverse than in the total plankton samples as obvious in the diversity indices presented in Table 4.2.8.4. The occurrence and total abundance of the major groups in the net plankton analysis were in the order: Charophyta (3494 Org/m^3) > Bacillariophyta (529 Org/m^3) > Chlorophyta (366 Org/m^3) > Ochrophyta (33 Org/m^3). On the other hand, the occurrence and total abundance of the major groups in the total plankton samples were in the order of Charophyta (120000 Org/m^3) > Bacillariophyta (65000 Org/m^3) > Ochrophyta (20000 Org/m^3) > Chlorophyta (10000 Org/m^3).

In all the water samples, phytoplankton species/major taxa that are indicators of biological pollution were not present. Likewise, Shannon Wiener diversity index [H] in all the samples both from net and total plankton samples were greater than 1 (Table 4.2.8.4). According to Pawar (2015) values less than 1.0 for Shannon Wiener diversity index [H] in aquatic ecosystem indicate heavy pollution, values between 1.0 and 3.0 indicate moderate pollution, and values exceeding 3.0 indicate non-polluted water. These all confirm that the water samples from the area had little or no biological pollutants.

Table 4.2.8.1: Description of Sampling Stations and Hydrobiology Studies carried out at the Stations

SN	Station	Waterbody/ Source	Investigation / study activities				
			Water quality	Sediment quality	Plankton	Benthos	Water and Sediment Microbiology
1	Station 1	Underground water/Borehole	√	X	X	X	√
2	Station 2	Underground water/Borehole	√	X	X	X	√
3	Station 3	Surface water/Stream	√	√	√	√	√
4	Station 4	Underground water/Well	√	X	X	X	√
5	Station 5	Underground water/Well	√	X	X	X	√
6	Station 6	Surface water/Stream	√	√	√	√	√
7	Station 7	Surface water/Stream	√	√	√	√	√
8	Station 8	Surface water/River	√	√	√	√	√
9	Station 9	Underground water/Well	√	X	X	X	√
10	Station 10	Underground water/Borehole	√	X	X	X	√
11	Station 11	Surface water/Stream	√	√	√	√	√
12	Station 12	Surface water/River	√	√	√	√	√

√ = applicable (sampled)
X = not applicable (not sampled)

Plate 4.2.8.1a: Water quality sampling from the Angwan- distribution tap of Borehole II, at TCN, Kaduna Sub-Station.

Plate 4.2.8.1b: Sampled Stream at Salawu Village, Kaduna.

Plate 4.2.8.1c: Sampled Well water at the sampling at the Seriki's House at Pole-waya Village, Kaduna State

Plate 4.2.8.1d: Macro-invertebrate Stream behind TCN Kaduna Sub-Station, Kaduna State.

Plate 4.2.8.2a: Sampled stream down Chukker hydrobiological Farm, Kaduna State

Plate 4.2.8.2b: Water quality and sampling at River Galma, Kaduna State

Plate 4.2.8.2c: Water quality sampling of Well behind TCN Jos Sub-Station, Plateau State.

Plate 4.2.8.2d: Water quality and water sampling in River Lungu at Lungu Village, Via Jengre, Plateau State.

Biological primary productivity in surface waterbodies in the area comprised on the average (2.40 ± 1.00 kcal/m^3/day) (57%) respiration and 1.80 ± 0.46 kcal/m^3/day (43%) net production, indicating greater respiration than photosynthetic activities in the waterbodies from the area (Table 4.2.8.5). In the Kaduna end of the project net productivity accounted for almost 70 % of the gross productivity while respiration accounted for about 30 % of the gross productivity. However, at the Jos end of the project, respiration accounted for about 81 % of gross productivity as against net productivity of about 19 % of the gross production. This is an indication of greater photosynthetic activities than respiration in the waterbodies from the Kaduna area and vice-versa for the waterbodies from the Jos end of the project area. Gross productivity was higher in the Jos area surface water samples (average = 6.66 ± 0.54 kcal/m^3/day) of the project than that of Kaduna surface water samples (average = 2.97 ± 0.52 kcal/m^3/day) as presented in Table 4.2.8.5.

Zooplankton fauna

The zooplankton fauna of the area comprised altogether 12 species; nine species of the Rotifera, two species of Copepods and a species of Diptera. The net plankton samples were richer and more diverse in terms of species composition but lower in abundance copared to the total plankton samples. In terms of both species richness and abundance of the zooplankton faunae in the area: Rotifera > Copepoda > Diptera. The diversity indices of the net plankton composition revealed that Station 3 was more diverse, i.e. Shannon Wiener diversity index [H] > 2.0 indicating a more stable ecosystem in the area. Likewise, Station 7 was the least diverse with only two species of zooplankton recorded from the area and Shannon Wiener diversity index [H] < 1.0, indicating a disturbed ecosystem. Only one major zooplankton group (i.e. the Rotifera) was identified in all the total plankton samples analysed from the area as presented in Tables 4.2.8.6.

Benthic macro-invertebrate fauna

The benthic macro-invertebrates from the area belonged to two major phyla namely: Arthropoda and Mollusca. They comprised six species belonging to the class Insecta and five of the members of the classs Gastropoda. The class Insecta was more richer with six species, abundant (1300 Org./m^2) and with higher occurrence (100 %), than the class Gastropoda with five species, abundance of 425 Org./m^2 and occurred only in three (50 %) out of the six surface waters sampled from the area. The dragon fly larva was identified in all the bottom samples of the surface water from the area (occurrence = 100 %). Diversity indices showed that Station 8 was the most diverse with Shannon Wiener diversity index [H] = 1.71 while Station 11 was the least diverse with Shannon Wiener diversity index [H] = 0.45 (Table 4.2.8.7). The abundance and high diversity of the class Insecta from the area is an indication of the fact that the waterbodies were less polluted as most of the insects' larvae from the bottom sediments of the area are indicators of clean water conditions. This is also an evidence of little or no organic pollution of the waterbodies in the area.

Table 4.2.8.2: Physico-chemical Characteristics of Sediments from waterbosies in the study area

S/N	Parameter	Unit	Station						Range	Mean±S.E.	(GBL)	C_f
			St. 3	St. 6	St. 7	St. 8	St. 11	St.12				
Physical												
1	Textural Classification		Silty-Sand	Sand	Silty-Sand	Silty-Sand	Silty-Sand	Sand	-	-	NS	-
2	Composition of Sand	(%)	69.2	95.2	63.2	79.2	63.2	93.2	63.2 - 95.2	77.2 ± 5.9	NS	-
3	Composition of Silt	(%)	27.4	3.4	33.4	15.4	29.4	1.4	1.4 - 33.4	18.4 ± 5.6	NS	-
4	Composition of Clay	(%)	3.4	1.4	3.4	5.4	7.4	5.4	1.4 - 7.4	4.4 ± 0.9	NS	-
5	Sediment Temperature	(ºC)	29.6	25.6	29.1	32.3	27.7	31.4	25.6 - 32.3	29.3 ± 1.0	NS	-
General Chemical												
6	pH in H_2O		6.4	6.6	5.8	6.5	6.3	6.4	5.8 - 6.6	6.3 ± 0.1	NS	-
7	pH in $CaCl_2$		5.9	5.9	5.1	6.1	5.6	6.1	5.1 - 6.1	5.8 ± 0.2	NS	-
8	Conductivity	(μScm^{-1})	3690	600	1090	630	720	1000	600 - 3690	1288 ± 487	NS	-
Exchangeable Cations												
9	Aluminium ion (Al^{3+})	(cmol/kg)	0.6	0.0	0.2	0.0	0.6	0.0	0.0 - 0.6	0.2 ± 0.1	82300[(a)]	2.4×10^{-6}
10	Hydrogen ion (H^+)	(cmol/kg)	0.9	0.6	0.8	0.6	1.1	0.8	0.6 - 1.1	0.8 ± 0.1	NS	
11	Sodium ion (Na^+)	(cmol/kg)	0.19	0.20	0.24	0.25	0.22	0.23	0.19 - 0.25	0.22 ± 0.01	23600[(b)]	9.3×10^{-6}
12	Potassium (K^+)	(cmol/kg)	0.51	0.48	0.64	0.45	0.56	0.43	0.43 - 0.64	0.51 ± 0.03	20900[(b)]	2.4×10^{-5}
13	Calcium (Ca^{2+})	(cmol/kg)	0.32	0.50	0.30	0.03	0.77	0.50	0.03 - 0.77	0.40 ± 0.10	41500[(b)]	9.6×10^{-6}
14	Magnesium (Mg^{2+})	(cmol/kg)	0.72	0.25	0.67	0.58	0.90	0.56	0.25 - 0.90	0.61 ± 0.09	23300[(b)]	2.6×10^{-5}
15	Cation Exchange Capacity (CEC)	(cmol/kg)	3.24	2.03	2.85	1.91	4.15	2.52	1.91 - 4.15	2.78 ± 0.34	NS	-
16	Base Saturation	(%)	53.70	70.44	64.91	68.59	59.04	68.25	53.70 - 70.44	64.16 ± 2.66	NS	-
Anions and Nutrients												
17	Chloride (Cl^-)	(mg/kg)	7.20	7.20	15.20	7.20	9.00	10.90	7.20 - 15.20	9.45 ± 1.30	NS	-
18	Sulphate (SO_4^{2-})	(mg/kg)	0.18	0.53	0.28	1.03	0.08	1.16	0.08 - 1.16	0.54 ± 0.10	NS	-
19	Total Nitrogen (TN)	(%)	0.85	0.87	1.48	1.11	0.48	0.79	0.48 - 1.48	0.93 ± 0.14	NS	-
20	Available Phosphorus (P)	(mg/kg)	2.29	3.17	2.22	5.62	1.58	5.38	1.58 - 5.62	3.38 ± 0.70	NS	-
21	Organic Carbon	(%)	8.24	8.31	14.32	10.74	4.66	7.52	4.66 - 14.32	8.97 ± 1.33	NS	-
22	Organic Matter	(%)	14.21	14.33	24.67	18.52	8.03	12.96	8.03 - 24.67	15.45 ± 2.30	NS	-
Heavy Metals/Trace Elements												
23	Silver (Ag)	(mg/kg)	0.10	0.08	0.08	0.09	0.11	0.08	0.08 - 0.11	0.09 ± 0.01	0.07[(a)]	1.29
24	Aluminium (Al)	(mg/kg)	8.16	7.80	6.75	7.10	10.31	8.20	6.75 - 10.31	8.05 ± 0.51	8.42[(c)]	0.96
25	Arsenic (As)	(mg/kg)	0.10	0.08	0.11	0.12	0.10	0.10	0.08 - 0.12	0.10 ± 0.01	1.80[(a)]	0.06
26	Cadmium (Cd)	(mg/kg)	0.016	0.02	0.019	0.018	0.02	0.031	0.016 - 0.031	0.021 ± 0.002	0.20[(a)]	0.11
27	Chromium (Cr)	(mg/kg)	0.006	0.003	0.002	0.003	0.004	0.003	0.002 - 0.006	0.004 ± 0.001	100[(a)]	4.0×10^{-5}
28	Cobalt (Co)	(mg/kg)	0.009	0.008	0.012	0.01	0.01	0.008	0.008 - 0.012	0.010 ± 0.001	25[(b)]	4.0×10^{-4}

29	Copper (Cu)	(mg/kg)	0.60	0.29	0.66	0.38	0.65	0.20	0.20 - 0.66	0.46 ± 0.08	55[(a)]	0.01
30	Iron (Fe)	(mg/kg)	175.0	165.0	616.0	289.0	333.0	198.0	165.0 - 616.0	296.0 ± 69.6	56300[(a)]	0.01
31	Manganese (Mn)	(mg/kg)	84.9	19.2	37.1	88.3	65.4	43.9	19.2 - 88.3	56.5 ± 11.3	950[(a)]	0.06
32	Nickel (Ni)	(mg/kg)	2.60	1.05	1.85	1.45	4.10	1.90	1.05 - 4.10	2.16 ± 0.44	75[(a)]	0.03
33	Lead (Pb)	(mg/kg)	3.35	2.40	1.00	1.90	5.15	2.25	1.00 - 5.15	2.68 ± 0.58	12.5[(a)]	0.21
34	Mercury (Hg)	(mg/kg)	0.22	0.19	0.21	0.16	0.23	0.20	0.16 - 0.23	0.20 ± 0.01	0.08[(a)]	2.50
35	Zinc (Zn)	(mg/kg)	0.65	0.74	0.51	1.38	1.23	0.84	0.51 - 1.38	0.89 ± 0.14	80.0[(c)]	0.01

GBL = Geochemical Background Levels,

C_f = Contamination Factor = $\frac{\text{Metal Content of Sediment}}{\text{Geochemical Background values of the metal}}$

NA = Not applicable,

NS = Not stated,

[a] = (Average Earth Crust values of elements) – Schropp and Windom (1988)

[b] = (Global Earth Crust values of elements) – Lide (2009)

[C] = (Average Continental Crust values) – Taylor and McLennan (1995)

NB: $C_f \leq 1$ = Low contamination

$1 \leq C_f \leq 3$ = Moderate contamination

$3 \leq C_f \leq 6$ = Considerable contamination

$C_f \geq 6$ = Very high contamination

Table 4.2.8.3: Checklist and outline classification of recorded planktonic organisms from the study area

S/N	Plankton type	Major taxon	Species
1	**Phytoplankton**	**Bacillariophyta (Diatoms)**	*Achnanthidium duthiei*
2			*Cymbella prostrata*
3			*Diatoma* sp.
4			*Gomphonema olivaceum*
5			*Navicula* sp.
6			*Tabellaria fenestrata*
7			*Tabellaria flocculosa*
8		**Charophyta (Green algae)**	*Actinotaenium cucurbitinum*
9			*Closterium acerosum*
10			*Closterium cornu*
11			*Clostrerium croasdale*
12			*Closterium didymotocum*
13			*Closterium kutzingii*
14			*Closterium lineatum*
15			*Closterium lunula*
16			*Closterium parvulum*
17			*Closterium* sp.
18			*Cosmarium brebissonii*
19			*Cosmarium depressum*
20			*Cosmarium pachydernum*
21			*Cosmarium pseudogranatum*
22			*Desmidium swartzii*
23			*Euastrum pinnatum*
24			*Gomphosphenia grovei*
25			*Gonatozygon monotaenium*
26			*Groenbladia neglecta*
27			*Hyalotheca dissiliens*
28			*Pleurotaenium* sp.
29		**Chlorophyta (Green algae)**	*Actinastrum hantzschii*
30			*Actinastrum* sp.
31			*Spirogyra sp*
32		**Ochrophyta (Yellow-green algae)**	*Meringosphaera spinosa*
33			*Stipitococcus vasiformis*
34	**Zooplankton**	**Rotifera**	*Anuraeopsis fissa*
35			*Argonothoica feliacea*
36			*Asplanchna priodonta*
37			*Collotheca mutabilis*
38			*Gastropus stylifer*
39			*Keratella cochlearis*
40			*Monostyla bulla*
41			*Platyias patulus*
42			*Rotaria citrinus*
43		**Copepoda**	*Megacyclops viridis*
44			*Nauplius larvae*
45		**Diptera**	*Chironomus* sp.

Table 4.2.8.4: The abundance (Org./m^3) and occurrence (%) of phytoplankton (Net/Total Plankton analysis) from the investigated waterbodies in the study area

S/N	Taxon (Phytoplankton)	Net Plankton Analysis									Total Plankton Analysis								
		Station						Total	Mean±S.E.	Occurrence (%)	Station						Total	Mean±S.E.	Occurrence (%)
		St. 3	St. 6	St. 7	St. 8	St. 11	St. 12				St. 3	St. 6	St. 7	St. 8	St. 11	St. 12			
Bacillariophyta (Diatoms)																			
1	*Achnanthidium duthiei*	33	0	33	0	33	0	99	17 ± 7	50	-	-	-	-	-	-	-	-	0
2	*Cymbella prostrata*	33	0	0	0	0	0	33	6 ± 6	17	-	-	-	-	-	-	-	-	0
3	*Diatoma* sp.	0	33	0	33	0	0	66	11 ± 7	33	20000	20000	5000	0	0	0	45000	7500 ± 4031	50
4	*Gomphonema olivaceum*	-	-	-	-	-	-	-	-	0	0	5000	5000	0	5000	5000	20000	3333 ± 1054	67
5	*Navicula* sp.	33	33	0	0	0	0	66	11± 7	33	-	-	-	-	-	-	-	-	0
6	*Tabellaria fenestrata*	33	33	0	0	0	33	99	17 ± 7	50	-	-	-	-	-	-	-	-	0
7	*Tabellaria flocculosa*	67	0	33	33	33	0	166	28 ± 10	67	-	-	-	-	-	-	-	-	0
Charophyta (Green algae)																			
8	*Actinotaenium cucurbitinum*	-	-	-	-	-	-	-	-	0	5000	0	0	5000	5000	0	15000	2500 ± 1118	50
9	*Closterium acerosum*	33	0	0	0	0	0	33	6 ± 6	17	-	-	-	-	-	-	-	-	0
10	*Closterium cornu*	-	-	-	-	-	-	-	-	0	5000	5000	0	5000	0	0	15000	2500 ± 1118	50
11	*Clostrerium croasdale*	0	33	33	0	0	33	99	17 ± 7	50	-	-	-	-	-	-	-	-	0
12	*Closterium didymotocum*	0	100	0	0	0	0	100	17 ± 7	17	-	-	-	-	-	-	-	-	0
13	*Closterium kutzingii*	-	-	-	-	-	-	-	-	0	0	10000	0	5000	5000	5000	25000	4167 ± 1537	67
14	*Closterium lineatum*	33	33	33	0	33	0	132	22 ± 7	67	-	-	-	-	-	-	-	-	0
15	*Closterium lunula*	0	67	33	0	33	33	166	28 ± 10	67	-	-	-	-	-	-	-	-	0
16	*Closterium parvulum*	-	-	-	-	-	-	-	-	0	10000	15000	5000	0	5000	5000	40000	6667 ± 2108	83
17	*Closterium* sp.	33	0	0	33	0	0	66	11 ± 7	33	-	-	-	-	-	-	-	-	0
18	*Cosmarium brebissonii*	33	67	33	0	0	0	133	22 ± 11	50	0	5000	0	0	0	0	5000	833 ± 833	17
19	*Cosmarium depressum*	33	0	300	0	0	33	366	61 ± 48	50	-	-	-	-	-	-	-	-	0
20	*Cosmarium pachydernum*	0	0	100	0	0	0	100	17 ± 17	17	-	-	-	-	-	-	-	-	0
21	*Cosmarium pseudogranatum*	33	33	33	0	0	33	132	22 ± 7	67	-	-	-	-	-	-	-	-	0
22	*Desmidium swartzii*	233	0	0	0	33	33	299	50 ± 37	50	5000	0	5000	0	5000	5000	20000	3333 ± 1054	67
23	*Euastrum pinnatum*	0	67	0	67	0	33	167	28 ± 13	50	-	-	-	-	-	-	-	-	0
24	*Gomphosphenia grovei*	67	67	0	0	0	0	134	22 ± 14	33	-	-	-	-	-	-	-	-	0
25	*Gonatozygon monotaenium*	0	33	167	0	0	0	200	33 ± 27	33	-	-	-	-	-	-	-	-	0
26	*Groenbladia neglecta*	67	0	0	0	0	67	134	22 ± 14	33	-	-	-	-	-	-	-	-	0
27	*Hyalotheca dissiliens*	0	0	1000	0	67	0	1067	178 ± 165	33	-	-	-	-	-	-	-	-	0
28	*Pleurotaenium* sp.	0	0	100	33	33	0	166	28 ± 16	50	-	-	-	-	-	-	-	-	0
Chlorophyta (Green algae)																			

29	*Actinastrum hantzschii*	200	0	0	0	0	0	200	33 ± 33	17	-	-	-	-	-	-	-	-	0
30	*Actinastrum* sp.	33	0	0	0	0	67	100	17 ± 11	33	-	-	-	-	-	-	-	-	0
31	*Spirogyra* sp.	0	0	0	33	33	0	66	11 ± 7	33	0	0	0	0	0	10000	10000	1667 ± 1667	17
Ochrophyta (Yellow-green algae)																			
32	*Meringosphaera spinosa*	0	33	0	0	0	0	33	6 ± 6	17	5000	0	0	5000	5000	0	15000	2500 ± 1118	50
33	*Stipitococcus vasiformis*	-	-	-	-	-	-	-	0		0	0	0	0	0	5000	5000	833 ± 833	17
Total (major taxa)																			
	Total Bacillariophyta	199	99	66	66	66	33	529	88 ± 24	100	20000	25000	10000	0	5000	5000	65000	10833 ± 3962	83
	Total Charophyta	565	500	1832	133	199	265	3494	582 ± 259	100	25000	35000	10000	15000	20000	15000	120000	20000 ± 3651	100
	Total Chlorophyta	233	0	0	33	33	67	366	61 ± 36	67	0	0	0	0	0	10000	10000	1667 ± 1667	17
	Total Ochrophyta	0	33	0	0	0	0	33	6 ± 6	17	5000	0	0	5000	5000	5000	20000	3333 ± 1054	67
	Total Phytoplankton	997	632	1898	232	298	365	4422	737 ± 259	100	50000	60000	20000	20000	30000	35000	215000	35833 ± 6635	100
Diversity Indices																			
	Richness (S)	16	13	12	6	8	9	27	-	-	6	6	4	4	6	6	11	-	-
	Evenness (e^H/S)	0.722	0.916	0.432	0.955	0.963	0.948	0.676	-	-	0.833	0.853	1.000	1.000	1.000	0.957	0.826	-	-
	Dominance (D)	0.121	0.092	0.318	0.185	0.136	0.125	0.088	-	-	0.240	0.222	0.250	0.250	0.167	0.184	0.127	-	-
	Simpson (1-D)	0.880	0.908	0.682	0.815	0.864	0.875	0.912	-	-	0.760	0.778	0.750	0.750	0.833	0.816	0.873	-	-
	Shannon (H)	2.447	2.477	1.646	1.746	2.041	2.143	2.905	-	-	1.609	1.633	1.386	1.386	1.792	1.748	2.207	-	-
	Margalef	2.172	1.861	1.457	0.918	1.229	1.356	3.097	-	-	0.462	0.455	0.303	0.303	0.485	0.478	0.814	-	-

Table 4.2.8.5: Primary productivity and respiration of the investigated waterbodies from the study area

S/N	Sampling Code No:	Respiration (Kcal/m^3/day)	Net production (Kcal/m^3/day)	Gross production (Kcal/m^3/day)
1	**Station 3**	0.72 (17 %)	3.6 (83 %)	4.32
2	**Station 6**	0.72 (22 %)	2.52 (78 %)	3.24
3	**Station 7**	0.72 (33 %)	1.44 (67 %)	2.16
4	**Station 8**	1.44 (67 %)	0.72 (33 %)	2.16
5	**Station 11**	6.48 (90 %)	0.72 (10 %)	7.20
6	**Station 12**	4.32 (71 %)	1.8 (29 %)	6.12
	Range.	0.72 – 6.48	0.72 – 3.60	2.16 – 7.20
	Mean±S.E	2.40 ± 1.00 (57 %)	1.80 ± 0.46 (43 %)	4.20 ± 0.86
Samples from Kaduna State area of the project				
	Range.	0.72 – 1.44	0.72 – 3.60	2.16 – 4.32
	Mean±S.E	0.90 ± 0.18 (30 %)	2.07 ± 0.63 (70 %)	2.97 ± 0.52
Samples from Plateau State area of the project				
	Range.	4.32 – 6.48	0.72 – 1.80	6.12 – 7.20
	Mean±S.E	5.40 ± 1.08 (81 %)	1.26 ± 0.54 (19 %)	6.66 ± 0.54

Table 4.2.8.6: The abundance (Org./m^3) and occurrence (%) of zooplankton (Net/Total Plankton analysis) from the investigated waterbodies in the area

S/N	Taxon (Zooplankton)	Net Plankton Analysis									Total Plankton Analysis								
		Station						Total	Mean±S.E.	Occurrence (%)	Station						Total	Mean±S.E.	Occurrence (%)
		St. 3	St. 6	St. 7	St. 8	St. 11	St. 12				St. 3	St. 6	St. 7	St. 8	St. 11	St. 12			
Rotifera																			
1	*Anuraeopsis fissa*	33	0	100	33	67	0	233	39 ± 16	67	-	-	-	-	-	-	-	-	0
2	*Argonothoica feliacea*	33	0	0	33	0	0	66	11 ± 7	33	0	5000	5000	0	0	0	10000	1667 ± 1054	33
3	*Asplanchna priodonta*	0	33	0	100	67	100	300	50 ± 19	67	-	-	-	-	-	-	-	-	0
4	*Collotheca mutabilis*	33	0	0	0	0	33	66	11 ± 7	33	-	-	-	-	-	-	-	-	0
5	*Gastropus stylifer*	67	0	0	0	67	0	134	22 ± 14	33	-	-	-	-	-	-	-	-	0
6	*Keratella cochlearis*	0	33	0	0	0	0	33	6 ± 6	17	5000	0	0	5000	0	10000	20000	3333 ± 1667	50
7	*Monostyla bulla*	33	33	0	0	67	33	166	28 ± 10	67	-	-	-	-	-	-	-	-	0
8	*Platyias patulus*	33	0	0	0	0	0	33	6 ± 6	17	-	-	-	-	-	-	-	-	0
9	*Rotaria citrinus*	33	33	0	0	0	0	66	11 ± 7	33	-	-	-	-	-	-	-	-	0
Copepoda																			
10	*Megacyclops viridis*	0	0	0	0	233	33	266	44 ± 38	33	-	-	-	-	-	-	-	-	0
11	*Nauplius larvae*	33	0	0	0	500	0	533	89 ± 82	33	-	-	-	-	-	-	-	-	0
Diptera																			
12	*Chironomus* larvae	33	0	33	33	0	0	99	17 ± 7	50	-	-	-	-	-	-	-	-	0
Total (major taxa)																			
	Total Rotifera	265	132	100	166	268	166	1097	183 ± 28	100	5000	5000	5000	5000	0	10000	30000	5000 ± 1291	83
	Total Copepoda	33	0	0	0	733	33	799	133 ± 120	50	-	-	-	-	-	-	-	-	0
	Total Diptera	33	0	33	33	0	0	99	17 ± 7	50	-	-	-	-	-	-	-	-	0
	Total Zooplankton	331	132	133	199	1001	199	1995	333 ± 137	100	5000	5000	5000	5000	0	10000	30000	5000 ± 1291	83
Diversity Indices																			
	Richness (S)	9	4	2	4	6	4	12	-	-	1	1	1	1	0.000	1	2	-	-
	Evenness (e^H/S)	0.966	1.000	0.876	0.864	0.683	0.864	0.729	-	-	1.000	1.000	1.000	1.000	0.000	1.000	0.9449	-	-
	Dominance (D)	0.121	0.250	0.627	0.335	0.322	0.335	0.143	-	-	1.000	1.000	1.000	1.000	0.000	1.000	0.5556	-	-
	Simpson (1-D)	0.880	0.750	0.373	0.665	0.678	0.665	0.857	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.4444	-	-
	Shannon (H)	2.162	1.386	0.560	1.240	1.410	1.240	2.168	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.6365	-	-
	Margalef	1.379	0.614	0.205	0.567	0.724	0.567	1.448	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.097	-	-

Table 4.2.8.7: Benthic macro-invertebrate fauna abundance (Org./m^2) and occurrence (%) from the investigated waterbodies in the study area

S/N	Taxon	Station						Total	Mean±S.E.	Occurrence (%)
		St. 3	St. 6	St. 7	St. 8	St. 11	St. 12			
Insecta										
1	Odonata (Damsel-fly larvae)	0	50	0	0	25	50	125	21 ± 10	50
2	Odonata (Dragon-fly larvae)	50	100	125	50	125	150	600	100 ± 17	100
3	Ephemeroptera (May-fly larvae)	0	25	0	0	0	0	25	4 ± 4	17
4	Plecoptera (Stone-fly larvae)	0	75	0	0	0	25	100	17 ± 12	33
5	Coleoptera (Adult Beetles)	150	125	25	0	0	50	350	58 ± 26	67
6	Hemiptera (Adult Bugs)	100	0	0	0	0	0	100	17 ± 17	17
Mollusca										
7	*Bulinus globosus*	50	0	25	50	0	0	125	21 ± 10	50
8	*Cleopatra* sp.	0	0	0	75	0	0	75	13 ± 13	17
9	*Melanoides tuberculata*	0	0	0	100	0	0	100	17 ± 17	17
10	*Physa acuta*	0	0	25	25	0	0	50	8 ± 5	33
11	*Radix natalensis*	0	0	25	50	0	0	75	13 ± 9	33
Total (major taxa)										
	Total Insecta	300	375	150	50	150	275	1300	217 ± 49	100
	Total Mollusca	50	0	75	300	0	0	425	71 ± 48	50
	Total Benthic macro-invertebrates	350	375	225	350	150	275	1725	288 ± 36	100
Diversity Indices										
	Richness (S)	4	5	5	6	2	4	11	-	-
	Evenness (e^H/S)	0.897	0.887	0.736	0.922	0.785	0.804	0.674	-	-
	Dominance (D)	0.306	0.244	0.358	0.194	0.722	0.372	0.188	-	-
	Simpson (1-D)	0.694	0.756	0.642	0.806	0.278	0.628	0.812	-	-
	Shannon (H)	1.277	1.490	1.303	1.710	0.451	1.169	2.003	-	-
	Margalef	0.512	0.675	0.739	0.854	0.200	0.534	1.342	-	-

Water and Sediment Microbiology

The occurrence and distribution of recorded microbial flora in water and sediment samples are presented in Tables 4.2.8.8 and 4.2.8.9 respectively. A total of seven bacterial and sixteen fungal species isolates were recorded from the water sources. The most widely occurring bacterial isolates was *Pseudomonas aeruginisa* (100% occurrence) followed by the Coliform *Klebsiella edwardsii (92%). Acinectobacter parapertusis, Escherichia coli* and *Klebsiella pneumonia* were fairly widespread (33 – 50%) while *Klebsiella pneumonia* and *Pseudomonas pseudomallei* showed limited distribution. The number of isolates per station occurred in the range of 2-5 (mode = 4). The fungal flora comprised mostly of molds with *Rhizopus japonicas* being the most widely occurring species isolate. In general, less fungal isolates occurred per station (mode = 3) than bacterial isolates. Many more species of bacteria (n=11) were recorded from the sediment samples than from the water sources (n=7). Four isolates *viz: Acinectobacter calcoaceticus, Acinectobacter mallei, Gaffkya tetrsgena and Proteus rettferi* were limited only to sediment samples. But as with water samples, two species *Klebsiella edwardsii and Pseudomonas aeruginosa* were widely distributed in the sediment samples.

The number of fungal isolates per sample / station varied from 1 to 7 (median = 4). The fungal flora in sediment was qualitatively dominated by the genera *Aspergillus and Mucor*

each with three species respectively. The most widely solates were *Rhizopus japanicus (83%) and Clonestachys roseaf (50%) while Mucor ramannisus*, *Pullularia pullutans* and *Trichophyton schoenleinii* (33% occurrence each) were fairly distributed. For bothe water and sediment sample the microbial flora comprised 12 bacterial isolates an 25 fungal isolates. The abundance of Total heterotrophic bacteria (THB) in water samples (range = 100 – $1.60x10^5$cfu/ml, mean±s.e = $4.2x10^4$±$1.5x10^4$ cfu/ml) as well as in sediment samples ($2.5x10^3$ – $2.7x10^{11}$cfu/ml, mean±s.e. = $4.5x10^{10}$±$4.9x10^{10}$cfu/ml) were much higher than their corresponding values of total heterotrophic fungi (THF) for water (range = 10^2 – $3.0x10^4$cfu/ml, mean±s.e. = $3.6x10^3$±$2.5x10^3$ cfu/ml) and sediment samples (10^2 – $2.0x10^4$ cfu/ml, mean±s.e. = $8.7x10^3$±$3.8x10^3$ cfu/ml) respectively. The THB and THF abundance in most of the samples occurred within the well known range for unpolluted water and sediment sources (Tables 4.2.8.10 and 4.2.8.11)

Table 4.2.8.8: Occurrence of Microbial species isolates in Water samples from Kaduna-Jos

S/N	Taxon	Station												
		1	2	3	4	5	6	7	8	9	10	11	12	% Frequency
Bacteria														
1	*Acinetobacter parapertussis*	-	+	+	-	+	+	-	-	+	-	+	-	50
2	*Escherichia coli*	-	-	-	-	-	+	+	-	+	+	-	-	33
3	*Klebsiella edwardsi*	+	-	+	+	+	+	+	+	+	+	+	+	92
4	*Klebsiella ozoenae*	-	-	-	+	-	-	-	-	-	-	+	-	17
5	*Klebsiella pneumoniae*	-	-	-	+	-	-	+	-	+	+	-	-	33
6	*Pseudomonas aeruginosa*	+	+	+	+	+	+	+	+	+	+	+	+	100
7	*Pseudomonas pseudomallei*	-	-	-	-	-	+	-	-	-	-	-	-	8.3
Fungi														
8	*Aspergillus flavus*	-	-	+	-	-	-	-	-	-	-	-	-	8.3
9	*Aspergillus fumigatus*	-	-	-	-	-	-	-	+	-	-	-	-	8.3
10	*Aspergillus glaucus*	+	-	-	-	-	-	-	-	-	-	-	-	8.3
11	*Aspergillus restrictus*	-	-	-	-	-	-	+	-	-	-	-	-	8.3
12	*Cladosporium herbarum*	-	-	-	-	-	-	-	+	-	-	-	-	8.3
13	*Cladosporium werneckii*	-	-	-	-	-	-	-	-	-	-	-	+	8.3
14	*Clonestachys roseaf*	-	-	-	+	+	-	-	-	-	-	-	-	17
15	*Fusarium* sp.	-	-	-	-	-	-	+	-	-	-	-	-	8.3
16	*Mucor eretus*	-	-	-	-	-	-	-	-	-	-	+	-	8.3
17	*Mucor mucedo*	-	-	-	-	-	-	-	-	-	-	-	+	8.3
18	*Penicillium digitatum*	-	+	-	-	-	-	-	-	-	-	-	-	8.3
19	*Penicillium expansium*	-	-	-	-	+	-	-	-	-	-	-	-	8.3
20	*Pullularia pullutans*	-	-	-	-	-	-	-	-	-	-	+	-	8.3
21	*Rhizopus japanicus*	+	+	+	+	+	+	+	-	+	+	+	-	83.3
22	*Scopulariopsis brevicarlis*	-	+	-	-	-	-	+	-	-	-	-	-	17
23	*Trichophyton schoenleinii*	-	-	-	+	-	-	-	-	-	-	-	-	8.3
	Total bacteria species	**2**	**2**	**3**	**4**	**3**	**5**	**4**	**2**	**5**	**4**	**4**	**2**	
	Total fungi species	**2**	**3**	**2**	**3**	**3**	**1**	**4**	**2**	**1**	**1**	**3**	**2**	
	Total microbial species	**4**	**5**	**5**	**7**	**6**	**6**	**8**	**4**	**6**	**5**	**7**	**4**	

Table 4.2.8.9: Occurrence of Microbial species isolates in sediment samples

S/N	Taxon	Station						
		3	6	7	8	11	12	% Frequency
Bacteria								
1	*Acinetobacter calcoaceticus*	-	-	-	-	-	+	17
2	*Acinetobacter mallei*	+	-	-	-	-	+	33
3	*Acinetobacter parapertussis*	-	-	+	-	+	+	50
4	*Escherichia coli*	-	-	+	-	-	-	17
5	*Gaffkya tetrsgena*	-	-	-	-	-	+	17
6	*Klebsiella edwardsi*	+	+	+	+	+	+	100
7	*Klebsiella oxytica*	-	-	+	-	-	-	17
8	*Klebsiella pnemoniae*	+	-	+	-	+	-	50
9	*Pseudomonas aeruginosa*	+	+	+	+	+	+	83
10	*Pseudomonas pseudomallei*	+	-	-	-	-	-	17
11	*Proteus rettferi*	-	-	+	-	-	-	17
Fungi								
12	*Aspergillus fumigatus*	-	-	+	-	-	-	17
13	*Aspergillus glaucus*	-	-	-	-	+	-	17
14	*Aspergillus restrictus*	-	-	-	+	-	-	17
15	*Botrytis cinerae*	-	-	-	-	+	-	17
16	*Cephalosporium sp*	-	-	-	+	-	-	17
17	*Clonestachys roseaf*	+	+	-	+	-	-	50
18	*Microsporium gypseum*	-	-	-	-	-	+	17
19	*Mucor eretus*	-	-	-	+	-	-	17
20	*Mucor hiemalis*	-	-	-	-	+	-	17
21	*Mucor ramannisus*	+	-	+	-	-	-	33
22	*Pullularia pullutans*	-	-	-	+	-	+	33
23	*Rhizopus japanicus*	+	-	+	+	+	+	83
24	*Rhizopus oryzae*	-	-	+	-	-	-	17
25	*Trichoderma sp*	-	-	+	-	-	-	17
26	*Trichophyton schoenleinii*	-	-	-	+	+	-	33
	Total bacteria species	**5**	**2**	**7**	**2**	**4**	**6**	
	Total fungi species	**3**	**1**	**5**	**7**	**5**	**3**	
	Total microbial species	**8**	**3**	**12**	**9**	**9**	**9**	

Table 4.2.8.10: Microbial abundance in water samples from the area

S/N	Sample No	THB@35°C (cfu/ml)	Coli MPN	THF @30°C (cfu/ml)
1	1	3400	4	300
2	2	500	-	600
3	3	54000	120	500
4	4	4300	43	200
5	5	2400	93	300
6	6	50000	210	100
7	7	50000	1100	10000
8	8	100	150	30000
9	9	160000	>1100	300
10	10	110000	>1100	400
11	11	70000	43	300
12	12	100	10	300
	Range	100 - 160000	0 - 1100	100 - 30000
	Total	504800	3973	43300
	Mean ± S.E.	42067 ± 14903	331 ± 135	3608 ± 2530

Table 4.2.8.11: Microbial abundance in sediment samples from the area

S/N	Sample No	THB@35°C (cfu/ml)	THF @30°C (cfu/ml)
1	3	270000000000	1300
2	6	2500	100
3	7	11000000	20000
4	8	43000000	20000
5	11	2000000	10000
6	12	280000	1000
	Range	2500 - 270000000000	100 - 20000
	Total	270056300000	52400
	Mean ± S.E.	45009380000 ± 44998120000	8733 ± 3852

4.2.9 TERRESTRIAL WILDLIFE FAUNA

4.2.9.1 Methodology

Direct and indirect methods of wildlife survey were used to ascertain the presence and type of animal species occurring in the project area during the EIA study.

Direct Observation:-Actual sighting of the animal species involving: spot identification, behavioural features (e.g. vocal calls) and indices of various species were done during the survey.

Indirect Observation:-This involved sighting of signs (e.g. footprints, spoors and calls) left by an animal and information received from the farmers and local hunters living within the sampled area. Other Indirect signs used to estimate animal abundance include: faecal pellets and dung piles. Each time an animal or group of animals is encountered, the following information were recorded according to Gaston *et a/. (2000).*

- Species type
- Number of individual animal counted
- Mode of detection (whether sight, vocalization or sound produced by an animal
- moving through the vegetation)
- Time sighted
- Observer's location
- Animal - Observer distance
- Animal activity when first detected

4.2.9.2 Results and Discussions

The records of wildlife forms in the study based on direct and indirect methods of survey used including literature from National Resources Conservation Council (1992) and interviews with local communities show that the major wildlife components of the study area belong to the vertebrate classes of Reptilia, Amphibia, Aves and Mammalia. Their habitats include the farmlands and residential areas. Wildlife resources especially mammals reported in the area are remarkably few, because the project area has been exposed to significant human impacts especially through hunting and clearance for agriculture. These would explain the sparse wildlife around the project area and suggest a less likely occurrence of rare or endangered species compared to unimpacted areas. The list of wildlife Species sighted or reported in and around the project area is provided in Table 4.2.9.1.

Mammals occasionally sighted during the period of study or reported to occur in the project area include the Gambian Sun Squirell (*Heliosciurus gambianus*) and small brown rat (*Arvicanthis niloticus*), common rats (*Rattus rattus),* House Mouse (*Mus musculus*), Giant rat (*Cricetomys emini*), African palm squirrel (*Epixerus ebii*), and Grass cutters (*Thryonomys swinderianus*). The presence of the big mammals like the Maxwell Duiker (*Cephalopus maxwelli*) and the African Civet Cat (*Cirettictis civetta)* was confirmed by the people farming within the new project site. The people also confirmed the dominance of the rodents: Giant Pouch Rat (*Cricetomys gambianus);* small brown rat (*Arvicanthis niloticus*) and Cane Rat (*Thryonomys swinderianus*) in the project area.

The Avian population, the dominant in terms of species types and number were the most noticeable. The weaver bird, *Ploessus cuculatus* and the common garden bulbul *Pyconotus barbatus* were the most common birds in the area. Francolin (*Francolinus bicalcaratus*) was however the only bird of economic importance. The Bronze Manikin (*Lonchura cucullatus*) also occurred in all the locations sampled. The small birds (about 4 cm in length) with barred rump and flank were observed to be roosting and nesting on small trees and shrubs and were seen feeding on seeds of grasses particularly those of *Panicum* species. The Weaver birds (*Ploessus cuculatus*) were observed only in areas with plenty of grasses with seeds on them. The Lizzard Buzzard (*Kaupi falco*), and black white tailed hornbill (*Tockus fasciatus*) occurred only at two locations. Other species include the black kites (*Milvus nigrans*), Chicken Hawk (*Accipter erythropus*), Cattle Egret (*Ardeola ibis*), White Egret (*Egretta alba*), Sparrows, Pin-Tailed Whydah (*Vidua macroura),* Pied Crow (*Corvus albus*), Wood Pecker (*Dendropicos pyrrhogaster*),

The reptilian fauna sighted or reported to occur in the area consists of snakes (Pyton (Morelia spilotata), Black cobra (*Naja melanoleuca*)), Black tree snake (*Thrasops occidentalis*) Common lizards (*Agama agama*), Monitor Lizard (*Veranus niloticus*) and frogs (Dicoglossus sp), Long-legged frog (Ptychodena sp), toads (Bufo regularis) and crabs common along the wet stream channels.

A number of species sighted in the rainy season but not during the dry season include the mouse-brown sun bird (*Anthreptes gabonicus*) (which is known to be dependent on nectars of flowers) and Black and White-tailed hornbill (*Tockus fasciatus*). The Senegal Indigo Finch (*Vindua calybeata*) and the Yellow Fronted Canary (*Serinus mozambicus*) sighted during the rainy season sampling were also absent during the dry periods. Four (4) reptilian species which were not sighted during the rainy period were sighted during the dry season. These are the rainbow lizard, the monitor lizard (*Varanus niloticus*), the black cobra (*Naja nigricollis*) and the West African Green tree mamba (*Dendroaspis viridis*).

Table 4.2.9.1: List of Wildlife Species sighted or reported in and around the project area

Common Nane	Biological Name	Number Seen
MAMMALS		
Common Rats	*Rattus rattus*	5
House Mouse	*Mus musculus*	4
Giant Bush Rat	*Cricetomys gambianus*	2
African Palm Squirrel	*Epixerus ebii*	2
Ground Squirrel	*Xenus erythropus*	IH*
Grass Cutters	Thryonomys swinderianus	IH
African Civet	*Civettictis civetta*	IH
Small Deer		IH
Antelope	*Neotragus batesi*	IH
Bushbuck	*Tragelaphus scriplus*	IH
Maxwell's Duiker	*Cephalopus maxwelli*	IH
BIRDS		
Black Kites	*Milvus nigrans*	8
Chicken Hawk	Accipter erythropus	2
Cattle Egret	Ardeola ibis	>10
White Egret	*Egretta alba*	IH
Common Vultures	*Necrosyrtes monarchus*	>10
Sparrows,	Sparrows,	IH
Eagle	Eagle,	IH
Pin-Tailed Whydah	*Vidua macroura*	IH
Pied Crow	*Corvus albus*	IH
Wood Pecker	Dendropicos pyrrhogaster	IH
Bronze Manikin	*Lonchura cucullatus*	IH
Weaver Bird	*Plesiositagra cucullatus*	>10
White-Crested hornbill	*Tropicranus albocristatus* Cassin	IH
Nectar Bird	*Anthreptes collaris* Vieil.	IH
REPTILIA AND AMPHIBIANS		
Pyton	*Morelia spilotata*	1
Black Cobra	*Naja melanoleuca*	IH
Black Tree Snake	*Thrasops occidentalis*	IH
Common Lizards	*Agamma agamma*	10
Monitor Lizard	*Veranus niloticus*	5
Frogs	*Dicoglossus sp*	3
Long-Legged Frog	*Ptychodena sp*	2
Toads	*Bufo regularis*	2
Crabs		2

**IH interview with communities, hunters, or literature search*

Literature review and information gap analysis revealed a dearth of information on the wildlife of the project area, resulting in an unclear picture of wildlife diversity, abundance and distribution. Most of the wildlife taxa would, therefore, be classified as not evaluated or "data deficient" based on IUCN (1994) guidelines. This implies that data is insufficient to

assign conservation status to these wildlife taxa. Under these circumstances, the IUCN (1994) recommends that such organisms should be given the same degree of protection as threatened taxa, at least until their status can be evaluated. Other than the small mammals whose conservation status may be considered as satisfactory (survival not threatened), most vertebrate wildlife would be considered as rare (and therefore vulnerable). Some of the mammalian (*Neotragus batesi*, *Athercunus africanus* and *Tragelephus spekei*), avifauna (Family Arceidae) and reptilian (Pyton (*Morelia spilotata*) and Crocodyius) species identified are threatened or endangered and international trade is either prohibited or requiring licenses (NEST, 1991).

4.2.10 SOCIO-ECONOMICS AND HEALTH STATUS

4.2.10.1Methodology

Socio-Economic and Health Status Survey

Before the commencement of the study, Project-affected communities to be studied, village heads, youth organizations, opinion leaders and interest groups were first identified. Emissaries were then sent to the communities to inform them of the proposed project-related visits and mission in their communities.

Social data were collected to address the possible impact of the project on the cultural, archaeological, economic resources and health of the communities, using detailed field survey which included semi-structured questionnaires (See sample questionnaire in Appendix 1), in-depth personal interviews (IDIs) and focus discussion groups (FDG). Because of the peculiar nature of the project location the socio-economic and health status survey was carried out using only qualitative method. Focus group discussion and in-depths interviews were conducted with key stakeholders including traditional rulers and community leaders and youths of the fifteen communities. Socio-economic indicators such as population, ethnic composition, religion, major economic activity, availability of social infrastructure were discussed during the interview sessions. The perceptions of members of these communities about the construction of the new transmission line were also discussed. Other topics discussed during the interviews include expectations of the communities from the TCN, problems encountered with the existing transmission line and what can be done to help the communities.

Plate 4.10.1: Socio-economic Team at Lungu

Plate 4.10.2: Focused Group Discussion with Youth

Plate 4.10.3: Team with Seriki at Pole-Waya

Plate 4.10.4: Individual Interview at Danjaba

4.2.10.2 Results and Discussions

There are some key communities within the proposed project location (Table 4.2.10.1). These communities are located in some Local Government Areas cut across two states namely Kaduna and Plateau States.

Table 4.2.10.1: List of some host communities and Estimated Population along the 200km Jos – Kaduna 300KV DC Transmission Line and Associated Substations Facilities

S/N	State	LGA	Community	Estimated population
1	Kaduna	Igabi	Mando	27192
2	Kaduna	Igabi	Barakallahu	10402
3	Kaduna	Igabi	Rigachikun	29600
4	Kaduna	Igabi	Mararabar Jos	41262
5	Kaduna	Igabi	Amana Madachi	5658
6	Kaduna	Kauru	Polewaya	742
7	Kaduna	Igabi	Gwauro	
8	Kaduna	Igabi	Kangimi	3878
9	Kaduna	Igabi	Panshanu	16300
10	Kaduna	Soba	Gamagira	41393
11	Kaduna	Kauru	Yadin Kauru	1144
12	Kaduna	Lere	Ukissa	2286
13	Kaduna	Lere	Danjaba	3093
14	Kaduna	Lere	Lazuru	6383
15	Kaduna	Lere	Yadin Lere	501
16	Kaduna	Lere	Kantama	
17	Kaduna	Lere	Kauran Dawa	
18	Kaduna	Kauru	Barwa	2513
19	Plateau	Bassa	Kadamo	1016
20	Plateau	Bassa	Lungu	1271
21	Plateau	Bassa	Katako (Amo)	1751
22	Plateau	Bassa	Lalang	
23	Plateau	Bassa	Karambana	
24	Plateau	Bassa	Tarya	841
25	Plateau	Bassa	Kofa	
26	Plateau	Bassa	NEPA (Mr. Ali)	12240
27	Plateau	Bassa	Krosha	
28	Plateau	Bassa	Rafin Gwaza	
29	Plateau	Bassa	Rumfar Gwamna	614
30	Plateau	Bassa	Gurum Hausawa	3217
31	Plateau	Bassa	Zaria Road sub-station Jos	
			Total	**213297**

As indicated above, the socio-economic and health status of the project area was assessed using qualitative approach. As part of the socio- economic aspect of the EIA, only fifteen of the affected communities were selected due to safety challenges. The inhabitants of the project area are predominantly Hausa and Fulani. Other tribes are the Yorubas, Gbayi, Ibo, Lemaro, Amo and Kurama. However, the latter groups of people constitute less than 5% of the population. The language of the majority of the people of the area is Hausa. Table 4.2.10.2 shows the locations and coordinates of selected communities in the project area, while Figure 4.2.10.1 shows the estimated population of the selected host communities. With the exception of Mando and BarakalLahu, most of the inhabitants are indigene of the area (Figure 4.2.10.2).

Table 4.2.10.2: List of selected communities for socio-economic survey along the 200km Jos – Kaduna 300KV DC Transmission Line and Associated Substations Facilities

S/N	State	LGA	Community	Coordinates	
				Latitude	Longitude
1	Plateau	Bassa	Kadamo	10º 18' 15.400"	08º 40' 40.113"
2	Plateau	Bassa	Lungu	10°13'03.770”	008°45'24.210”
3	Plateau	Bassa	Katako	10º 11' 33.244"	08º 45' 56.423"
4	Plateau	Bassa	Gurum Hausawa	10º 01' 41.233"	08º 49' 09.110"
5	Kaduna	Kauru	Polewaya	10º 34' 12.324"	08º 15' 18.240"
6	Kaduna	Kauru	Yadin Kauru	10º 35' 47.260"	08º 11' 31.220"
7	Kaduna	Kauru	Barwa	10º 39' 40.320"	08º 01' 55.320"
8	Kaduna	Lere	Danjaba	10º 22' 08.224"	08º 37' 55.443"
9	Kaduna	Igabi	Mando	10º 35' 31.463"	07 º 24' 21.088"
10	Kaduna	Igabi	Barakallahu	10º 37' 20.844"	07 º 27' 43.054"
11A	Kaduna	Igabi	Rigachikun	10º 38' 35.211"	07 º 28' 17.604"
11B	Kaduna	Igabi	Rigachikun	10 º 37' 58.010"	07 º 28' 36.887"
12	Kaduna	Igabi	Mararrabar Jos	10 º 41' 33.891"	07 º 30' 37.217"
13	Kaduna	Igabi	Amana Madachi	10 º 44' 37.487"	07 º 41' 14.822"
14	Kaduna	Lere	Lazuru	10 º 26' 16.685"	08 º 40' 56.118"
15	Kaduna	Lere	Yadin Lere	10 º 24' 06.228"	08 º 06' 54.024"

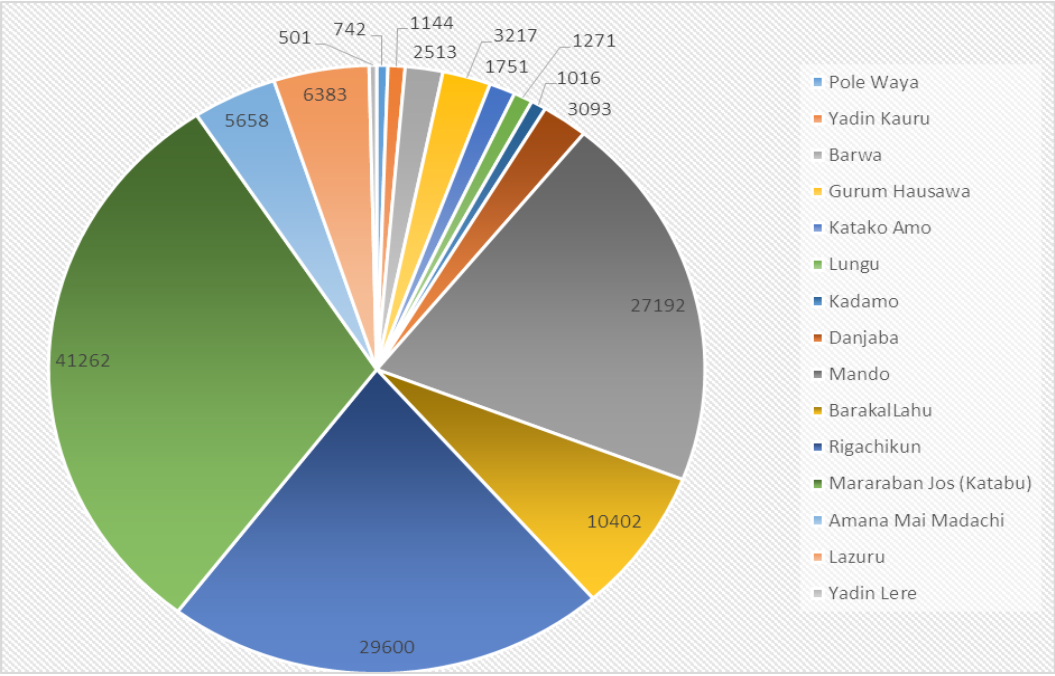

Figure 4.2.10.1: Estimated Population for the selected Communities

Household Structure

Most of the adult respondents are married and the common marriage type is polygamy. The in-depth interviews with key informants reveal that most men married many wives in order to increase the stock of their family labour supply. The majority of the households an average of six children per household.

Religion

The study revealed that the inhabitants of the area professed to be either Christians or Muslims. None of the adherents of these two popular religions practice traditional religion. In most of the communities, Muslim accounted for the majority. The only exception is Barwa and Danjaba where 100% of the inhabitants are Christians (Figure 4.2.10.2). Apart from either Christian or Muslim festivals which are celebrated yearly, none of the settlements claimed to have any traditional festivals.

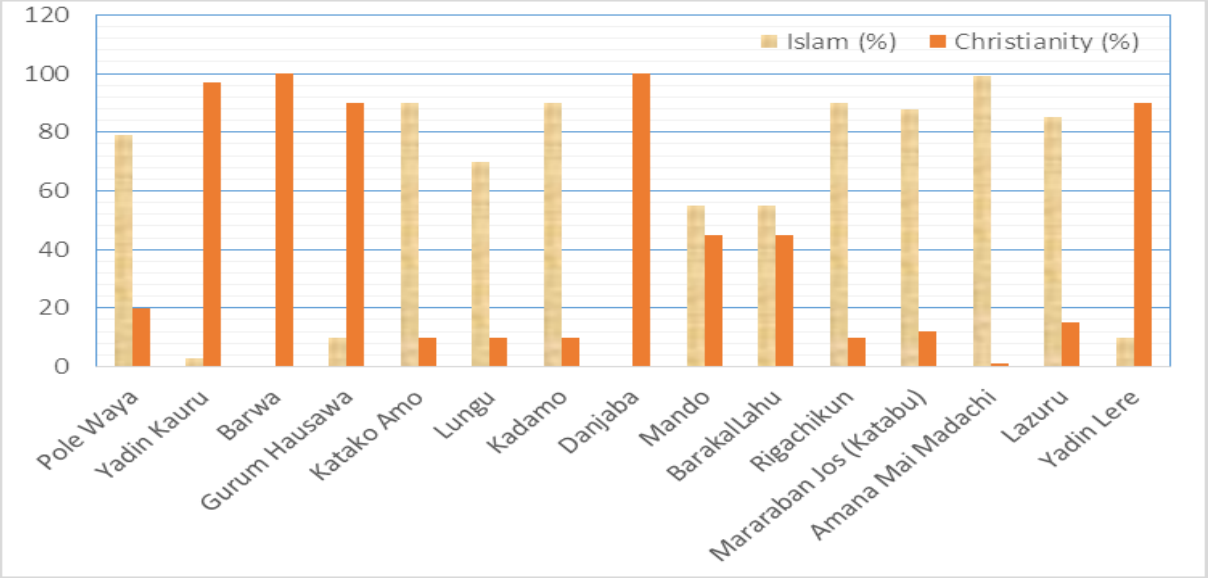

Table 4.2.10.2: Percentage Distribution of affected communities by religion

Social Infrastructures and Amenities

Most of the communities are supplied with some basic social amenities. For instance, most of the communities have good road network; the participants in FGD and in-depth interviews also claimed to have good health facilities in their localities; apart from Lazuru and Yadin Lere, all other communities are connected to national grid. But in spite of having electricity supply, most of the participants still claimed not to be enjoying adequate power supply. All affected communities have primary school and a number of the communities (Mando, BarakalLahu, Rigachikun and Mararaban Jos) have Secondary School. Even though not adequate, the communities are supplied with boreholes and the four communities with Secondary Schools also have pipe borne water. There are markets in most of the communities; the only exceptions are Amana Mai Madachi, Lazuru and Yadin Lere. In spite of all these, most of the participants claimed that these amenities are not adequate. There is no identifiable Non-Governmental Organization (NGO) or Community Based Organization (CBO) in the project area.

Quality of Life

The quantity and quality of available basic infrastructure and social amenities, including water supply, educational facilities, health, markets, electricity and transport facilities have been used as indicators of the level of development and quality of life. Based on low infrastructural development described above, the quality of life of the people in most of the project area can be described as poor. Virtually all the affected communities have primary schools, but not all of them have secondary school and there is no identifiable tertiary institution in the area. Very insignificant members of the affected communities own vehicles. A general improvement in the quality of the lifestyle of the people is therefore expected from the enhancement of the infrastructures and economic activities that will be associated with these development interventions.

Education

The level of educational attainment of inhabitants of the communities was low. Majority of the inhabitants had no formal education.

Economic Environment

(a) Occupation

Evident from focus group discussions indicated that the dominant occupation among the population is subsistence farming. Some of the inhabitants also engage in subsidiary occupations like trading. A substantial proportion of the inhabitants are artisan. Women are mainly involved in trading as their primary occupation while farming is secondary. There are a few teachers, local government employees and semi-skilled workers.

(b) Personal Income

Most of the stakeholders engaged in in-depth interview claimed that the average income of most of the inhabitant of the project area is low (compared to national average income) estimated at ₦30,000 per year. The dominance of the informal sector jobs (farming, trading, artisanship etc.) which accounts for more than 90% of the employment explains the low income levels of the inhabitants of the area as the sector is characterized by low productivity and income. According to World Bank ranking, anybody subsisting on less than US$1.00 (about ₦150) per day is classified as poor. Those earning N5,000 or less per month are considered as poor. According to the Federal Office of Statistics (now National Bureau of Statistics (NBS)), the average national incomes for urban and rural dwellers are N6,349 and N4,819.6, respectively. Given the national average levels of income (N5,150) and poverty level (57.8%) and based on the prevailing socioeconomic status of people in the area, it may be inferred that the communities are below the national average performance.

Perceived Impact of the Project

Development projects usually generate impacts on their host communities which may be positive or negative, real or perceived and may affect the people's receptiveness of the project as well as relationship with the project proponents. When asked if the proposed project development would have any effect on them, the respondents perceived some benefits from the project premised mainly on employment and community development projects.

Health and lifestyle characteristics of the project area

A health assessment of the selected communities was carried out with the aim of determining the current state of health of the communities which will serve as a baseline for further monitoring. The objectives of this health impact assessment were to (i) determine the likely impact of the project on the health and wellbeing of the population in the area and (ii) assess the existing health care services available within the communities

Each of the affected communities is supplied with functional health facility and thus makes estimation of disease burden for people in the area easy. However, as claimed by participants in the in-depth interview, these facilities are still inadequate. Therefore, the disease burden, measured by the prevalence of common childhood conditions as posited by the participants, was fairly heavy in the surveyed communities. A rough estimate indicates that about 20% of the children under age of 5 years, on the average, had a fever every week. This was above the national average and was an evidence of fairly high disease burden in the population of the project area. Response to the question on the usual source of medical attention indicates that few of the inhabitants patronize public health facilities. Some would use patient medicine stores while some would use home remedies.

4.2.11 WASTE MANAGEMENT

Wastes will be generated in the development and operation of this project. For this EIA, the sources and inventory of wastes were made at the interval of 20km along transmission line route. The waste stream encountered in the project area comprises both bio-degradable and non-bio-degradable products. The biodegradable wastes include domestic wastes, vegetable matter and other assorted organic materials. The non-bio-degradable wastes include plastics, nylon, scraps and other iron materials. Wastes are disposed of generally by free litter and open burning.

CHAPTER FIVE

POTENTIAL AND ASSOCIATED IMPACTS

5.1 INTRODUCTION

This chapter provides information on the potential environmental and social impacts of the proposed 200km Jos – Kaduna Transmission Line and associated facilities project. The environmental impacts of a project are those resultant changes or effects in environmental parameters (including social and health issues), in space and time, compared with what would have happened had the project not been undertaken (Glasson *et al.* 1999). Impacts has also been defined as any change to a resource or receptor brought about by the presence of a project component or by the execution of a project related action. Impact issues may significantly influence the decision and responses of proponent towards a proposed project development. In this section the sources and nature of the impacts associated with the various activities and phases of the proposed 200km Jos – Kaduna Transmission Line are assessed. The assessment include impact identification, classification or quantification, impact prediction and impact evaluation of the proposed project activities.

5.2 IMPACT ASSESSMENT METHODOLOGY

A number of methodologies exist for predicting the potential impacts of any project on the environment from complex human development activities. The following are five major approaches or methods of impact assessment most commonly used.

(i) Overlays (McHarg, 1968)
(ii) Leopold matrix (Leopold et al., 1971)
(iii) Battelie Environmental Evaluation System (Dee et al., 1972).
(iv) Peterson Matrix (Peterson et al., 1974)
(iii) Rau'Ad Hoc method' (Rau 1990)

Each of these methods employs the following steps:

- Identification of impacts
- Prediction of impacts
- Evaluation and interpretation of impacts
- Communication and
- Inspection procedure.

For this project, the identification of impacts has been carried out with regard to the scope of environmental (biophysical, social and health) components considered and their respective impact issues as presented in Table 5.2.1. The associated and potential impacts of the project activities were predicted using a combination of the Peterson Interaction Model (Peterson 1974), an interaction matrix model that relates project activities with environment components and the Rau'Ad Hoc method (Rau 1990). This methodology is expected to indicate whether the impact is beneficial or adverse, whether it has temporal or spatial dimension, and whether it is cumulative, spontaneous, and whether it is primary or secondary.

The Leopold Matrix, (Leopold, et al. 1971), was used to identify the cause-effect relationships between specific project actions in the environment and potential environmental impacts. The checklist presented in Table 5.2.1 shows a comprehensive list of environmental effects and social impact indicators that helped to review the possible consequences of contemplated actions. The method provides a semi-quantitative insight into the potential impacts, specified as an expert opinion value for Impact Magnitude and one for Impact Significance. Magnitude represents the extent and duration of interaction between the activity and the environment, while Significance, which represents the severity of impact and the importance of the environmental component, is related to the rate at which legislative environmental standards are exceeded. A significant impact is considered to be an impact that should be taken into account during the decision-making process.

Table 5.2.1: Impact Indicators for Various Environmental and Social Components

Components	Impact Indicators
	Biophysical
Climate	Humidity, temperature, rainfall, wind speed and direction
Air Quality	Particulates, NO_x, SO_x, CO_2, CO
Water Quality	Solids (DS, SS), turbidity, toxicity, eutrophication, contamination, microbiology, *E. coli*
Hydrology	Drainage, discharge, hydrologic balance, sedimentation, erosion
Hydrogeology	Ground water level, quality and availability
Soil/Land use	Erosion, fertility, subsidence, farming, hunting, recreation
Ecology	Diversity, distribution and abundance of aquatic and terrestrial flora and fauna
Noise and Vibration	Day-time disturbance, hearing loss, communication impairment, annoyance
Wildlife and Forestry	Abundance, diversity of species, numbers of unique, rare, or endangered species
	Socio-Economics
Population	Total population, gender ratio, age distribution
Infrastructure	Existing urban/rural infrastructure including waste handling facilities
Social & Cultural Structure	Local authority & governance structure, social vices, intra & inter ethnic clashes
Cultural & Archaeological	Shrines, burial grounds, archaeological resources
Transportation	Different types of transportation
Macro & Micro economy	Employment, Income
	Health Determinant
Pollution Related Health Problems/Diseases	Concentration of Air pollutants, (NOx, SOx, VOC, CO, SPM, Greenhouse gases). Contamination of surface waters & potable ground water, vibration, noise, illumination
Communicable & Non communicable Diseases	Disease burden, disease causing factors
Health/Recreational Facilities	Availability of & access to health care & recreational facilities
Psychosocial Factors	Drug use/abuse, communal violence, crime, suicide, depression, prostitution

More information is presented below on the two main methods of impact assessment adopted for the present project

The Rau'Ad Hoc Method

The Rau method provides guidance for total impact assessment while suggesting the broad nature of the impacts. Using this method, it is possible to quickly judge the order of

magnitude of effects or impacts as follows: No effect, Positive effect, Negative effect, Beneficial, Adverse, Problematic, Short-term, Long-term, Reversible, and Irreversible.

The Leopold Matrix of Impact Assessment Used

The Leopold Matrix is a comprehensive checklist designed for the identification, evaluation, assessment and analysis of environmental impacts of the development project following the interaction matrix analysis approach by Leopold. The Leopold Matrix developed for the proposed 200km Jos – Kaduna Transmission line project is provided as Tables 5.4.1. This checklist interaction matrix for environmental impact assessment was obtained by placing identified existing environmental components in the columns and the proposed project activities in the rows of the matrix. The number on the left hand side of the diagonal in a cell represents the magnitude of identified impact, while that on the right hand side represents the importance or significance of the impact. A plus (+) sign indicates a positive or beneficial impact, while the minus (-) sign is used to express negative or adverse impact.

The adverse environmental impacts identified were collapsed into impact indicators with similar ratings as above. The results of the matrix analysis were subjected to further testing, using hypothesis and statistical tools, and where appropriate, modeling. The rationale for assessing the likely impacts of the proposed project is based on the following considerations:

(a) Knowledge of the project activities (Table 5.2.1), equipment types, and operational procedures (chapter 2)
(b) The results of baseline studies, (chapter 4)
(c) Findings of other ESIA studies on similar projects and other literature findings on the primary project activities, (chapter 4)
(d) Comparison with FMEnv and other environmental guidelines and standards, (chapter 1)
(e) Series of expert group discussions,
(f) Past experience on other EIA projects.

The criteria applied to the screening of various activities are:

(i) Magnitude - probable level of severity.
(ii) Prevalence - likely extent of the impact.
(iii) Duration and frequency - likely duration (- long-term, short-term or intermittent).
(iv) Risks - probability of serious impacts.
(v) Importance - value attached to the undisturbed project environment.

The ranking of the severity of impacts, (impact magnitude) on a scale of 0-10, is to be interpreted as follows:

1 - 2 - negligible
3 - 4 - mild
5 - 6 - moderate
7 - 10 - severe

The degree of importance or probability of identified impacts is also structured in a similar way as follows:

1 - 2 - negligible
3 - 4 - low
5 - 6 - medium
7 - 10 - high.

Determination of Total Impact Score and Impact Severity

A total impact score was derived for each environmental component and for each project activity by adding up the products of magnitude (x) and the significance (y) for either the component or the activity. Thus the far right column of the matrix table (e.g. Table 5.4.2) provides a relative figure for the total impact on each environmental and social component. The lowest or the last row then provides a similar figure for the total impact caused by each project activity.

To further assess the significance of the severity associated with each potential negative impact identified in the previous section, a likelihood criterion is applied to each negative impact. The likelihood criteria are used to determine whether negative impacts can be prevented, mitigated or / are unavoidable. Assigning a significance ranking and a likelihood ranking to each impact allows for semi-quantitative evaluation of the severity of the impact. The colour coded impact severity matrix presented in Figure 5.2.1 illustrates the application of the impact severity and likelihood process.

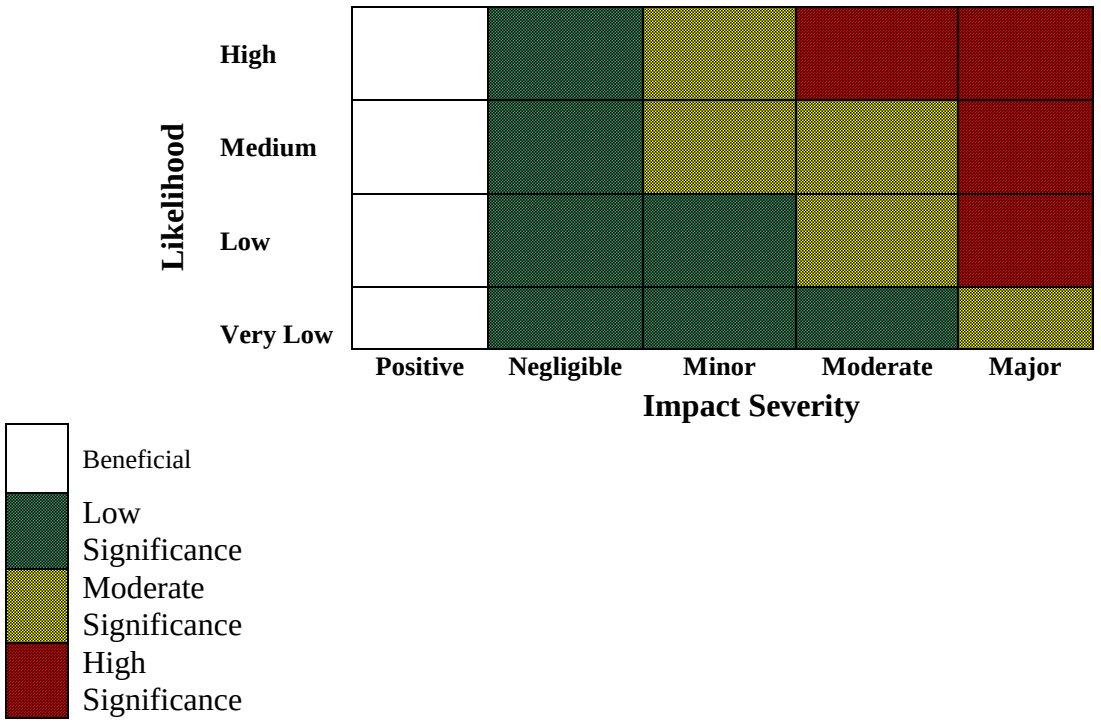

Figure 5.2.1: Impact Significance Matrix

The total or overall impact significance level is indicated by the position on the impact significance matrix (Table 5.2.1). For example, impacts placed within the red boxes have a

high likelihood of occurrence and a serious consequence, which if they have a high significance rating and thus high priority issues for further evaluation or management action. Similarly impacts in the yellow category are moderate impacts with medium priority. Impacts in the green boxes are low and are given lowest priority.

5.3 IMPACTS IN RELATION TO PROJECT PHASES AND ACTIVITIES

The activities that can impact directly or indirectly on the environment by the proposed project at its major phases are identified as follows:

Project Phase	Project Activities
Bush Clearing and Land Preparation	Site selection/Land take Mobilization of equipment and personnel Waste generation
Construction	Excavation, compaction, backfilling and grading Construction/civil works & foundation piling Installation of superstructures Waste generation Site clean up Demobilization of labour
Operation and maintenance	Commissioning Electricity generation Containment of wastes
Decommissioning	Dismantling of facilities Containment of wastes

5.4 IDENTIFICATION AND ASSESSMENT OF POTENTIAL IMPACTS

The potential impacts which have been identified to be associated with the power plant project have been classified as indicated in Table 5.4.1 into the following main groups:

- ***Adverse impacts*** – those that impact negatively on the environment and social status.
- ***Beneficial impacts*** – those that enhance the quality of the biophysical, health and social environment
- ***Reversible impacts***– impact that can revert to previous conditions
- ***Irreversible impacts*** – impacts that will remain permanent once the activity causing the impacts is terminated
- ***Long-term*** – any period greater than three months
- ***Short-term*** – a period of time less than three months

5.4.1 Potential Beneficial Effects

The principal benefits that will result from the 200km Jos – Kaduna Transmission line Project will include the following:

Environmental

- Improved access/opportunities for exploitation of natural resources

- Right-of-way areas may provide additional areas for grazing and agricultural activities
- Benefits to some wildlife species through increased 'edge effect' habitat created by ROW/Way leave areas particularly where vegetation control is well managed.

Social

- Significant increase in power transmission within the country
- Electrification to rural areas and potential new users
- Conformity with national and international standards
- Enhancement of the economic potentials of communities associated with the transmission line
- Provision of employment opportunities for local residents during project construction
- Poverty alleviation through provision of employment, promotion of small scale enterprise and community development projects with rural areas.
- Improvement in rural communication through use of the ROW and Way leave areas for transportation between communities.

Health

- Health promotion through health education and awareness on common diseases. This shall be provided to nearby communities in keeping with the provisions of the Environmental Management Plan (EMP)

5.4.2 Potential Adverse Impacts:

The principal potential negative impacts of the transmission line project include the following:

Environmental

- Increase in levels of noise, dust, emissions etc
- Disturbance of existing land use
- Disturbance of sensitive habitats
- Destruction of vegetation including potential medicinal plants
- Creation of increased access leading to resource over-exploitation
- Loss of visual aesthetics of local landscape
- Interference with other utilities such a telecommunications and air traffic facilities.
- Increased incidence of erosion and drainage problems
- Loss of land for habitation and other land use options including agriculture.
- Loss of natural resources including tree crops
- Alteration of biological productivity, habitat diversity and flood storage capacity of wetlands and floodplains
- Loss of flora and fauna
- Alteration of soil and sediment quality
- Disruption of wildlife, bird migration routes

Social

- Threats to traditional occupations including ecotourism
- Conflicts arising from labour issues
- Reduction in water quality during construction
- Increase in cost of living and inflation

- Increase in road and water traffic accidents
- Conflicts arising from unmet expectations
- Alteration in gender composition
- Alteration of ethnic composition

Health

- Potential health effects (Electromagnetic Fields)
- Injuries and fatalities resulting from electrocution consequent upon failure of line suspension
- Risk of bush fires and loss of lives and property
- Increase in morbidity and mortality due to communicable diseases
- Increase in Traffic Accidents
- Degradation of habitats
- Increase in morbidity and mortality
- Increase in Level of noise and sounds
- Reduction in Access to Nutritious and Health Diet
- Loss of Economic Trees and Medicinal Plants

Table 5.4.1: The Environmental Impact of Proposed 200km Jos - KadunaTransmission Line Project (from Rau's 1990 Method)

Impacts	No Effect	Positive Effects	Negative Effects	Beneficial Effects	Adverse Effects	Problematic	Short-Term	Long-Term	Reversible	Irreversible
Land Preparation and Construction										
Loss of land for other land uses & decreased agricultural production			*		*			*		*
Air quality impairment by particulate (dust) & gas emission from way leave clearing & construction equipment			*		*		*		*	
Increased noise level from clearing and construction equipment			*		*		*		*	
Soil deterioration due to erosion from vegetal cover removal			*		*			*	*	
Impaired surface water quality from siltation, erosional discharge from project site			*		*			*	*	
Reduced flora, fauna & wildlife population & diversity from bush clearing and land-use			*		*			*	*	
Increased employment opportunity and revenue		*		*			*			
Influx of labour, pressure on existing local infrastructure, increase in social vices & diseases			*		*		*		*	
Facility Operation and Maintenance										
Air quality impairment from production of ozone (O_3) through Corona effect			*		*		*		*	
Injury & death from electrocution			*		*			*		*
Potential forest fires			*		*			*		*
Health effects from electromagnetic fields			*		*			*	*	
Interference with radio/television transmission/reception & other telecom facilities			*		*			*	*	
Audible noise generated by corona effect around live (energised) conductors			*		*			*	*	
Increased electricity power supply along the transmission line route		*		*				*		
Enhancement of economic activities / improvement in rural economies		*		*				*		
Decommissioning										
Potential for work-related injuries and fatality			*		*		*		*	
Contamination of soil/vegetation by liquids, cleaning agents etc.			*		*			*	*	
Return of land to indigenes for farming; Increase in income, re-vegetation of areas previously occupied by structures. Increase in land available for agriculture and other land use		*		*			*			

5.4.3 Total Impact Score

Total or overall impact score was derived for each environmental component and for each project activity by adding up the products of magnitude (x) and the significance (y) for either the component or the activity. Thus the far right column in Table 5.4.2 provides a relative figure for the total impact on each environmental component. The lowest or last row provides the figure for the total impact caused by each project activity.

Most of the environmental components (17 out of 25) were characterised by impacts of low significance (Table 5.4.2). The environmental components characterised by impacts of medium significance include soil and geology, ecology and socio-economics (7 out 55) while health and safety was characterised by impact of high significant ranking (1 out of 25). Project activities such as assembly / erection of transmission tower (construction phase), generated power transmission and waste generation (operation and maintenance phase) and decommissioning impact only a few of the environmental component considered (≤5 component each).

The project activities with the highest impact ranking include construction of access road (-62 points), excavation / backfilling / pilling (-59 points) and waste generation (-52 points). Each of these project activities impact 15 – 21 of the 25 environmental components considered. On the other hand, the project activities with the lowest total impact rating are: containment of waste and debris (-13 points), waste generation (-23 points) and workforce demobilization (-23 points) under decommissioning, operations and construction phases respective. From Table 5.4.1, the mean, median and range of total negative impact for the project activities in the three phases of the project are follows

As obvious from the above table, total adverse impact on environmental components will be highest during construction phase and lowest during the decommissioning phase of the proposed transmission line project. Most of the positive significant impacts (rating 7- 8 points) occur under socio-economic and health status, notably population and job/income increase (Table 5.4.1). For the individual environmental components the recorded adverse impact occur within the range of 3-5 points i.e. low-moderate impact both in magnitude and significance.

Statistics	Site preparation and construction phase	Operational and maintenance phase	Decommissioning phase
Min	-23	-23	-13
Max	-62	-48	1
Mean	-46	-23	7
S.D.	±16	±21	±8
Median	-54	-23	7
N	7	3	7

Table 5.4.2: Impact Evaluation Matrix for the 200km Jos - KadunaTransmission **Line Project**

	Phase Development Activities													
	Site Preparation & Construction							Operation & Maintenance			Decommissioning			
Environmental Components	Equipment & Personnel Mobilization	Land / Way Leave Clearing	Excavation/Backfilling/Piling	Assembly / Erection of Transmission Tower	Construction of Access Roads	Waste Generation	Workforce Demobilization	Generated Power Transmission	Maintenance of Way Leave	Waste Generation	Dismantling of Structure & Facility	Containment of Wastes & Debris	Total weighted Factor	Ranking
1. CLIMATE														
Wind direction & speed				-3/-3									-3	Low
Temperature														Low
2. AIR QUALITY														
SPM	-3/-2	-3/-4	-5/-6		-3/-6	-3/-5			-3/-4				-27	Low
NO_x, SO_x,CO, CO_2, HC	-3/-2	-3/-4	-4/-5		-3/-4	-3/-4		-5/-4	-3/-4				-27	Low
3. WATER QUALITY														
Solids (DS & SS)		-3/-2	-3/-4		-3/-5	-3/-4			-3/-2		-3/-2	-2/-2	-22	Low
Turbidity		-3/-3	-3/-5		-3/-5	-3/-5			-3/-3		-2/-2	-2/-2	-23	Low
Toxicity					-3/-4								-4	Low
BOD/COD		3/-2			3/-4	-3/-4			3/-2	-3/-2			-14	Low
4. HYDROLOGY														
Drainage		-2/-1	-2/-4		-2/-5	-2/-3							-15	Low
Hydrologic balance		-2/-1			-2/-2								-3	Low
5. HYDROGEOLOGY														
Groundwater quality			-4/-5		-2/-5	-2/-4				-2/-2			-16	Low
Groundwater level			4/-5										-5	Low
6. SOIL & GEOLOGY														
Soil quality	-4/-3	-4/-5	-3/-6		-4/-6	-4/-3			-4/-4	-4/-3	-3/-2	-3/-3	-35	Med
Soil erosion	-4/-3	-4/-5	-3/-6		-4/-6	-4/-5			-4/-4		-2/-2		-31	Med
Farming	-3/-2	-3/-6	-3/-5		-3/-6	-4/-5			-3/-4				-28	Med
7. ECOLOGY														
Flora & Fauna diversity	-4/-3	-4/-5	-3/-4	-3/-5	-4/-5	-3/-3			-4/-3	-3/-6	-3/-2	-3/-2	-41	Med
Flora & Faunal abundance	-4/-4	-4/-6	-2/-4	-4/-5	-4/-5	-4/-3			-4/-4	-4/-6	-3/-2	-3/-2	-41	Med
8. NOISE														
Impaired hearing	-3/-3	-3/-5	-5/-4	-3/-4	-3/-5			-3/-5	-3/-4		-3/-4		-33	Low
Communication interference	-3/-4	-3/-4	-4/-3	-3/-4	-3/-5			-3/-2	-3/-4		-2/-3		-29	Low
9. WILDLIFE														
Diversity & abundance	-3/-4	-3/-6	-3/-6	-3/-4	-3/-6			-5/-4	-3/-4		-3/4		-30	Low
Habitat	-3/-4	-3/-6			-3/-6				-3/-4		-2/3		-23	Low
10. SOCIO-ECONOMIC & HEALTH														
Population	4/4	4/7	5/10		4/8		-4/-7	5/8	4/5		4/6		41	Med
Job/Income		4/7	5/10	2/6	4/6		4/-10	5/6	4/6		4/6		37	Med
Health & Safety	-3/-5	-3/-4	-3/-4	-2/-7	-3/-5	-2/-6	4/-6	-3/-6	-3/-4	-2/-4	-3/-3	-4/-2	-56	High
EMF								-2/-3	2/-2				-5	Low

- Notes: 0=No impact; 1-2=minimum; 3-4=Small; 5-6=Moderate; 7-8=Significant; 9-10 =Severe; x/y = Impact Magnitude/Indicator
- Value -/+ = adverse/beneficial; x = magnitude; y = significance; xy = relevance

5.5 DESCRIPTION OF IDENTIFIED IMPACTS

The key identified potential Environmental, Social and Health impacts of the project are described below with regard to project execution phase and environmental resources or/and receptors:

5.5.1. Land Preparation and Construction

5.5.1.1 Description of Environmental Impacts

(i) *Air quality*

The principal impacts which could impair air quality during way leave clearing, site preparation and construction are: dust (SPM) from earth moving equipment (if construction is in the dry season) and emission of SO_2, CO, NO_x, CO_2 gases from clearing and construction equipment. The emissions from the construction equipment and trucks will be too low to affect the SO_2 and NOx levels within and adjacent to the construction sites.

The impact of this phase on air quality is negative, direct effect, local scope, medium term, temporary, reversible, mitigable, of little significance and consequence.

(ii) *Noise*

The noise sources during site preparation and construction activities are the heavy equipment and machinery. Heavy equipment and machinery will be required for the various aspects of bush clearing and the excavation and earth moving, land preparation operations and construction on the transmission line route. The list of various construction equipment that may be used in this project and associated noise produced by the various construction equipment at 50-m distance from the source is given in Table 5.5.1. Their operation will lead to elevated levels of noise. These may result in hearing impairment in human populations. The noise sources are however stationary and of short-term (order of days) at a particular location and is anticipated not to be significant on the community dwellers beyond a distance of 100m from the site.

The impact of this phase on noise level is negative, direct effect, local scope, medium term, temporary, reversible, mitigable, of little significance and consequence.

(iii) *Land Use, Agriculture*

Land take by the project for the ROW and access route will lead to altered land use pattern from the present use for farming. The land-take will cause displacement of land users (farmers) and properties. However, if adequate compensation is paid, it would improve the personal income of landlords/indigenes.

The impact of this phase on land use and agriculture is negative, direct effect, local, immediate, permanent, irreversible, immitigable, and significant.

(iv) Soil and Geology/Geophysical

Bush clearing activities during site preparation shall involve the removal of land vegetation, which would lead to exposure of the soil to adverse weather conditions and erosion. The width of the Transmission Line ROW shall be 50m.

The process of constructing tower bases will involve excavation (using and excavator), compaction and backfilling. Back filling involves the dumping of soil back on the excavated ditches. In general, the first stage will be to return the soil in the reverse order.

Excavation, back filling and levelling the land for tower foundation and installation will disturb the soil and alter the original relief of the area. The back filling may affect the drainage pattern of the area if not properly done and induce serious erosion problems along the ROW if soil is not properly re-instated. However, because of the limited spatial extent ($100m^2$) at each tower location, the impacts on land use are of two significant (3/3).

The impact of this phase on soil quality is negative, direct effect, local, immediate, permanent, irreversible, immitigable, but of low significance and consequence.

(v) *Water Quality*

Clearing of vegetation on the project site will lead to soil surface exposure and compaction. If the soil is exposed for a long period, the risk of erosion will increase, including linear erosion (a concentrated drainage of water over the land surface). The impact on water quality during this phase is expected to take place during heavy rain which may erode compacted soil and carry off materials such as sand and soil from the stockpile and from the project location to nearby stream. This coupled with discharge from construction site may reduce the quality of receiving waters.

The impact of this phase on water quality is negative in nature, direct, of local scope, immediate, temporary, reversible, mitigable, small to moderate significance and scale.

Table 5.5.1: Details of Some of the Construction Equipment to be used and Potential Impacts

S/NO.	DESCRIPTION	ESTIMATED QUANTITY	POWER RATING** (KW)	NOISE LEVEL* (db)	FUEL CONSUMPTION LTR./ HR.
1.	DUMPER TRUCKS	3	10	90	1.5
2.	CONCRETE MIXER	3	5	90	0.8
3.	EXCAVATOR (TCB)	2	35	85	5.0
4.	PAY LOADER	2	50	80	7
5.	EXCAVATOR	1	70	80	10
6.	TIPPER TRUCKS	3	20	90	3.0
7.	COMPRESSOR	1	10	100	1.5
8.	MOBILE CRANE	1	40	80	6
9.	GENERATOR	1	800	90	35
10.	OTHER EQUIPMENT (COMPRESORS, POKERS, DRILLING M/CS, WELDING M/CS, GRINDING M/CS, E.T.C.)	1 SET	100	90	Electricity operated

* *Noise level as given at 50 meters distance from source*

** *Power Rating is as given by the Manufacturer and may vary at the time of Construction depending on availability*

(vi) Ecology

Changes in the natural habitats arising from way leave clearing and obliteration of vegetation will lead to the reduction in population and diversity of plants and wildlife especially the

relatively immobile animals as well as the migration of the animals that are capable of escaping. This will lead to the reduction of biodiversity in the area.

Earth moving work to structure the land for the tower installation will also result in the burial of plant cover and isolated organisms. In the specific case of the area directly affected, the vegetation is largely annual crops, with a few bushes and scattered small trees. The elimination of isolated organisms will only affect the small area intended for the structure.

The phytobenthic and zoobenthic communities existing around the area will be impacted from increased turbidity and resultant reduced decrease in the penetration of sunlight of nearby surface water receiving the erosional deposits from the project area.

This impact is negative, direct effect, local scope, immediate, permanent, reversible, immitigable, with residual effect of little significance and scope.

Although the transmission corridor does not traverse any areas of significant conservation importance, the various wetlands, freshwater swamp and riparian forests which line the major surface waters on the line could be considered of considerable ecological sensitivity. Construction work which will require removal of segments of such forest and associated wetlands will also suffer impact in the form of trampling and loss of resident fauna and flora.

The impacts in this case will be long term, reversible although localized to the immediate segments that will be affected.

(vii) *Wildlife*

Clearing of the transmission right of way and the subsequent erection of towers and string of conductors will necessarily result in the removal of plant vegetal matter along the corridor of the way leave. The removal of the vegetation (wildlife habitat) shall lead to migration of wildlife from the area. Site preparation and construction will also result in the movement of vehicles and heavy machinery representing noise sources which will tend to drive out wildlife in the project area directly affected and its immediate surroundings.

The effect is significant; irreversible (since the ROW shall be maintained at a low height), and permanent until the life span of the project (> 25 years).

(viii) Impact on Natural Resources

Clearing of the transmission right of way and the subsequent erection of towers and string of conductors will necessarily result in the removal of plant vegetal matter along the corridor of the way leave. This will result in biodiversity loss which will include plants of local medicinal importance on which the local communities depend. The impacts will be long term, reversible but localized to the immediate segments that will be affected.

Transmission line and the associated access roads will also translate into access to hitherto remote locations along the transmission line particularly where the line cuts though riparian forest resources which will thus be utilized as access route for the exploitation of those areas which have hitherto been difficult to access. This could easily lead to the over-exploration and decimation of those riparian forest resources.

This impact will be positive if it allows sustainable exploitation of natural resources and negative if it leads to over-exploitation and decimation of what is available.

(ix) Loss of visual Aesthetics of Local Landscape

Erection of the transmission line towers and the installation of the conductors and ancillary facilities will intrude into the visual aesthetics and scenery of the rural landscape and negatively impact on the scenic beauty of the landscape.

This impact will be permanent, long-term, however, localized and reversible.

(x) Interference with other Utilities such a Telecommunications

High voltage transmission lines are known to interfere with telecommunications. Transmission line transect has been carefully routed to avoid communities, built up areas and locations with other utilities. The highly dispersed settlement pattern of most of the communities also lends to dilute this impact.

(xi) Obstruction of Flight Paths

Helicopter flights, military training flights and other low-flying aircrafts may be obstructed by high tension transmission lines. The maximum height of the towers is sufficient to interfere with the normal flight height of average helicopters. Although the transmission line location is not known to witness flights associated with military and oil industrial activities, flights must however take into account the transmission line which may obstruct low-flying craft.

5.5.1.2 Description of Social Impacts

Detailed assessment by activity of the potential impacts of the project on the social-economic life of the communities are presented as follows

(i) Demographic Impacts

The settlements in the project area are predominantly rural and therefore their population sizes are generally small, less than 500. Given the small size of most of the communities, the influx of job seekers and workers during the construction phase will significantly affect the demography of the communities, not just in terms of population numbers but also in terms of population structure. The latter will be a function of the selective nature of migration which is often dominated by adult male population. Construction activity will no doubt affect the sex ratio of communities for the period the activity is taking place in particular communities.

(ii) Socio-Economic Impacts

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. Because employment in the transmission project will attract higher income, there would be some re-direction of labour from agriculture and other sectors of the local economy to the project. In addition, the higher personal incomes associated with employment in the project could cause some inflation in the local economy. Therefore, price increases and re-direction of labour are likely to be among the major consequences of the project on the local economy.

(iii) Impacts on Lifestyles

Projects of the type under review which lead to the influx of non-locals into predominantly rural, traditional and conservative communities have some visible impacts on lifestyles, some of which may be offensive to local norms, customs and practices. A common impact on lifestyles concerns sexual and other forms of behaviour, as well as modes of dressing. Sexual laxity/prostitution and alcoholism are the most vexatious 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 largesse from companies either for themselves or for their communities.

(iv) Impacts on Cultural Properties

There are 3 cultural properties of note in the host communities along the ROW of the proposed transmission line. The noted cultural property is shrine. However, traditional worship is no longer very significant in the areas because of the influence of Islam and Christianity. Therefore, the impact of the transmission line construction on cultural properties and practices will be very minimal.

(v) Impacts on Social Infrastructure

The most common social infrastructures are primary and secondary schools, healthcare facilities, electricity and water supply systems which are very limited in the communities. The project will engender population growth due to the influx of workers. The capacity of the limited local infrastructures in some of the communities cannot cope with the increased demand that will result from population growth during the construction of the transmission line.

(vi) Impact on Natural Resources

Ordinarily, a major impact on natural resources will be occasioned by land-take and destruction of vegetation along the transmission corridor. Of necessity, the farms and plant species of economic value to the people will have to be destroyed while constructing the transmission line. In addition, the expected increase in population will lead to increased demand for fuel wood and lead to some deforestation.

(vii) Employment Opportunities

This project is expected to generate limited employment opportunities for local residents over the period that it lasts. During the land preparation and construction phase particularly, opportunities for the engagement of unskilled labour will abound to the benefit of local communities. In addition to the direct demand for the local construction and assembly sector, there is also the likelihood that business and income will be generated for local commerce and services associated with demand for food, sales of materials, transport, etc, representing a boosting of local economic activity.

Positive impact, direct/indirect, local and regional scope, short term, temporary, reversible, and of average significance and scale which could be reinforced

(viii) Influx of Construction Crew

The presence of non-resident workers involved as construction crew is expected to contribute to increased income to the area. Their presence will stimulate increase in commercial activities. This is a short-term positive impact. It could also introduce some negative impacts with respect to pressures on existing infrastructure, increase in social vices and introduction of infections hitherto unknown in the rural communities.

(ix) Increase in cost of Living and Inflation

An increase in cost of living and inflation implies a likely increase in the cost of health services. Considering the low level of income of locals and the inadequacy of existing health services this will take essential health services further from the reach of majority of locals. Malnutrition may also increase in local communities from anticipated inflation and higher cost of living, resulting in less resource for food.

5.5.2 Project Operation and Maintenance

Transmission line way leave shall be regularly cleared of all tall vegetation to ensure that trees do not grow to within 10m of the conductor wires on the line. Access tracks shall be maintained, together with the management of re-growth and plants. Transmission line maintenance will also involve regular checking of the line for integrity and degree of sag. All maintenance shall be through access roads which shall be constructed /upgraded for the purpose.

5.5.2.1 Description of Environmental Impacts

(i) Impacts on air quality and climate

The physical structure which will be erected for the transmission line or the extension for the substation due to their limited physical extent would not influence wind fields or local air flow. During operation of a transmission line no contamination of the atmosphere (with gases, aerosols etc.) will occur. The corona effect might lead to production (insignificant) of Ozone (O_3) around the conductors.

(ii) Noise

Audible but insignificant humming noise will be generated by corona effect around live (energized) conductors

(iii) Loss of economic trees

Operation and maintenance of the transmission line will involve regular clearing of transmission line way leave of all tall vegetation and trees (including potential economic trees) within 10 m of the conductor wires on the line.

(iv) Boosting of the local economy

The project will increase electricity power supply along the transmission line route and meet the requirement for power supply in the light of the deficiencies of the electricity system in the area.

This will increase opportunity for local business and contracting, enhance economic activities and improve the rural economies

Positive impact, indirect effect, local and regional scope, short to medium-term, permanent, reversible, average significance and scope.

(v) Pressure on existing infrastructure

Project may result in increased accessibility of the area, leading to influx of people to the area in search of gainful employment, increased pressure on the existing/inadequate social amenities and services, (such as accommodation, health care, water and electricity). This may lead to a loss of cultural values of the people and higher levels of crime and moral decadence.

The potential influx of local people and other Nigerian nationals, particularly males, seeking employment, if unfulfilled, will lead to frustration and may also have an impact on population structure (age and gender), social infrastructure, level of service provision, the general quality of health, and the level of crime and moral decadence.

5.5.2.2 Description of Social and Health Impacts

The main social impacts of the transmission line activities are waste generation and disposal, noise, pressure on health infrastructure, water and air quality impairment, which are adverse,

short term, and of low magnitude and significance. The others – injuries, population changes, influx of commercial sex workers - are adverse, long term and of medium to high magnitude and significance. Economic/income, and population changes are beneficial/adverse, long term and of medium/high magnitude and significance (Table 5.5.2).

(i) Increase in Morbidity and Mortality

Observed levels of morbidity and mortality from common ailments were high. The availability and capabilities of health services were also less than adequate for all the communities along the transmission line. Influx of people into the area is expected to occur at all phases of the project, but more so during mobilization and at the peak of construction activities. This implies that the demand on existing health services shall increase. It also implies that the current levels of morbidity and mortality may increase.

Currently, the communities in the project area are characterized by poor housing, inadequate sanitation and water supply, influx of people is likely to increase pressure on an already deficient and inadequate community infrastructure and could lead to increase in the morbidity from other communicable diseases such as diarrhoea/gastroenteritis, respiratory tract infections and malaria.

(ii) Increase in Traffic Accidents

Increase in movement of people, equipment and goods means an increase in the potential for road and water traffic accidents. This would act indirectly to increase the morbidity and mortality incidences in the area. Particularly during the mobilization and construction phases of the project, road traffic incidents may be expected in the hitherto quiet rural communities unaccustomed to such volume of vehicular traffic.

(iii) Potential Health Effects of Electromagnetic Fields

Health impairments may arise from electromagnetic fields generated as a consequence of the charge on the conductors. A wide safety zone within which no human habitation or activity is allowed will ensure that such effects are reduced to the minimum.

(iv) Risk of Electrocution

This is a major hazard of transmission lines particularly where they inevitably have to pass close to communities. Examples exist of transmission tower collapse with consequent electrocution for the immediate area by the high tension lines.

(v) Risk of bush fires and loss of lives and property

Bush fire may arise when vegetation comes in close contact with transmission lines. Failure of transmission line towers and consequent falling to the ground of the conductors may result in fires arising from the charged conductors. Such fires may result in considerable loss of lives and property which are adverse and irreversible impacts.

(vi) Transportation of Personnel, Equipment, and Materials

The increase in traffic from the transportation of personnel, equipment, and materials may increase the rate of exposure to accidents. Roads may temporarily be obstructed or diverted to allow for movement of heavy equipment and materials. The soils of the project area would be compacted if vehicles drive on earth roads and materials were stored on the ground. The effect is not significant, short term and reversible.

(vii) Increase in levels of noise, dust, emissions etc

The operation of the machinery will result in elevated levels of noise and vibration in the otherwise quite rural setting. These may result in hearing impairment in human populations and scaring away of wildlife. Emission of SPM, COx, $SO_{x,}$ NO_x from construction equipment could impair air quality and lead to health problems for the people particularly if construction is conducted during the dry season. These impacts are expected to be highest in the immediate vicinity where heavy machinery is being operated.

Table 5.5.2: Potential Social and Health Impacts of 200km Jos - KadunaTransmission Line Project Activities

Project Phase	Activity	Impact	Impact indicator	Type of Impact		Duration (Short/ long term)	Magnitude *	Significance **
				Beneficial	Adverse			
Site preparation	ROW Clearance Tower spotting	**Noise**	**Noise level**		X	Short term	Low	Low
		Waste disposal	Garbage heaps, foul odour (H_2S)		X	Short term	Low	Low
		Pressure on health infrastructure	Prevalence of diseases		X	Short term	Low	Low
Construction	Excavation, Compaction and Backfilling Concrete works and foundation pilling Assembly and erection of transmission line towers and ancillary facilities/structure	Water quality impairment	Water-borne diseases turbidity, trace elements e.g., iron, oil & grease		X	Short term	Low	Low
		Waste disposal	As for site Preparation		X	Short term	Low	Low
		Pressure on health infrastructure	Increased prevalence of diseases & complications		X	Medium/ Long	Medium	Medium
		Air quality Impairment	Air quality		X	Long term	Low	Low

Operation	Power transmission; Transmission line inspection	Risk of electrocution	Mortality		X	Long term	Low	Low
		Injuries	Injury		X	Long term	High	High
		Waste disposal	As for site preparation		X	Long term	Medium	Medium
		noise generated by corona effect	Noise level		X	Long term	Low	Low
		Health effects from electromagnetic fields	Radiation		X	Long term	Low	Low
		Economic/ Income	Affordable access to healthcare & food	X	X	Long term	High	High
Decommissioning & abandonment	Collection and disposal of wastes	Waste disposal	As for site preparation		X	Short term	High	High

** Magnitude represents the degree and extent of interaction between activity and health of the community.*
*** Significance is severity of impact and the importance of the health component impacted*
Low = Incident has occurred rarely in the community
Medium = Incident has occurred several times per year in the community.
High = Incident has occurred several times in every section of the community per year.

5.5.3 Decommissioning

The transmission line and the ancillary installations have a life expectancy. The facility will be designed, built and maintained to operate efficiently for a specific life cycle after which it will be decommissioned.

If a decision is made to decommission the line, the following steps will be taken towards the process.

- Dismantling of the towers and conductors
- Dismantling of tower foundations
- Removal of all material from transmission line
- Restoration of land to its original situation as much as possible
- Hand over of the reclaimed land to the original community and landowners.

Decommissioning of the transmission line and the ancillary installations will result in potential for work-related injuries and fatality from the dismantling process but increase land available for agriculture and other land use from the restoration of land to its original situation as much as possible and hand over of the reclaimed land to the original community and landowners

5.6 RISK ASSOCIATED WITH THE PROJECT

Risk assessment (RA) is another terms sometimes found associated with ESIA. This is usually in response to events as the chemical, exposure and exposure to occupational diseases etc. in the present project the risk assessment of exposure to spill, waste disposal, tower collapse, injury and diseases are also considered. Some of these events or occurrences are covered by some of legislation guiding or applicable to the proposed project.

5.6.1 Environmental Risks by each Project Activity

Fuel and lubricant Spills

There is a potential for minor oil spillage to occur during refueling operations of the construction equipment. Single incidents of small volume spills are likely to pose a threat to terrestrial habitat. Depending on the spill volume, the impact is expected to be localized. Other construction related threats include vehicle collisions and welding. The impact from this event will be local and should be managed by using standard procedures and contingency plans.

Waste Disposal

A number of waste types shall be produced during the construction and operational phases of the projects. These include metal scraps, gaskets, lubricant filters, domestic waste associated with base camp etc. Improper waste disposal would lead to loss of aesthetics, risk of accidents by sharp objects/scrap piles, and contamination of soil and water bodies (through run-offs). The effects of improper waste disposal are significant, but it can be reversed and are of short term.

Tower Collapse

Construction failures and eventual tower collapse would lead to electrocution, fire and destruction of lives and properties. The design intent is that the towers and foundations are installed within specified tolerances and will be inherently safe. Past experience indicates that, although such failure would create a potentially serious hazard, the probability of such failure is extremely low.

5.6.2 Risk Associated With Sabotage Activities

Risks from such activities are unquantifiable and beyond the proponent's control. They are acknowledged to be significant enough to warrant attention in the facility HSE and security management plan, which will advise manager on proper proactive response to all sources of risk in the normal operation of the facility.

5.6.3 Diseases Risk Associated With Sabotage Activities

Malaria

All the communities are vulnerable to the risk of malaria, but those members of the communities with immunity are less vulnerable and may not be affected by the disease. Some migrant workers including expatriates from temperate regions who have no previous exposure to malaria may contract it. Construction workers and camp followers will be exposed to the malaria parasite. Inadequate accommodation will increase their exposure to mosquitoes. In the dry season, they are confined to the vicinity of permanent ponds, and river pools. The health risk is therefore high and may increase.

Diarrhea

Diarrhea has a high prevalence rate in the project area. The project is not likely to alter the existing disease pattern in the communities. The environmental condition such as faecal contaminated water and food, which encourages disease development, is not likely to increase in magnitude during the construction and operational phases of the project. The transient increase in water turbidity, which may occur during tower base construction phase, can cause irritation of bowel in some individuals.

The health services available in the communities in the project area have the capability to deal with diarrhea cases. The health sector in the project area has been acquainted with the proposed project and may require increased budget to accommodate the additional pressure on their infrastructure and drug supply. The project will produce no change in diarrhea prevalence.

Respiratory tract infections

The prevalence rate of these diseases is moderately high in the project area especially in the dry season with its dusty air. All members of the communities are vulnerable to the infections. Activities such as excavation during the construction phase of the project will produce dust particles which, if inhaled, will predispose the workforce and nearby communities to respiratory tract infections. The North-East trade winds from the Sahara desert bring dusty, cool air during the harmattan period (December-January) and may increase the prevalence of the diseases. Suspected cases of respiratory tract infections are referred to hospitals for full diagnosis and treatment.

The risk of respiratory tract infections is moderately high. However, an increase is expected during excavation which will produce additional dust particles. These particles will further predispose the vulnerable groups in the communities to infection.

Skin rashes

This disease, which results from poor sanitation and its spread aided by overcrowding, is of low prevalence. The prevalence may increase due to the presence of poor, job seeking immigrants

in the communities of the project area. The available health facilities have the capability to cope with the expected increase.

Injury

The prevalence rate of injuries is low along the Kaduna-Jos Expressway. The proposed project will involve transportation of heavy equipment, pipes and personnel, thus increasing the density of vehicles on the road. The potential for road accidents will likely increase, considering the present level of reckless driving on the highway. During the construction phase, occupational accidents may occur particularly among unskilled labour force. In the operational phase, fire outbreak may result from tower failure. Snake bite and scorpion sting may occur in all the phases of the project. The available health facilities in the project area will require reinforcement in terms of equipment, medication and personnel to cope with the expected increase in the rate of accidents and injuries.

5.7 Project Specific Risk and Hazard Assessment

The purpose of undertaking a risk and hazard assessment is to present non-routine environmental hazards, which may arise during the construction and operational phases of the transmission line project. Risks addressed include potential effects on the terrestrial, air environment as well as health effects on the local population of the affected areas. The main contributions to overall risk for each phase of the project include:

- Construction activities (spills, welding, etc.)
- Construction failures
- Tower collapse leading to electrocution and fire
- Transmission Line/Conductor Breaks
- Hazard or toxic chemicals
- Dropped objects
- Rains

The approach adopted to describe the management of the acute hazards that have been identified in this project is consistent with Hazards and Effects Management Process (HEMP). HEMP is a structured methodology for assessing hazards and associated risks where the focus is on Health, Safety and Environment. The process describes the hazards in four phases - identify, assess, control and recovery.

The HEMP structured methodology aims to secure awareness of the relevant hazards and manages the associated risks. By recognizing and preventing that “potential to harm” being realized, harm will be avoided. There are many hazards, and associated with each hazard are risks. A risk is likelihood of consequences. Thus risk is a function of the likelihood, or chance of something going wrong and the severity of the potential consequences or outcome. Mismanagement of one particular hazard can have consequences that simultaneously impact to a varying degree on several of the broad risk types. For instance failure of transmission line towers and consequent falling to the ground of the conductors may result in fires arising from the charged conductors. Such fires may result in considerable loss of lives and property.

CHAPTER SIX

IMPACT MITIGATION MEASURES

6.1 INTRODUCTION

As presented in Chapter 5, the proposed 200km Jos - Kaduna Transmission Line and Associated Substations Project has the potential to impact the various components of the biophysical, health and social environment of the project area. The identified negative impacts have been ranked variously as low, medium and high. To preserve the environment, a number of steps have been taken to mitigate the significant, high and medium ranking negative impacts, as well as enhance those impacts identified as positive. The mitigation measures proffered for the predicted impacts of the proposed project activities took cognizance of 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 proposed mitigation measures in Nigeria;
- View sand concerns of stakeholders as expressed during extensive consultations carried out during the study.

The residual effects that may remain after the application of the impact mitigation measures have also been discussed for further reduction to as low level as possible.

6.2 BEST AVAILABLE CONTROL TECHNOLOGY

In order to ensure that the impacts emanating from the project activities are mitigated, time-tested standard designs (presented in Chapter three), employing new technology with bias for environmental safety and economics are adopted in all the phases of the project – land preparation and construction, operation and maintenance. The measures that will mitigate the impacts identified with the respective project activities and to which TCN shall be highly committed are discussed below and presented in Table 6.2.1.

6.3 MITIGATION OF POTENTIAL IMPACTS

6.3.1 Land Preparation and Construction Phase

(i) Impact on Land Use and Agriculture

TCN shall:

- compensate communities for land take and farmlands in line with Federal Government Land use decree and TCN procedural guideline.
- use existing access/right of way to avoid excess land take
- increase productivity of remaining farmers through training/awareness on the mechanised farming

(ii) Impact on Air Quality

TCN shall:

- ensure the use of clearing and equipment with acceptable levels of exhaust gases, which conform to national standards and specifications.

- carry out major construction/civil works during dry season and wet grounds to reduce dust or provide silt curtains to control the suspended particles in the run-offs during wet season
- put in place dust control measures during construction including (i) proper location of material stockpiles, especially sand and soil downwind from the residential and other establishments; (ii) frequent wetting of the stockpile and working area; (iii) screening of or providing wind breaks for stockpiles; (iv) covering of trucks; and (v) proper selection of equipment and control of speed limits in construction area.
- require all workers to wear nose and mouth masks during land preparation and construction activities;

(iii) Impact on Noise Level

TCN shall:

- use equipment, which emit low levels of noise which conform to national standards and specifications.
- enforce workers to use noise defenders/ ear muffs at high noise zones.
- use acoustic barriers or encasing device for isolating and reducing the individual noise level for generator units

(iv) Impact on Water Quality

TCN shall:

- ensure no contamination of soil, water and vegetation, liquid fuel/lubricants from machines and vehicles during refuelling.
- enforce proper waste management practices and good in-house sanitary practices for base camp workforce.
- reduce time frame between clearing trenching and backfilling/re-vegetation to minimize runoff and erosion contaminating surface water

(v) Impact on Ecology/Biodiversity

TCN shall:

- enforce "no hunting of game animals" during site preparatory activities.
- avoid excess land take and minimize bush clearing during construction.
- enforce proper waste management practices and good in-house sanitary practices for base camp workforce.

(vi) Waste Management

TCN shall

- ensure that bund walls are used for storage of working materials
- ensure regular collection and disposal of wastes in accordance with the waste management plan approved by TCN
- ensure that disposal of all wastes is in line with regulatory standards

(vii) Socio-Economics and Health

The expected socioeconomic impacts of the Transmission Line Project include the following:

- Demographic Impacts (redirection of labour, inflation).
- Socio-economic Impacts (redirection of labour, inflation).
- Impacts on Lifestyles (sexual laxity, alcoholism, youth militancy).
- Impacts on Cultural Properties (religious sites/shrines, etc).
- Impacts on Social Infrastructure (schools, health care facilities, water supply).

- Impacts on natural resources (land uptake, destruction of vegetation and farms).

6.3.2 Operation and Maintenance Phase

(i) Line Maintenance

TCN shall:

- Ensure regular maintenance of right of way for Transmission Line.
- Provide security and surveillance to prevent vandalization.
- Use qualified and experienced staff to undertake project.

(ii) Increased traffic volumes and road traffic accidents

TCN shall:

- Pre-mobilize all vehicles
- Put in place visible warning signs on roads and vehicles
- Put speed breakers at sections traversing communities
- Enforce vehicle monitoring device/ TCN journey management policy/night driving and alcohol policy

(iii) Improvement in local economies

TCN shall

- ensure that all supplies and labour are sourced locally using community members as possible
- give preference to youths from the host communities in unskilled labour employment.
- pursue community assistance programmes along with project development phases to boost the socio-economic and health conditions of the area.

(iv) Increased pressure on local infrastructure

TCN shall:

- make adequate accommodation arrangement prior to mobilization of workforce to reduce pressure on local housing
- TCN shall support the development of the health facilities in communities

(v) Demobilization of workforce

TCN contractor shall

- provide severance package in line with conditions of service and Nigerian labour laws
- provide counselling for staff in preparation for the handover
- investigate the possibility of staff retention by operation or in handover agreement
- ensure that the contractor adopts a transparent approach towards staff on all handover matters
- ensure that the contract for employment of staff shall include information on the date of handover to new operator

(vi) Injury and death from electrocution

TCN shall:

- ensure proper design, construction and installation of towers and associated facilities

- provide and maintain first aid facilities at all places where workshops, offices, stores, living accommodations, maintenance facilities, etc. are situated
- ensure that personnel trained in first aid are available in an emergency at all such places
- ensure the maintenance of a high standard of sanitation throughout the camp areas and elsewhere on the site
- support health enlightenment campaigns which encourage improved sanitary conditions in the community.

6.3.3 Decommissioning and Abandonment Phase

TCN shall:

- Re-vegetate all bare areas
- Restore land to original form as much as possible and return to indigenes for other land use.
- Educate/guide road users on days of movement of dismantled parts.

6.4 SUMMARY OF IMPACTS AND MITIGATION

The potential impacts and recommended mitigation measures are summarized in Table 6.2.1.
It is obvious from the table that adequate mitigation measures have been provided to ensure that all high and medium ranking impacts were reduced to low ranking impact i.e. there were no residual impacts after the application of the mitigation.

Table 6.2. 1: Summary of Identified Impacts and Proposed Mitigation Measures for the 200Km Jos - Kaduna Transmission Line and Associated Facilities Project

Project Phase/Activity	Project Activity	Associated/Potential Impacts	Significance Rating Before Mitigation	Mitigation Measures	Significance Rating After Mitigation
Planning	Route Selection/ Land Take	Loss of land for other land use options including agriculture	High	TCN shall • pay adequate compensation to affected land owners	Low
		Decreased agricultural production	High	TCN shall ▪ increase productivity of remaining farmers through training/awareness on the mechanised farming	Low
	Mobilization of Equipment and Personnel	Increase in noise	Low	TCN shall • inform communities in advance of likely increase in noise • ensure that workers in high noise areas wear ear protecting equipment	Low
		Reduction in air quality	Low	• TCN shall ensure that all internal combustion engines are properly maintained	Low
		Increase in road traffic	Medium	TCN shall • shall schedule large & slow moving vehicles during off peak periods • Ensure maintenance of all project roads of any damage caused by project • Raise community awareness of unusual activity through a safety advisory team	Low
		Incidence of accidents/injury	Medium	TCN shall • Pre-mobilize of all vehicles • Put in place visible warning signs on roads and vehicles • Enforce safe traffic rules	Low

				• Enforce vehicle monitoring device/TCN journey management policy/night driving and alcohol policy • Provide first aid training to workforce and first aid boxes in operational vehicles	
Site Preparation	Way Leave /Land Clearing	Loss of economic trees and other land based assets	Medium	TCN shall • limit cleared area to what is required • Carry out re-vegetation of land cleared for temporary use	Low
		Decrease in agricultural/Natural Resource production	Medium	TCN shall • pay adequate compensation to affected land owners • increase productivity of remaining farmers through training/awareness on the mechanised farming	Low
		Increase in noise levels	Low	TCN shall • ensure that all construction equipment shall be in proper operating condition & fitted with factory standard silencing features as appropriate • inform communities in advance of likely increase in noise • ensure that workers in high noise areas wear ear protecting equipment • construct sound proofing walls around stationary power generating sources	Low
		Desecration of cultural properties e.g. burial/ancestral sites, sacred forests etc	Low	TCN shall • avoid sacred sites during mapping out the transmission lines • pay adequate compensation for all valuable assets and sites on	Low

				the ROW	
		Air quality impairment from emission of dust, particulate matter	Low	TCN shall • provide and enforce the use of PPEs (e.g nose masks and ear muffs) • Water construction sites to reduce dust levels especially during dry season	Low
Construction	Assembly and Erection of Transmission Line Towers and ancillary facilities /structures	Visual alteration in the aesthetics of the existing landscape and scenery	Low	Impact not significant	
		Interference with wind fields and local air flow	Low	Impact not significant	
		Obstruction of flight paths (air traffic)	Low	TCN shall • keep towers always visible for flights to take into account the transmission line which may obstruct low-flying craft.	Low
	Construction Access Roads	Loss of land for other land use options	Medium	TCN shall • pay compensation to land owners • limit cleared area to what is required	Low
		Improvement in rural road network and transportation	Medium	• TCN shall ensure maintenance of all project roads of any damage caused by project	Low
		Improvement in local economy and income flow	Medium	• TCN shall ensure that all supplies and labour are sourced locally using community members as much as possible	Low
		Impacts on air quality	Low	TCN shall • ensure that nose masks are worn by site workers during construction • water construction sites to reduce dust levels especially during dry season	Low

		Increased noise levels	Low	TCN shall • ensure that all construction equipment shall be in proper operating condition & fitted with factory standard silencing features as appropriate • inform communities in advance of likely increase in noise level • ensure that workers in high noise areas wear ear protecting equipment	Low
		Contamination of environmental media (soil, water) from oil & grease	Low	TCN shall • ensure proper waste management practices and good housekeeping practices • ensure regular collection and disposal of wastes in accordance with TCN's waste management& regulatory standards	Low
		Increase in erosion	Medium	TCN shall • re-vegetate/grass bare areas following construction, especially shoulders of roads • avoid unnecessary clearing and corridor width restricted where necessary • implement erosion control plan	Low
	Concrete Works and Foundation Pilling	Deterioration of surface & ground water quality	Low	TCN shall • ensure regular collection and disposal of wastes in accordance with waste management plan approved by TCN • ensure that disposal of wastes is in line with regulatory standards	Low
	Excavation, Compaction &	Soil quality impairment	Low	• TCN shall ensure proper backfilling e.g. returning the	Low

	Backfilling			soil in the reverse order	
	Influx of Labour	Pressure on existing local infrastructure	Medium	TCN shall • make adequate accommodation arrangement prior to mobilization on workforce to reduce pressure on local housing • shall support the development of infrastructure e.g. health facilities in communities • provide basic recreational facilities for workers within their camps	Low
		Introduction of STIs including HIV/AIDS	Medium	TCN shall • conduct public enlightenment & health education on common communicable diseases such as malaria, TB, STIs including HIV/AIDS • ensure that contractors implement social and health awareness programs for all workers at induction and on a continuous basis throughout the life of the project	Low
		Increase in social vices	Medium	TCN shall • conduct enlightenment campaign and health education for the abatement of abuse drugs, alcohol among workers throughout the life of the project • ensure that contractors enforce the alcohol and drug policy for staff • encourage contractors to support sporting activities • conduct public enlightenment & health education on common communicable	Low

				diseases such as malaria, TB, STIs including HIV/AIDS • engage and support local security systems • ensure the contractors implement social and health awareness programs for all workers at induction and on a continuous basis throughout the life of the project	
		Improvement in the local economy	Medium	• TCN shall ensure that all supplies and labour are sourced locally using community members as much as possible	Low
		Indigene-Migrant labour conflicts	Medium	TCN shall • ensure that all host communities are represented in the employment of locals during land clearing and construction to avert any conflict that could arise from perceptions of unfairness • ensure that land clearing and excavation jobs are reserved exclusively for the host communities • abide by all MOUs signed with the host communities	Low
		Safety and Security	Medium	TCN shall • erect and maintain fences around all open excavations, and other areas where necessary to ensure safety and security • mitigate against	Low Low

				stealing/robbery and the resulting conflict with the local population	
	Waste Generation: vegetation, felled trees, domestic refuse, scrap metals, filters, welding torches and spent electrodes, plastic containers sewage, domestic wastewater Diesel/Oil/Condensate	Contamination of soil, surface/ground water	Medium	TCN shall • Ensure proper waste management and good housekeeping practices • ensure regular collection and disposal of wastes in accordance with TCN waste management & regulatory standards	
	Demobilization of Workforce		Medium	TCN shall • ensure that contractors provide severance package in line with conditions of service and Nigerian labour laws • investigate the possibility of staff retention by operation or in handover agreement • ensure that contractors provide counselling for staff in preparation for the handover • ensure that the contractors adopt a transparent approach towards staff on all handover matters • ensure that the contract for employment of staff shall include information on the date	Low

				of handover to new operator • support training schemes for skill acquisition to facilitate readjustment	
Operation	Maintenance of Way Leave	Opportunity for local business & contracting	Medium	• TCN shall ensure that all supplies and labour are sourced locally using community members as much as possible	Low
		Loss of economic trees	Low	• TCN shall limit cleared area to what is required	Low
	Power Transmission	Production of ozone (O_3) through Corona effect and impact on air quality	Low	• TCN shall as much as possible ensure that transmission line is at a safe distance from the nearest human settlement	Low
		Injury and death from electrocution	Medium	TCN shall • ensure that transmission line is at a safe distance from the nearest human settlement • ensure proper design & construction of transmission line to be failure proof • put in place transmission line danger signs to limit unnecessary activities of inhabitants on the ROW	Low
		Potential forest fires	Medium	TCN shall • ensure proper design & construction of transmission line to be failure proof • provide contingency for fire out break	Low
		Health effects from electromagnetic fields	Low	TCN shall • ensure that transmission line is at a safe distance from the nearest human settlement	Low

		Interference with radio/television transmission/reception and other telecommunication	Low	TCN shall ▪ ensure that transmission line is at a safe distance from the nearest human settlement and telecommunication facilities	Low
		Audible noise generated by corona effect around live (energized) conductors	Low	TCN shall ▪ ensure that transmission line is at a safe distance from the nearest human settlement	Low
		Increased electricity/power supply along the transmission line route	Positive	▪ TCN shall pursue the availability of power supply from the project	Low
		Enhancement of economic activities	Positive	TCN shall ▪ ensure that all supplies and labour are sourced locally using community members as much as possible ▪ pursue the availability of power supply from the project which shall stimulate local economy	Low
Decommissioning	Dismantling of Tower and conductor lines Removal of dismantled materials	Noise Safety of Workers & road users	Low	TCN shall ▪ ensure that workers use PPEs ▪ Educate/guide road users on days of movement of dismantled parts	Low
	Containment of Wastes and Debris	Soil and Water contamination from oil and grease and chemicals	Low	▪ TCN shall ensure that wastes are disposed of in accordance with her waste management plan for this project	Low
	Handover of land to the original community and landowners	Opportunity for other land use options including agriculture Improvement of agricultural production and enhancement of economic activities	Positive	TCN shall ▪ Restore land to original form as much as possible before return to indigenes for other land use ▪ Re-vegetate all bare areas	Low

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 INTRODUCTION

Environmental management is a planned, integrated programme aimed at ensuring that unforeseen and unidentified impacts of a proposed project are contained and brought to an acceptable minimum. In conducting its business activities, TCN places a strong emphasis on maintaining safe and healthy working conditions for its personnel and minimising the effect of its activities on the general public as well as the natural environment. These objectives are achieved through the implementation of an HSE policy that integrates environmental management approaches into its developmental and operational schemes and which typically addresses a number of environmental issues including the following:

- Identification of environmental sensitivities (Chapter 4)
- Identification of potential significant impacts (Chapter 5)
- Adoption of design measures or operational procedures that eliminates or reduces impacts to acceptable levels (Chapter 3)
- Establishing Emergency and Contingency Plans;
- Monitoring the effectiveness of environmental protection strategies; and
- Auditing the success of the overall strategy.

The EIA study of the proposed 200km Jos - Kaduna Transmission Line and Associated Substations Project has addressed the impacts of the project (Chapter 4). The results show that if the mitigating measures articulated are implemented, the impacts of the project are not severe and are thus acceptable (Chapter 5). As part of the continuing process of management of Health, Safety and Environment issues relating to the project, the latter issues of monitoring and audit can now be addressed.

In order to ensure that the environmental considerations and mitigation measures of the EIA are implemented and to guarantee the accommodation of the provisions of the Health and Safety plan in subsequent stages of the projects, an Environmental Management Plan (EMP) has been developed. The EMP consists of plans, procedures and programmes, covering areas such as: the handling of hazardous materials and wastes, emission and discharge monitoring, site inspection and auditing and emergency response. It is formulated to ensure that the environmental mitigation requirements outlined in the EIA are central to the management of the implementation and operation of the proposed projects.

The EMP has been comprehensively developed by following international standards for (environmental) management planning such as the International Standards Organisation (ISO 14001). It covers all the phases of the projects from project design to project decommissioning. The various responsibilities and tasks involved in implementing the EMP vary with the project stage and are summarized in Table 7.1.

Table 7.1: Summary of Environmental Management Responsibilities for Various Stages of Project

S/N	Project Phase	Action
1	Project design	Review design compliance with EMP and regulations
2	Project planning and scheduling	Setting up of an environmental focal point
3	Contingency planning	Training, plan development and implementation
4	Project mobilization	Supervision of the process
5	Construction phase	Supervision including inspection, monitoring, and auditing activities
6	Construction, demobilization	Supervision of the process
7	Operations and maintenance phase supervision	Supervision including inspection, monitoring and auditing of activities
8	Project Decommissioning	Post project monitoring and auditing

7.2 OBJECTIVES OF THE EMP

The objectives of the EMP are to ensure that the impacts of the project on the environment is kept to the barest minimum or completely mitigated. This can be achieved by:

- Ensuring that all stipulated legislation and regulation on the protection of the environment are complied with;
- Ensuring that environmental concerns are fully integrated into project planning;
- Promoting adherence to the provisions of the HSE Policy of TCN;
- Promoting awareness of the importance of Environmental Management Planning among workers and other stakeholders;
- Encouraging adherence to the principles of good housekeeping and the use of best available technologies;
- Ensuring that the Project is successfully and safely implemented with minimal harm to both the environment and the health of the workers.

In order to make the implementation of the proposed EMP worthwhile, a two-pronged environmental management framework has been developed for adoption. The framework consists of:

a) an Environmental Management System (EMS); and
b) an Environmental Monitoring Programme

7.2.1 Environmental Management System (EMS)

Environmental Management System (EMS) is that part of the overall management system which includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the Environmental Policy. This implies that for an EMS to be put in place in an organization, the organization must have an environmental policy. In the case of TCN, a combined health, safety and environmental policy already exists (refer to Chapter 1). The relevance of an EMS is that it

assists an organization in achieving excellence in sustainable environmental development. TCN shall develop and incorporate an EMS component into its operational procedures for the implementation of the proposed project.

7.2.2 Environmental Monitoring Plan

Environmental Monitoring Plan is the systematic schedule for collection of environmental data through a series of repetitive measurements. UNEP (1996) describes three known types of environmental monitoring within the conceptual EIA framework as follows:

- *Baseline Monitoring* – refers to the measurements of environmental parameters during the pre-project period
- *Effects Monitoring* – involves the measurements of environmental parameters during project construction and implementation so as to detect changes in these parameters which can be attributed to the project; and
- *Compliance Monitoring* – is the periodic or continuous measurement of environmental parameters of discharges to ensure that regulatory requirements and standards are met. Compliance monitoring can either be *Mitigative Measures Monitoring* which relates to the prescribed mitigation measures put in place by the pre-project EIA to the existing operational structure of the project, or *Regulatory Compliance Monitoring*, which compares the regulatory monitoring requirements to the existing operational, occupational and environmental parameters.

TCN shall adopt a systematic monitoring schedule that will comprise both effects and compliance monitoring plans for the implementation of the proposed project. Baseline requirements are already embodied in Chapter 4 of this report and are therefore not considered in this chapter. The monitoring schedule prescribed by this EIA shall be implemented as the post-EIA Monitoring Programme by TCN.

7.3 PROJECT EMP REQUIREMENTS

7.3.1 Project Proponent and Regulatory Agencies' Requirements

As clearly indicated in the previous sections of this report, the proposed project will no doubt have both positive and negative impacts on the biophysical, social environment and health conditions within and around the project area. The onus of implementing the project in the best environmentally friendly manner lies on TCN and the various institutions/agencies that shall be involved in the project implementation. The essence of this exercise is to apportion roles and responsibilities to all the various parties involved in the implementation of the project. The following roles shall be undertaken by TCN for the purpose of the project.

7.3.1.1 Staffing and Training

TCN shall ensure that every category of its operational staff is adequately trained on the various aspects of the job. Personnel will be trained on safety/start-up and shut down operations / frequencies / preventive maintenance/ safety checks and maintenance of facilities. TCN shall also reinforce staff training with regular induction courses and refresher courses/programmes.

TCN shall also ensure that personnel of its Health, Safety and Environment Department, saddled with the responsibility of coordinating periodic

safety activities/ are effectively trained in handling safety equipment, fire fighting and other contingencies.

7.3.1.2 Emergency Contingency Plan

TCN shall develop a sound emergency contingency plan for the entire project lifespan. The contingency plan shall cover actual and potential incident/accident that might occur in the course of the operations. The development of the contingency plan will assist TCN in having a framework on how emergency cases will be handled and the procedures on follow-ups.

7.3.1.3 Facilities Surveillance

This is a salient system maintenance requirement for the environmental sustainability of the proposed transmission line project. TCN shall carry out constant equipment and facilities surveillance to detect on time, the malfunctioning or deterioration of equipment/facilities and sabotage. This surveillance shall aim at taking prompt corrective/repair measures on detected faults.

7.3.1.4 Project Planning and Implementation Strategy

TCN shall carry out various activities during the project in such a way as to avoid injury to its employees, while preserving their health and safety as well as those of its contractors and other stakeholders. It shall also minimize to the barest minimum, the environmental impacts that are likely to result from the project facility operations. This will be achieved by:

- the integration of environmental management issues into the proposed project plan;
- the development of a waste management plan for the proposed project;
- the review of environmental issues during project review meetings; and
- the promotion of environmental management awareness among personnel;

7.3.1.5 Project Operations

TCN shall implement all inputs contributed by the regulatory agencies into the proposed project operations and shall also ensure that these agencies are carried along as the project advances. By statutory regulation, the Federal Ministry of Environment (FMEnv) is expected to play active roles in the implementation and approval of the proposed project design. Among the requirements that the regulators shall consider during the design phase of the project include:

- international standards and codes for the project design,
- technology which shall be simple but competent to ensure efficiency in project safety components,
- technology which shall be environmentally friendly and support a healthier environment, and
- adequacy of safety facilities to cover all units of operation.

The role of the regulators shall also be, among other things, to ensure that the highest level of safety and environmental awareness is brought to bear on project implementation and that mitigation measures recommended in this EIA are appropriately implemented throughout the entire lifespan of the project operations.

7.3.2 Environmental Monitoring Requirements

Environmental monitoring is essentially a process aimed at detecting negative impacts of a project on the environment early enough to take remedial actions.

Monitoring Objectives

In order to measure and quantify the impacts of the project development on the receiving environment, the following monitoring objectives have been established:

(i) Monitor alterations in existing physical, chemical, biological and social characteristics of the environment.
(ii) Determine whether any detected changes in environmental components are caused by the project or natural occurrences.
(iii) Determine the impacts of non-compliance with EIA and EMP requirements by the contractors, in particular to monitor emissions and discharges and ensure compliance with local, national and international standards.
(iv) Determine the effectiveness of the ameliorating measures that have been put in place;
(v) Highlight areas of concern unforeseen in the EIA and EMP and provide a basis for recommending further amelioration measures.

Monitoring Impact Indicators

Impact indicators are defined in terms of carrying capacity, threshold levels and regulations / enforcement standards. In identifying impact indicators, priority is given to environmentally sensitive areas, and in this regard, it is noteworthy that the entire project area falls under this category. Based on the results of baseline studies and consideration of FMEnv limits, the following impact indicators (Table 7.2) are identified with the corresponding environmental components.

Table 7-2: Monitoring Impact Indicators

Environmental Components	**Impact Indicators**
Air Quality	Particulates volume discharged, SO_2, NO_x, CO, NMHC, heavy and trace metals.
Soil	Texture, pH, Total Organic Carbon, Nutrients, Heavy metals, oil & grease
Quality of receiving water	DO, COD, BOD, pH, Nutrients, Turbidity, TDS, TSS, Heavy metals, Hardness, oil & grease
Aquatic ecology	Diversity, Abundance, Benthic Fauna
Socio-Economic	Population, infrastructure, social & cultural structure, cultural & archaeological, transportation, macro & micro economy
Health Status	Pollution related health problems/diseases, communicable & non communicable diseases, nutritional status, health/recreational facilities, accidents/fires/explosion.

Monitoring Programme

The monitoring programme that has been designed will meet the data needs of TCN for self enforcement of corporate policy and compliance with national and international regulatory standards. The programme is based on the status of the existing environment and the assessed incremental impact of the additional facilities on areas designated as environmentally sensitive. The proposed monitoring programme is shown in Table 7.3.

Scope of Monitoring

The monitoring programme will be developed to verify the emissions and discharges based on existing national and international regulations on environmental pollution and on the findings in each monitoring campaign. The Environmental Guidelines and Standards for the Industry in Nigeria (FMEnv, 1991) defines a required monitoring programme. The quality of the environment in the project area can be verified by focusing on measuring specific indicators of environmental quality parameters that are representative for the overall environmental quality and at the same time relatively easy to measure.

Monitoring Methodology

The procedures for assessing the impacts of projects on the environment include:

- identifying the source and characteristics of all wastes generated;
- quantifying emissions and discharges to the environment; and
- quantifying and qualifying land-take and its direct effect on terrestrial ecology.

This environmental assessment will continue to evolve along with the project, and is in fact the iterative process of impact mitigation. Monitoring and audit will continue throughout the life of the project. Monitoring may involve measuring specific indicators of environmental quality parameters and comparing with baseline levels. The frequency of this depends on the results of the monitoring and inspections. If the results of the monitoring measurements give rise to concern about the environmental quality of water and sediment, for example, more detailed surveys will be performed which may include the sampling and analysis of organisms living within the habitats of the project area.

Parameters to be monitored

In this regard, the baseline data in this document shall be the benchmark database for the monitoring activities that will be carried out with regards to the proposed project. The indicators of environmental quality that will be monitored include the following:

(i) Air Quality

The air quality of the study area under the proposed project is predicted to be good and therefore, it is necessary to retain it or at least reduce the rate of its deterioration. Table 7.3 summarizes the recommended mitigation, monitoring and training for each category of environmental resources and impacts. In this regard, the following air quality parameters shall be monitored:

- Total suspended particulates (TSP)
- Noxious gases - SO_x, NO_x, CO, H_2S, NMHC

Monitoring shall be carried out at least biannually and/or as specified by the regulators along the transmission line and sub-stations to monitor environmental performance and the combustion process itself.

(ii) Noise Level

It is necessary to monitor the level of noise that workers are exposed to along the transmission line and at all the neighbouring communities. Noise monitoring shall be done during project activities and quarterly thereafter.

iii) Land Use

The premises on which the new transmission line shall be sited will monitor for the purpose of rehabilitation and re-vegetation to prevent degradation.

(iv) Soil/Sediment Quality

As these ecosystem components serve as habitats for numerous macrofauna and receivers of several contaminants from various activities, the soil and sediment quality status around the project area shall be monitored on a regular basis. The parameters that are crucial to this monitoring are:

- Heavy metal concentrations
- Total hydrocarbon concentration
- Exchangeable cations
- Anions
- pH
- Benthic macrofauna (Sediment)

Soil samples shall be obtained along the transmission line, and around the communities to confirm the soil quality. Monitoring of these parameters shall be carried out once a year following standard methods as specified by the regulatory authorities.

(v) Water Quality and Effluent

Presently, results of laboratory analysis on water quality in the study area are within acceptable limits, certain project operations (eg. operational wastes (spent oil / grease, solid waste, domestic liquid wastes and sewage) could contribute to its degradation. To this effect, certain water parameters that shall be monitored in order to keep record of any water quality changes include:

- pH
- Conductivity
- Total Dissolved Solids (TDS)
- Dissolved Oxygen (DO)
- Biological Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Turbidity
- Total Hydrocarbon Content
- Phytoplankton and zooplankton

These parameters shall be monitored as specified by the regulatory authorities.

(vi) Socioeconomics and Health

Socio-economic parameters depicting social economy and general well-being, population, income, settlement pattern, health, safety and security, level of development and quality of life

shall be monitored through studies. The host communities' feelings and relationship with TCN shall be gauged through regular meetings with the communities. Health parameters including pulmonary symptoms as detailed in Chapter four shall continue to be monitored on workers in the transmission line with a view to taking corrective measures.

(vii) Waste Management

TCN shall take all practical and cost effective measures to minimize the generation of wastes, by employing the four R's (Reduce, Reuse, Recycle, and Recovery) through process of optimization or redesign, efficient procedures and good housekeeping. The strategies for waste management to be adopted are summarized as follows:

- To reduce the volumes of wastes generated.
- To recycle and re-use wastes whenever feasible.
- To treat hazardous waste and make them inert before disposal.
- To ensure safe and responsible collection, storage and disposal of all wastes.
- To provide auditable records of all waste streams.
- To monitor waste disposal activities in order to prevent future liabilities.
- To reduce the negative impact of the project operations on the environment.

Specifically, construction and facility operation activities will result in the generation of a variety of wastes. They include:

Solid Wastes

These types of waste include cleared vegetation, domestic refuse, scrap metals, filters, welding torches and spent electrodes. 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.

Aqueous /Non Aqueous Wastes

i) Black and Grey Water

Black water refers to sewage whereas grey water is domestic wastewater. These shall be disposed off in accordance with national standards and guidelines.

ii) 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 off in designated sites.

Gaseous Emissions and Discharges

The atmospheric emissions principally associated with gaseous discharges during the construction activities are: Carbon dioxide (CO_2), Carbon monoxide (CO), Methane (CH_4), Oxides of Nitrogen (NOx) and Sulphur Dioxide (SO_2).

Waste management is of prime importance in pollution prevention during the operations and as such, it is a line responsibility. Line supervisors shall be actively involved in the monitoring and control of wastes generated by their activities. The guideline for waste management would be used to further develop and articulate a tailored waste management plan that takes account of waste identification methods, waste storage, waste tracking, monitoring and audit of waste disposal sites. All effluents and other wastes emanating from project activities shall be treated in accordance with government regulations prior to disposal at appropriate and approved sites. A

user friendly Waste Management Plan, covering all aspects of wastes produced in the course of the project shall be made available to all staff.

Waste Handling

For proper handling and disposal, wastes shall be well defined at source and the definition transmitted along with the waste to the final disposal points. Contractors and TCN 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

Waste Disposal

All wastes shall be cleared regularly from the site and disposed off at TCN or Government designated areas and facilities by State Environmental Agency accredited contractor. Wastes in transit must be accompanied and tracked by consignment notes. The waste consignment notes shall contain the following information as a minimum:

- Date of dispatch;
- Description of waste;
- Waste quantity/container type;
- Consignee/driver name and means of transportation; and
- Confirmation of actual disposal (time and date)

Waste disposal options in line with TCN guideline shall be as follows:

Waste Type	Management
Drums/Containers	• Bulk transport and storage for high volume consumption items • Refill and reuse containers • Where possible, non-refillable containers could be returned to vendor for re-use or solid to scrap vendors
Industrial wastes (electrode studs, scrap metals)	• Metal waste will be sold to scrap vendors • Industrial wastes will be disposed of in designated areas in accordance with regulation.
Domestic waste (plastics paper, food, etc)	• Reduce packaging wastes (paper & plastics) by use of bulk handling • Paper wastes shredded at designated points • Food wastes to be composted
Medical Waste (used needles & syringes, expired drugs, blood & blood products etc)	• Medical waste (hazardous & non-hazardous) shall be collected in colour coded bins and transported to medical incinerator for incineration

Table 7.3: Environmental Management Plan for 200km Jos - Kaduna 330 KV DC Transmission Line Project

Project Activity	Impact	Mitigation/Enhancement	Compliance Requirement	Parameter For Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
Route Selection/ Land Take	Loss of land for other land use options including agriculture	TCN shall pay adequate compensation to affected land owners	Federal & State Legislation	List of all bonafide land owners	Once before land acquisition	One month before land acquisition	TCN, FMEnv/SEA /LGA
	Decreased Agricultural Production	TCN shall provide farming support facilities such as improved varieties of seedlings and other extension services to farmers	TCN Policy	Records of supportive actions	Six monthly during construction	Six monthly during construction	TCN Community Relation Team/ FMEnv/SEA /LGA
Mobilization of Equipment and Personnel	Potential increase in road traffic volume & road traffic congestion	TCN shall schedule large and slow moving vehicles during off peak periods	TCN SAFETY Policy	Journey management record; Night driving permit and statistics	Weekly	Monthly	Contractor SAFETY adviser
		TCN shall maintain/repair all roads regularly used by the project	FMW standards	Percentage of completion	Monthly, six months prior to mobilization	Monthly	TCN/ FMEnv/SEA /LGA
	Potential increase in road traffic Accidents	Raise community awareness of unusual activity through the safety team	TCN SAFETY Policy and business ethnics	Record of awareness sessions	Monthly	Six monthly	TCN Community Relation Officers
		Pre-mobilization of all vehicles	TCN contract agreement	Pre-mob certificate and statistics	Weekly	Monthly	TCN Contract Holder

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
		Visible warning signs on roads and vehicles	Federal traffic regulation	Number and adequacy of signs and speed breakers	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
		Vehicle monitoring device/ TCN journey management policy/night driving and alcohol policy shall be enforced	TCN alcohol and drug and SAFETY Policy	Journey management record; Night driving permit and statistics	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
		First aid training of workforce and provision of first aid boxes in operational vehicles	TCN standards	Number of first aid certificates issued and records of vehicle first aid boxes audit	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
	Increase in noise levels	Enforce “no night” driving policy except when unavoidable	TCN SAFETY Policy	Night Driving permit and statistics	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
		TCN shall ensure that all vehicles and equipment conform to World Bank limits for noise	FMEnv Standards /World Bank guidelines	Vehicle maintenance records	Monthly	Monthly	TCN/ FMEnv/SEA/LGA
	Reduction in air quality	TCN shall ensure that only vehicles with pre-mobilization certificates are used to reduce emissions from vehicle exhaust	FMEnv Standards	Pre-mob certificates and statistics	Weekly	Monthly	TCN/ FMEnv/SEA/LGA

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
Site Preparation and Construction							
Land clearing, excavation	Loss of flora and fauna	Site clearing shall commence from developed (e.g. roads) to undeveloped areas to provide escape routes for wildlife	None	Site clearing inspection records	Daily	Weekly	TCN/ FMEnv/SEA/LGA
		Hunting by the workforce shall be prohibited	FMEnv	Compliance records	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
		TCN shall educate construction workers and host communities on the sensitive nature of the biodiversity of the area and the need for conservation	FMEnv	Records of SAFETY meetings and community enlightenment sessions	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
	Loss of habitat	TCN shall limit cleared area to what is required	FMEnv	Site clearing inspection records	Daily	Weekly	TCN/ FMEnv/SEA/LGA
		TCN shall encourage the re-vegetation of land cleared for temporary use where feasible	FMEnv	Implementation records	One month after site clearance	Three monthly	TCN/ FMEnv/SEA/LGA
	Community agitation	TCN shall ensure • Equitable employment opportunities for the host communities	TCN Policy	Employment & compensation payment records	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
		• Prompt implementation of agreements on compensation • Regular consultation with stakeholders • abide by all MOUs signed with the host communities	TCN Policy	Records of compliance with MOU items	Monthly	Quarterly	TCN/ FMEnv/SEA/LGA
	Stress on existing security structures	TCN shall ensure that both contractor and TCN develop a high level of security consciousness both within and outside the work area	None	Statistics of security breaches	Weekly	Monthly	

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
		Security reports shall reviewed by the TCN Transmission Project Manager	TCN Policy	Security Reports	Weekly	Monthly	TCN
		If required, special security force shall be established and deployed for the project.	TCN Policy	Number of special security personnel on site	Monthly	Monthly	TCN
		TCN shall ensure that a liaison to foster partnership with the community so as to guarantee security for the project is established and sustained	TCN Policy	TCN community meetings	Monthly	Monthly	TCN/ FMEnv/SEA/LGA
	Increase in dust emission and noise	TCN shall ensure that nose masks and earmuffs are worn by site workers during excavation	TCN SAFETY Policy	SPM, records of respiratory diseases and noise levels	Monthly	Monthly	TCN/ FMEnv/SEA/LGA
		Water shall be sprayed on construction sites to reduce dust levels especially during dry season	FMEnv/World Bank Standards	Records on compliance, SPM at selected sites within 500m band	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
	Potential increase in erosion	TCN shall re-vegetate areas not needed for construction as soon as possible following	FMEnv/TCN Policy	Records of re-vegetation exercise	Monthly	Quarterly	TCN/ FMEnv/SEA/LGA
	Threat to health of workers (snake bites, insect stings, injuries etc)	TCN shall ensure that anti-venom/antihistamine is provided on site to mitigate snake bites and insect stings	TCN Policy	First aid training records and statistics	Monthly	Quarterly	TCN/ FMEnv/SEA/LGA
		TCN shall ensure that an adequate number of trained First Aiders are available at work sites	TCN Policy	Compliance records	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
		TCN shall ensure that awareness is created among site workers on the likelihood of exposure to poisonous wildlife and plants	TCN Policy	Records of anti-venom/antihistamine at site clinic	Monthly	2-monthly	TCN/ FMEnv/SEA/LGA
Influx of	Changes in local	Prior to commencement of the	None	Records of	Weekly	Monthly	TCN/ FMEnv/SEA/LGA

Labour and followers (dependents, bounty seekers, CSWs etc)	population	construction phase, TCN 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 population will grow		applications at employment office and copy of advertisement			
		TCN shall look into the development of off-site job recruitment to discourage influx of people	None	Documentary evidence of implementation	3-months	6-monthly	TCN
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**
	Increase in morbidity (including STIs) and mortality	Health awareness on the mode of transmission of STIs (including HIV/AIDS)	None	Statistics of health awareness lectures	Intensive phase one to two months prior to mobilization and quarterly there after	Quarterly	TCN SD and Occupational Health teams/ FMEnv/SEA/LGA
		As much as possible, psychological support shall be provided to persons living with the HIV virus	Government Policy	Records of HIV support program	Quarterly	6-monthly	TCN SD and Occupational Health teams/ FMEnv/SEA/LGA
		Immunization of workforce as appropriate	None	Records of statistics of immunization	During mobilization	Quarterly	TCN/ FMEnv/SEA/LGA
		TCN shall enforce Expatriate malaria policy	TCN Policy	Compliance	Monthly	Annually	TCN
		Vector control to reduce Incidence of malaria (such as regular spraying of camp and provision of insecticide treated nets (ITN)	TCN	Records and statistics of ITN distribution	Monthly	Quarterly	TCN/ FMEnv/SEA/LGA
		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	None	Statistics of health awareness lectures	Monthly	Quarterly	TCN/ FMEnv/SEA/LGA

		cultural values					
		Alcohol and drug policy shall be implemented to encourage healthy lifestyle for workers	TCN Policy	Records of violations	Monthly	6-monthly	TCN/ FMEnv/SEA/LGA
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**
		TCN shall support the activities of the state action committee on STIs/HIV/AIDS within the local communities	None	Records of supportive action to SACA	Monthly	Quarterly	TCN/ FMEnv/SEA/LGA
		TCN shall provide site clinic to take care of minor illnesses for all workers	TCN Policy	Statistics of attendance, morbidity and mortality	Weekly	Monthly	TCN/ FMEnv/SEA/LGA
	Increase in social vices	Intensive enlightenment campaign and health education for the abatement of abuse of drugs, alcohol in the communities and among workers throughout the life of the project	Law against smoking in public places and NDLEA Act	Enlightenment campaign/health education statistics; records of cases of abuse in the workforce	At least 3 months before commencement of construction activities then 6-monthly thereafter	Annually	TCN/ FMEnv/SEA/LGA
		TCN shall ensure that contractors enforce the alcohol and drug policy for staff	TCN Policy	Records of violation	6-monthly	Annually	TCN/ FMEnv/SEA/LGA
		TCN shall support public health lectures with emphasis on common communicable diseases such as malaria, TB, STIs including HIV/AIDS	None	Statistics of health awareness lectures	1 to 3 months before mobilization and then quarterly thereafter	Quarterly	TCN/ FMEnv/SEA/LGA
		TCN shall support local security systems	TCN Policy	Record of TCN support	Quarterly	6-monthly	TCN/ FMEnv/SEA/LGA

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
		TCN shall ensure that contractors implement social and health awareness programs for all workers at induction and on a continuous basis throughout the life of the project	TCN Policy	Statistics of social and health awareness programmes	At induction and quarterly thereafter	Annually	TCN/ FMEnv/SEA/LGA
	Pressure on existing infrastructures and utilities	TCN shall make adequate accommodation arrangement prior to mobilization of workforce to reduce pressure on local housing	Public Health Law (CAP 103): Building regulations code	Accommodation plan	3 months prior to mobilization	1 month go mobilization	TCN
		TCN shall support the health facility in the communities	TCN Policy	Support provided	Monthly	Monthly	TCN OH team/ FMEnv/SEA/LGA
		TCN shall provide basic recreational facilities for workers within their camps	None	Number and types of facilities	Quarterly	6-monthly	TCN/ FMEnv/SEA/LGA
		TCN shall extent water supply from camps/worksites to communities at strategic points	None	Number of water stand points outside the camps	Monthly	Quarterly	TCN/ FMEnv/SEA/LGA
	Increase in inflation level	TCN shall support skill development and enhancement of the local communities through training	None	Number of beneficiaries of skill acquisition	6-monthly	Annually	TCN/ FMEnv/SEA/LGA
			None	Records of enlightenment sessions	6-monthly	Annually	TCN/ FMEnv/SEA/LGA

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
Construction of High tension line, field manifold and telecoms tower	Increase in dust, noise and vibration	TCN shall ensure that all construction equipment shall be in proper operating condition and fitted with factory standard silencing features if appropriate	FMEnv	Number of equipment fitted with such facilities; maintenance records	Monthly	Quarterly	TCN/ FMEnv/SEA /LGA
		TCN shall provide and enforce the use of PPEs (e.g nose masks and earmuffs)	TCN Policy	Compliance	Weekly	Monthly	TCN/ FMEnv/SEA /LGA
		Water shall be sprayed on construction sites to reduce dust levels especially during dry season	None	Records of compliance	Daily	Weekly	TCN/ FMEnv/SEA /LGA
		TCN shall construct sound proofing walls around stationary power generating sources	TCN Policy	Compliance	Monthly	Quarterly	TCN/ FMEnv/SEA /LGA
	Increase in potential for erosion	TCN shall re-vegetate areas not need for construction as soon as possible	TCN Policy	Records of re-vegetation	Monthly	Quarterly	TCN/ FMEnv/SEA /LGA
	Soil degradation	TCN shall provide containment for chemicals and liquid discharges	TCN Policy	Compliance	Weekly	Monthly	TCN/ FMEnv/SEA /LGA
		TCN waste management policy shall be enforced	FMEnv & TCN Policy	Waste collection records	Weekly	Monthly	TCN. FMEnv/SEA /LGA
		TCN shall ensure that a controlled fuelling, maintenance and servicing protocol for construction machinery at worksite is established and followed to minimize leaks and spills	TCN Policy	Fuelling, maintenance and servicing record	Weekly	Monthly	TCN, FMEnv/SEA /LGA
	Injury workers	TCN shall carry out first aid training of workers	TCN Policy	Training records	Monthly	Annually	TCN, FMEnv/SEA /LGA
		TCN shall provide and enforce appropriate use of PPEs (e.g life vests, hard hats, eye goggles)	TCN Policy	Compliance	Weekly	Monthly	TCN/ FMEnv/SEA /LGA
		TCN shall ensure toolbox talks are held, prior to work activities	TCN Policy	Compliance	Weekly	Monthly	TCN/ FMEnv/SEA

							/LGA

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
	Loss of biodiversity	TCN shall limit cleared area to what is required	TCN Policy	Compliance	Once during construction	Once during construction	TCN/ FMEnv/SEA/ LGA
		TCN shall ensure that sire clearing is commenced from developed (e.g roads) to undeveloped areas to provide escape routes for wildlife	TCN Policy	Compliance	Once during construction	Once during construction	TCN/ FMEnv/SEA/ LGA
		TCN shall undertake to educate construction workers on the sensitive nature of the biodiversity of the area and the need for conservation	TCN Policy	Records of enlightenment sessions	Monthly	Annually	TCN FMEnv/SEA/ LGA
		TCN shall ensure that hunting by employees of the contractors shall be prohibited	TCN Policy	Plans for enforcement and records of violation	6-monthly	Annually	TCN/ FMEnv/SEA/ LGA
		TCN shall re-vegetate land cleared for temporary use where feasible	None	Compliance	2 months after construction	6 months after construction	TCN/ FMEnv/SEA/ LGA
	Reduction in air quality	TCN shall ensure that all mobile and stationary internal combustion engines are properly maintained	FMEnv	Maintenance records	Monthly	Annually	TCN/ FMEnv/SEA/ LGA
Waste generation and disposal	Increase in breeding ground for disease vectors and other agents of diseases	TCN waste management policy shall be enforced	FMEnv /TCN Policy	Compliance	Weekly	Monthly	TCN/ FMEnv/SEA/ LGA
	Increase in nuisance effect	TCN shall enforce adequate waste management on site	Public Health Law (CAP 103), TCN/ Policy	Compliance	Monthly	Quarterly	TCN/ FMEnv/SEA/ LGA
	Blockage of natural drainages	TCN shall ensure that wastes are disposed of at appropriate locations provided for waste disposal and collected as quickly as possible	Public Health Law (CAP 103), TCNPolicy	Compliance	Monthly	Quarterly	TCN/ FMEnv/SEA/ LGA
	Pressure on existing waste management system	TCN shall explore ways to assist the communities in managing wastes	Public Health Law (CAP 103): TCN Standard	Records of supportive action	Quarterly	Annually	TCN/ FMEnv/SEA/ LGA

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
Operation and Maintenance							
Operation and Maintenance of High tension line	Increase in noise levels, health problems from electromagnetic field	TCN shall encourage community members Not to settle near the High tension line fence	TCN Policy	Visual monitoring of the level of encroachment	6-monthly	Annually	TCN
	Collapse of transmission line tower leading to electrocution of humans and animals	TCN shall undertake regular inspection of line sag and integrity	TCN Policy	Compliance	6-monthly	Annually	TCN
	Noise disturbance from inspection vehicles etc	TCN shall not employ helicopter overly for routine inspection. Communities shall be informed of Inspection schedule	TCN Policy	Maintenance records	6-monthly	Annually	TCN FMEnv/SEA/ LGA
Abandonment and Decommissioning							
Surface equipment dismantling, excavation, removal and disposal of concrete works and pipes	Increase in dust generation	TCN shall ensure proper use of appropriate PPE	TCN Policy	Compliance	Weekly	Monthly	TCN
		TCN shall ensure that water is sprayed to reduce dust levels	None	Records of Compliance	Daily	Weekly	TCN
	Increase in noise levels	TCN shall inform communities in advance of likely increase in noise level during decommissioning					TCN
		TCN shall ensure proper use of PPEs (ear muffs)	TCN Policy	Compliance	Weekly	Monthly	TCN
	Increase in respiratory tract diseases	TCN shall ensure that all personnel are medically certified for the operation prior to engagement	TCN Policy	Compliance	Monthly	Annually	TCN

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
		TCN shall enforce appropriate use of PPEs (nose mask)	TCN Policy	Compliance	Weekly	Monthly	TCN/ FMEnv/SEA/ LGA
		TCN shall use barriers to minimize the spread of dust	None	Compliance Record	Monthly	Quarterly	TCN/ FMEnv/SEA/ LGA
	Danger of electrocution from charged conductors	TCN shall follow laid down regulations for decommissioning of high tension transmission lines	TCN Policy	Compliance Record			TCN/ FMEnv/SEA/ LGA
	Increase in waste generation	TCN shall ensure that wastes are disposed of in accordance with her waste management plan for this project	TCN Policy	Compliance	Weekly	Monthly	TCN/ FMEnv/SEA/ LGA
	Potential for community agitation (from unequitable employment, pollution and resistance to dismantling of equipment)	TCN shall ensure fair community representation in the employment of local labour	None	Employment Records	Quarterly	Six-monthly	TCN/ FMEnv/SEA/ LGA
		TCN shall abide by the MOUs signed with the communities for this project	Contractual	Compliance with MOU items	Yearly	Once during decommissioning	TCN

SEA-State Environmental Agencies; LGA: Local Government Area

7.3.3 Emergency Contingency Planning Requirements

Despite all care and diligence exercised in project execution, accidents do occur. Accidents could occur from equipment failure or third party sabotage, all to the detriment of the environment. Consequently, Contingency Plans are usually made to handle such situations. Given the fact that accidents do occur due to human error, equipment failure or sabotage, there is a need to put in place sound and cost effective emergency response and contingency plans that can be promptly activated to minimize losses due to such accidents. Such contingency plans shall cover all project facilities and ancillary services. TCN has incorporated into the engineering design of the proposed project, all the necessary safety measures to ensure that the release of products, hazards, incidents, near misses and accidents are minimized, if not completely eliminated.

7.4 MANAGEMENT PLANS AND OPERATIONAL PROCEDURES

TCN has designed the proposed EMP to comply with all applicable local and international statutory requirements and to meet the project objectives with respect to operations and maintenance reliability and health, safety and environment (HSE) performance excellence. TCN shall undertake the project in accordance with the following standards:

Federal Ministry of Environment Regulations and Guidelines

- Nigerian Government Legislation
- Project specification
- TCN specification and standard
- Project Design and Engineering Practice (DEP), safety manuals/ etc;
- Industry Standards and Codes of Practice.
- Contractors Codes and Working Standards

7.5 MANAGEMENT AND REGULATORY RESPONSIBILITIES ON THE EMP

The effective implementation of an Environmental Management Plan (EMP) requires a well-set-up organizational structure, which designates operational responsibilities to the appropriate technical and managerial departments and individuals involved in the life cycle of the operations of the project. The designated responsibilities are often based on technical and managerial capabilities of the designees and also assist in tracing the origins of lapses that may occur during operations. Often times, when appropriate responsibilities are effectively apportioned and implemented by the designees, organizational management systems achieve the desired objectives. Organizational management responsibilities are often improved upon along the process when new areas of need emerge. TCN having recognized the importance of a well-structured organization management system in the attainment of sustainable environmental development of its operations has put in place responsibility commitments designated to its operational and managerial departments and staff. This will help in the achievement of the desired goals.

7.5.1 Project Organization and Responsibilities

TCN has established a policy and schedule for responsibilities and training on matters relating to the environment. There is a line responsibility for which all level of staff is accountable. Line management will take full responsibility for environmental issues.

A focal point, the Management Safety, Health and Environmental Committee, consisting of the General Manager, Assistant General Manager (Health, Safety and Environment (HSE) Division Team), Directors, and Head of Engineering, Company HSE Manager, Company Doctor, HSE Reps –Logistics, has been set up to coordinate HSE performance and is responsible for compliance with safety and environmental standards and regulations. The Committee is charged with the following specific tasks:

- The developing and maintaining of the Environmental Management Plan (EMP) and associated plans for materials management, waste management, accident preparedness and response, inspection and monitoring, staff training;
- The implementation of the Environmental Management Plan related tasks;
- Conducting or organising periodic audits;
- Initiating or organising corrective actions when necessary;
- Preparing and managing documentation related to environmental performance;
- Regular and incidental reporting to the TCN management;
- Liaising and reporting to the appropriate environmental regulatory authorities.

TCN's management thus, affirms total commitment to safety and plans to ensure that all environmental considerations are integrated into related activities. Induction and training courses for staff are part and an effective parcel of environmental management system, which is of paramount importance to TCN.

7.5.2 Operational Controls for the EMP

The operational control for the effective implementation of the EMP is shown in the Table 7.4:

Table 7.4: Operational Controls for the EMP

Project Coordinator	Oversee and coordinate all activities pertaining to the project and responsible for safety during the construction phase.
Operations Manager	Manage all technical operations pertaining to the project and responsible for safety during the operations phase.
HSE Manager	Ensure that TCN operates in accordance with its HSE plans and assists line management in performing their line duties.
Facilities/Site Engineer	Monitor, report and ensure the efficient working conditions of all facilities on site
Community/ Regulatory Liaison Officer	Liaise with the host communities and regulators on TCN 's behalf
Federal Ministry of Environment	Ensure that environmental recommendations in the EIA to mitigate against construction impacts are implemented
Plateau and Kaduna State Environmental Protection Agencies	Ensure that environmental recommendations in the EIA to mitigate against construction impacts are implemented

The management and regulatory responsibilities on a project of this magnitude mandate stakeholders' commitments to environmental and socio-economic issues attached to project sustainability. TCN, as a company, has a mandatory responsibility under the Nigerian law to perform its operations in the best environmentally and socio-economically sustainable way. So, also, the regulatory agencies (FMEnv and Kaduna and Plateau State Environmental Protection Agencies) are empowered by law to take responsibility for the monitoring of the operations of all organizations operating within the boundaries of the country/state to ensure environmental and socio-economic sustainability of the recipient communities.

The host communities also have an important stake in the environmental and socio-economic sustainability of the project by giving the required support to both the operators and the regulators.

7.5.3 EMP Supporting Structure

The Implementation of the Environmental Management Plan shall be executed by the appropriate TCN Staff. Furthermore, the management of TCN shall demonstrate its visible commitment by allocating sufficient resources for the effective implementation of the EMP

7.5.4 Management Review and Improvement Plan

TCN's General Manager, HSE Manager and other senior management shall review and document at appropriate intervals the implementation process of the EMP and its performance to ensure its continual improvement and effectiveness.

7.6 PERFORMANCE MONITORING AND REPORTING

It is necessary to monitor the environment, especially with regards to certain parameters, in order to be able to establish the efficacy or otherwise of recommended mitigation options. It has been established that monitoring should focus on ways and means of protecting and managing recipient environmental habitats.

7.6.1 Reporting Requirements

In the cause of the operation of the project, the Operations Managers shall be responsible for monitoring and reporting the following:

- Power transmission processes;
- Provision of other ancillary services and facilities
- Health/ safety and environmental performance

The project manager shall be responsible for monitoring and reporting for the facilities and associated components.

Reports will be prepared and submitted to the Operations Manager who makes his own reports available to the regulators when required. The reports will be prepared for the following activities:

- discharge to the environment
- use of certain substances
- waste transfers for disposal
- environmental incidents

Environmental topics of concern shall be discussed at the regular safety meetings attended by all the relevant stakeholders.

7.6.2 Discharge Reports

Weekly summaries of laboratory results of discharges (if any) into the recipient environments shall be made by the Operations Manager and made available to the relevant stakeholders when required. Those required in addition to the chemical parameters shall also report volumes of discharge.

7.6.3 Environmental Incident Report

Pollution incidents and near misses malfunction will be documented in environmental incident reports prepared by the Safety Officer, as and when such incidents occur. A copy of each such report will be provided to the regulators when required.

The pollution incident reports will include the following details: date, incident location, type of pollutant, source of pollutant, cause, volume, affected areas, action taken and follow-up activities.

7.6.4 Weekly Health, Safety and Environment Meetings

Weekly HSE meetings will be organized by the Safety Officer, which will cover health, safety and the environment. These will provide a forum for the personnel, operating crew to raise points of environmental concern and for the Safety Officer to discuss recent incidents or areas for improvement. The Safety Officer will keep a record of these meetings, including topics raised, action points, progress on previous action points and a list of attendees.

7.6.5 Community Relations Report

This report will be prepared by the Community Relations Officer on quarterly basis and made available to the relevant authorities when required. This will assist TCN in developing strategies to co-exist in the best sustainable way with their hosts and other relevant stakeholders. The report will rate the organizational performance based on actions taken in the interest of the relevant stakeholders and the response of the stakeholders to the organization's actions. The report will also focus on citizens' values and recommendations on the project for effective implementation of their inputs.

7.6.6 Environmental Auditing/Review

The effectiveness of the EIA process relies on the availability and quality of information and data. In order to ensure that the EIA process remains valid and robust, the monitoring data must be reliable. Audit schemes aim at verifying the effectiveness of environmental control and highlights areas of weakness in environmental management. The audits are focused on areas of project perceived to be environmentally sensitive and having the highest environmental risk. The environmental audit process provides an assessment of the project, environmental management strategies and the effectiveness of the system in fulfilling the Company's environmental policy. Periodic auditing of the facilities and operations shall be embarked on every four years or as required by the regulators. The objectives of the environmental auditing shall include the following;

- identifying current environmental problems
- periodic evaluation of company environmental policies
- examination of environmental management practices and monitoring standards
- comparing environmental status with FMENV and other local, national and international regulatory standards and requirements
- recommending areas of improvements in the company EMP
- the Project will perform its own internal environmental audits annually

7.6.7 Environmental Monitoring Schedule/Reporting

The environmental monitoring activities shall be scheduled for the various environmental components in project area. TCN is committed to ensuring that this schedule is strictly adhered to in order to effectively maintain a friendly operational environment.

7.6.8 Monitoring of the Health, Safety and Environment (HSE) Policy

TCN shall fully implement its HSE policy during the entire duration of this project and all safety protocols for this project shall be adequately communicated to TCN staff and contractors personnel. The HSE Officer for the proposed project shall ensure strict compliance with the

provisions of the HSE policy and recommendations in this EMP. In addition, the HSE Officer shall ensure that contractor's HSE Officer conducts "*Tools Box Talk*" every day prior to the commencement of work and submits minutes of safety meetings and HSE monthly statistics records submitted to TCN management. Other responsibilities of the HSE Officer shall include:

- review of all safety and environmental protection issues identified in the course of engineering design, HAZID, HAZOP and EIA studies with the purpose of fine-turning them for implementation;
- implementation of safety and environmental provisions of the EIA report by the officials of TCN and its contractors;
- implementation of the contingency plan of TCN and all legislative requirements mentioned in the EIA report;
- supervising all environmental matters arising in the course of project implementation as well as developing/implementing environmental audit programme as follow-up studies and
- keeping adequate records and making them available to regulators and interested third parties.

TCN shall equally ensure that contractor's personnel engaged on this project are adequately trained in safety, environmental management and emergency procedures. TCN through her HSE Officer shall monitor contractor's performance in complying with environmental guidelines and standards and mitigation measures mentioned in the EIA report. In particular, personnel must have an understanding of the rationale for the recommended mitigation measures and monitoring. Such environmental monitoring shall cover material storage area, equipment repair yards, construction workers camps and sites. This is essential to ensure compliance with good practices and other special requirements to mitigate adverse impacts and detect any impact, which may occur so that corrective actions can be initiated. Therefore, TCN HSE Officer shall focus on critical environmental issues, which shall include but not limited to:

- waste generation;
- environmentally sensitive locations such as swamps;
- actions that could lead to changes in water quality such as high turbidity etc

TCN shall ensure that adequate warning signs are put in place to minimize or eliminate accidents throughout the duration of the construction period. Similarly, a buffer zone or safety zone should be created to prevent unwarranted encroachment by unauthorized third party. All chemicals, paints, thinners and other hazardous materials must be adequately stored and applied in a safe manner to prevent damage to the environment.

7.6.9 Health Management

7.6.9.1 Personal Medical Fitness

TCN shall ensure that a qualified medical doctor, registered by the Nigerian Medical Association, certifies all personnel employed for any company's work as medically fit for their job. The examining physician for each such personnel shall issue a certificate of medical fitness valid for one year.

7.6.9.2 Health Work Environment

TCN shall ensure that all personnel accommodation locations are regularly fumigated against mosquitoes and other vermin, and shall ensure that its personnel and those of its subcontractors (if any) maintain the highest standard of personal and environmental hygiene.

7.6.10 Waste Management

During project operation, it is inevitable that discharges of materials to the environment will occur. If these are not controlled, they may act as a source of environmental disturbance or nuisance. The level of discharge expected has been quantified in Chapter Four. All the wastes that cannot be re-used will be safely managed and disposed off in a manner that meets regulatory requirements. Below are the waste management guidelines and waste disposal systems that will be implemented in this project.

(i) *Waste Inventory*

The primary wastes include solid wastes, exhaust emission gas, flue gas sulfur dioxide, carbon monoxide, chemicals and containers, construction materials, fuel storage containers, scrap metal and domestic and sewage wastes.

The wastes shall first be segregated, minimized and/or disposed of in the planned landfill in accordance with waste management standards as outlined in this Section of the report.

It is the responsibility of TCN, and its contractors to develop a comprehensive waste management plan for the proposed project. The waste management plan shall be in compliance with international protocols, FMEnv and TCN waste management standards.

The contractors shall keep waste tracking documentation and make it available on demand for inspection and verification of practice by TCN, regulators and interested stakeholders. The contractor's waste management protocol shall have the following minimum provisions:

- Waste reduction strategy,
- Classification and registration of all categories of wastes,
- The procedure for the segregation of wastes,
- The disposal of the following wastes:
  - construction debris;
  - scrap metals;
  - handling of fuel, chemicals and other hazardous materials;
  - biodegradable domestic wastes; etc
- The quantification and the inventory of all wastes

Adequate disposal of waste is vital to the implementation of any waste management system and, as such, all wastes as above shall be stored in designated storage areas, which shall be completely isolated from surface drains, and bounded to contain spillage. The transfer of garbage and special wastes to the Incinerator shall be accompanied by a Waste Consignment Note from TCN shall be logged and reported on a weekly basis by the Operations Manager.

TCN shall also have in place an agreement with a state environmental agency accredited waste disposal third party that has the facilities to collect non-incinerated waste and dispose appropriately in an environmentally friendly manner or at recommended disposal sites.

(ii) *Inspections, Audits and Monitoring*

During the course of power transmission, and eventual decommissioning of the projects, the agents of the regulatory authorities and TCN shall conduct regular inspections to determine the level of compliance with the guidelines of the EMP and applicable regulations and statutes. Specifically, the FMEnv waste discharge requirements (FEPA, 1994), and TCN waste management guidelines will be complied with. Site inspections by TCN and regulatory authorities shall be regular though not necessarily according to any structured pattern. The inspection of facilities, in accordance with the industry practice, will be at least once in six months.

7.7 MANAGING STAKEHOLDER PERCEPTION

Public interest in this project is expected to be high as the issue of electricity supply has always been a sensitive one in the country. 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 (chapter six). Nevertheless, stakeholder perceptions are bound to persist.

In executing the 200km Jos-Kaduna Transmission Line project, TCN shall manage these perceptions by employing and sustaining dialogue as well as involvement of the communities and other stakeholders in all phases of the project. In particular,

- TCN 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.

7.8 EMP AND COMMUNITY DEVELOPMENT

Most Community Development (CD) projects arise out of Participatory Rural Appraisal (PRA) exercises. TCN 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 the Project area. The EMT shall integrate whatever project arises from the PRA for this project area with the community development programmes of external bodies.

7.9 DECOMMISSIONING

The proposed transmission line project with the facilities and their ancillary installations have a life expectancy after which the performance of the project scales to diminishing returns or the project is no more viable and then will be decommissioned in accordance with a plan and TCN standard procedures that meet local regulatory requirements and international standards. As required in the Guidelines for the EIA study, the decommissioning Plan for the proposed project is presented below. The incorporation of remediation plans into the overall project planning is essential because it allows proponents to understand the need for restoring the environment into

its original, or near its original status when abandonment plans are being conceptualized. Operating projects beyond the designed lifespan makes it economically unproductive as returns from such investment become unattractive. Therefore, investors make appropriate plans for either temporary or permanent closures of facilities after the expiration of the project useful life. The useful life of any project is determined by a number of factors, among which are:

- specifications of materials,
- durability of equipment and machinery,
- profitability of the proposed project, and
- importance of the end product

The activities to be carried out during the decommissioning phase shall include the following:

- Dismantling of towers including excavation
- Dismantling of all surface equipment including conductors and grounding wires
- Removal and disposal of concrete works
- Removal and disposal of conductors, etc

The potential impacts that might result from the decommissioning phase of the proposed project include:

- physical disturbance of the environment arising from the removal of the tanks and ancillary equipment,
- potential hazards/accidents associated with decommissioning activities, and
- waste management problems

The strategy to be adopted for site remediation shall depend on the prevailing biophysical and social environmental attributes and the attendant impacts that may result from such an action. The following measures need to be planned for implementation after decommissioning:

• Facilities and ancillary equipment shall be dismantled completely
• All equipment and debris shall be removed from the environment
• Good waste management plan shall be implemented.

For abandonment, strict adherence to facilities abandonment policy of TCN, which includes restoring the project environment to its original status as much as possible, shall be encouraged. The procedure shall be in accordance with approved TCN and international industry standards. It is expected that if these measures are implemented, an environmentally friendly site restoration after decommissioning will be achieved.

7.10 ENVIRONMENTAL ACTION PLAN

This Environmental Action Plan has been developed to meet the following specific short and long term objectives:

- To ensure compliance with legislation and company policy;

- To achieve, enhance and demonstrate sound environmental performance built around the principle of continuous improvement;
- To integrate environmental concerns fully into project operational philosophies;
- To rationalize and streamline existing environmental activities to add value to efficiency and effectiveness;
- To encourage and to achieve high performance and response from individual employees and contractors;
- To provide standards for overall planning, operation, audit and review;
- To enable management to establish environmental priorities;
- To ensure that all stated objectives are applicable throughout the organization.

7.11 FOLLOW-UP ACTION PLAN

The FMEnv is expected to conduct surprise inspection from time to time to confirm compliance with its standards. Such visits would help focus on issues such as:

- Noting of signs of poor housekeeping in the inspection of facility such as oil accumulation around the facility;
- Provision of adequate personal protective equipment
- Checking that the control equipment is functioning properly;
- The means of transport to and from the site and the associated impacts;
- Boundary site reconnaissance to determine the adjacent properties/facilities and their sensitivity;
- Views of stakeholders on the operation at the project;
- The disposal routes of any waste;
- Contacting the local regulatory agencies to determine compliance record and whether complaints have been made by the public;
- Annual compilation of all the monitoring results and highlight of the activities related to project safety and the environment of the quality control unit.

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CHAPTER EIGHT

DECOMMISSIONING PLAN

8.1 INTRODUCTION

The proposed transmission line project with the facilities and their ancillary installations have a life expectancy after which the performance of the project scales to diminishing returns or the project is no more viable and then will be decommissioned in accordance with a plan and TCN standard procedures that meet local regulatory requirements and international standards. As required in the Guidelines for the EIA study, the decommissioning Plan for the proposed project is presented below. The incorporation of remediation plans into the overall project planning is essential because it allows proponents to understand the need for restoring the environment into its original, or near its original status when abandonment plans are being conceptualized. Operating projects beyond the designed lifespan makes it economically unproductive as returns from such investment become unattractive. The transmission line and the ancillary installations have a life expectancy. The facility will be designed, built and maintained to operate efficiently for the life cycle (>25years) after which it will be decommissioned.

8.2 STAKEHOLDERS CONSULTATION FOR DECOMMISSIONING

The project-decommissioning plan will include consultation with various stakeholders including host communities, nearby facility owners, regulatory bodies and experts.

8.3 WIND-DOWN OPERATIONS

As the Project approaches the end of its economic viability, plans will be put in place to wind down operations and maintenance. The decommissioning of the project will be planned for a significant period (usually about five years) before the final decommissioning. This will allow for a carefully planned redeployment and, where necessary, disengagement of personnel as appropriate.

8.4 DECOMMISSIONING OF FACILITIES

At the end of the facilities utility, all equipment will be decommissioned. In general, the activities to be carried out during the decommissioning phase shall include the following:

- Dismantling of towers including excavation
- Dismantling of all surface equipment including conductors and grounding wires
- Removal and disposal of concrete works
- Removal and disposal of conductors, etc

8.5 ENVIRONMENTAL AND SOCIAL IMPACTS OF DECOMMISSIONING ACTIVITIES

The potential impacts that might result from the decommissioning phase of the proposed project include:

- physical disturbance of the environment arising from the removal of the tpwers and ancillary equipment,
- potential hazards/accidents associated with decommissioning activities, and
- waste management problems

8.6 MITIGATION MEASURES FOR DECOMMISSIONING

The strategy to be adopted for site remediation shall depend on the prevailing biophysical and social environmental attributes and the attendant impacts that may result from such an action as discussed in Chapter 6. The following measures need to be planned for implementation after decommissioning:

- Facilities and ancillary equipment shall be dismantled completely
- All equipment and debris shall be removed from the environment
- Good waste management plan shall be implemented.

For abandonment, strict adherence to facilities abandonment policy of TCN, which includes restoring the project environment to its original status as much as possible, shall be encouraged. The procedure shall be in accordance with approved Environmental and Social Management Plan (ESMP) and international industry standards. It is expected that if these measures are implemented, an environmentally friendly site restoration after decommissioning will be achieved.

Decommissioning of the transmission line and the ancillary installations will result in potential for work-related injuries and fatality from the dismantling process but increase land available for agriculture and other land use from the restoration of land to its original situation as much as possible and hand over of the reclaimed land to the original community and landowners

8.7 RE-USE / RECYCLING OF EQUIPMENT

All facility components that can be used or recycled will be identified and quantified. Vehicles for the operation and other facilities will be scrapped and / or moved to other locations. Cleared locations will be re- vegetated using fast growing native plant species.

8.8 REPORTING

As required by regulations, a post-decommissioning report will be prepared and submitted to the Nigerian Regulators. The report will provide the following details:

- Overview of decommissioning 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

CHAPTER NINE

CONCLUSIONS

The Transmission Company of Nigeria (TCN) plans to construct the 200km Jos-Kaduna 330 kV DC Transmission Line to evacuate the electricity from Jos Substation. The EIA of the Transmission Line Project has been conducted in accordance with the regulatory requirements established by the Federal Republic of Nigeria and other statutory and international standards and has identified and evaluated the potential impacts of the project on the existing environment (biophysical, social and health). Mitigation measures have been recommended for unavoidable impacts considered significant, to reduce the rating of their identified adverse effects to levels as low as reasonably practicable (ALARP). Recommendations have also been made to enhance the benefits of the identified positive impacts. A project-specific Environmental Management Plan (EMP) for assessing the effectiveness of the mitigation measures in controlling identified significant impacts has been recommended.

The EIA has shown that with the implementation of the recommended mitigation measures embodied in the Environmental Management Plan, the 200km Jos - Kaduna 330kv DC Transmission Line and Associated Substation Facilities Project could be executed and decommissioned with minimal adverse impacts on the environment. The Project will result in substantial economic benefits to the local economy and Federal Government of Nigeria through increased electric power transmission and distribution. The local communities shall also benefit immensely from the project through employment opportunities and increased financial flows from supply of materials and contracts as well as community development projects that TCN will be committed to put in place.

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APPENDICES

APPENDIX 1

(SIA/HIA QUESTIONNAIRE)

ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED 200KM JOS – KADUNA 330KV D/C TRANSMISSION LINE AND ASSOCIATED SUBSTATIONS FACILITIES PROJECT
SOCIO-ECONOMIC/HEALTH SURVEY
QUESTIONNAIRE: COMMUNITY PROFILE

IDENTIFICATION
TOWN/VILLAGE/SETTLEMENT……

LOCATION…… GPS READING……

LGA……..
BRIEF HISTORY OF ORIGIN OF COMMUNITY (Describe in a separate sheet)

Field worker……

SR/N	Description	Codes	Remarks
1.	Ethnic Group	a. Major ethnic group b. Minority ethnic group	
2.	Number of Houses: (Use census approach)	a. Huts…….. b. Bungalows…… c. Storey Buildings……	
3.	Housing characteristics:	a. Main floor material…… b. Main wall materials…… c. Main roof material…….	
4.	Political structure:	Organogram (indicating leadership and hierarchy in community level decisions)	Use separate sheet
5.	Groups and Leaders:	a. Community Head (Title and Name) b. Chiefs-in-Council	

		c. Men's Group	
		d. Women's Group e. Youth Group	
6.	Demography:	a. Total population b. Number of houses c. Average household size d. Adults……Youths Males……. Females Infants (0 - 5)…...Children…… e. IMR f. CDR g. Under Five mortality h. MMR i. TFR	
7.	Education:	a. Government nursery school b. Private nursery school c. Government primary school d. Private school e. Government secondary school f. Private secondary school g. Tertiary institutions h. Net enrolment rate i. Gender disparity	
8.	Roads:	a. Tarred roads entering community…… b. Untarred roads entering community……	
9.	Sources of water for household use:	a. River b. Rain	
		c. Well d. Borehole e. Pipe bone (Tap)	
10.	Available social facilities:	a. Petrol station within 5km radius b. GSM c. Electricity d. Public toilets e. Police stations f. Fire stations g. Markets h. Banks i. Pharmacy j. Chemist/patent medicine store k. Recreational facilities	

		l. Archaeological sites	
11.	Industrial developments in the area within 10km radius	Name Location(GPS) Distance(km) 1. 2. 3. 4.	
12.	Health Facilities:	Government Facility: a. Hospital b. Comprehensive health centres c. Maternity/PHC d. Dispensaries Private health facility: a. Hospital/clinics b. TBAs c. Traditional/spiritual homes d. Faith based e. NGOs	
13.	Morbidity	Communicable a. b. c. d. Non communicable a. b. c. d.	
14.	Economic Activity	Men a. b. c. Women a. b. c. Youth a. b. c.	
15.	Waste/Refuse Disposal	a. Bush b. Open space within homestead c. Rivers/streams d. Incinerators e. others	
16.	Existing government sponsored	a.	

	development projects	b. c. d. e.	
17.	Existing non government sponsored development projects	a. b. c. d. e.	
18.	Major transport in the community	a. Roads b. Water c. Rail	
19.	Special features:	a. Sacred areas b. Shrines c. Forest reserves d. Common taboos	
20.	What effect will proposed electrification line have on the following	a. Personal/community b. Children's health c. Trade/business d. Social life	
21.	How can the effects be mitigated		
22.	Properties owned by members of the community	1. Farmland 2. Poultry 3. Plantation 4. Houses 5. Others	
23.	Pattern of land ownership	1. Inheritance 2. Tenant/Lease 3. Family 4. Outright purchase 5. Communal	
24.	Farming Methods	1. Garden 2. Fallow 3. Shifting cultivation 4. Rotational bush fallow 5. Others	

APPENDIX 2

(ENVIRONMENTAL STANDARDS)

ENVIRONMENTAL STANDARDS

Inorganic constituents for drinking water quality (Source: WHO, 1993)

Characteristic	Health-based guideline
Antimony (mg/l)	0.005
Arsenic mg/l	0.01
Barium mg/l	0.7
Boron mg/l	0.3
Cadmium mg/l	0.003
Chromium mg/l	0.05
Copper mg/l	2
Cyanide mg/l	0.07
Fluoride mg/l	1.5
Lead mg/l	0.01
Manganese mg/l	0.5
Mercury mg/l	0.001
Molybdenum mg/l	0.07
Nickel mg/l	0.02
Nitrate mg/l	50
Nitrite mg/l	3
Selenium mg/l	0.01
Uranium μg/l	140
Consumer acceptability level	
Aluminium mg/l	0.2
Chloride mg/l	250
Hardness as $CaCO_3$ mg/l	500
Hydrogen sulphide mg/l	0.05
Iron mg/l	0.3
Manganese mg/l	0.1
PH	6.5-9.5
Sodium mg/l	200
Sulphate mg/l	250
Total dissolved solids mg/l	1200
Zinc mg/l	4

EMISSION STANDARDS, ENVIRONMENTAL REGULATIONS 1987 (ENVIRONMENTAL QUALITY ACT 1974).

Item	Category of Vehicle	Maximum Sound Level Permitted (dBA)
3	Used for the carriage of goods. Permitted maximum weight does not exceed 3.5 tons. Engine is less than 200 hp DIN	81
6	Used for the carriage of goods. Permitted maximum weight exceeds 3.5 tons. Engine is less than 200 hp DIN	86
7	Used for the carriage of goods. Permitted maximum weight foes not exceed 3.5 tons. Engine is 200 hp DIN or more.	88

Source: Environmental Quality Act 1974 and Regulations

NIGERIA AMBIENT AIR QUALITY STANDARD (FEPA, 1991)

Pollutants	Time of Average	Limit
Particuclates Sulphur Oxides Sulphur Dioxide Non-Methane Hydrocarbon Carbon Monoxide Nitrogen Oxides (Nitrogen Dioxide) Photochemical Oxidants	Daily Average of hourly values (1 hour) Daily Average of hourly values (1 hour) Daily Average of hourly values (1 hour) Daily Average of hourly values (3 hourly averages) Daily Average of hourly values (8 hourly average) Daily Average of hourly values (range) Hourly Values	250ug/m^3 600ug/m^3 0.01ppm 160ug/m^3 10ppm (20ppm) 0.04-0.06ppm 0.06

NOISE EXPOSURE LIMITS FOR NIGERIA (FEPA, 1991)

Duration/Day-Hours	**Permissible Exposure Limit dB(A)**
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼	115
Impulsive or Impact Noise	< 140 dB, Peak

EFFLUENT LIMITATION/GUIDELINES IN NIGERIA FOR ALL CATEGORIES OF INDUSTRIES (FEPA, 1991)

Parameters	Units in Milligram per litre (mg/l) Unless Otherwise Stated	
	Limit for Discharge into Surface Water	**Limit for Land Application**
Temperature	Less than 40°C within 15 minutes of out fall	Less than 40°C
Colour (Lovibond Units)	7	-
pH	6 – 9	6 – 9
BOD_5 at 20°C	50	500
Total Suspended Solids	30	-
Total Dissolve Solids	2,000	2,000
Chloride (as CI)	600	600
Sulphate (as SO_4^{2-})	500	1,000
Sulphide (as S^{2-})	0.2	-
Cyanide (as CN^-)	0.1	-
Detergents (linear alkylated suphonate as methylene blue active substance)	15	15
Oil and Grease	10	30
Nitrate (as NO_3)	20	-
Phosphate (as PO_4^{3-})	5	10
Arsenic (as As)	0.1	-
Barium (as Ba)	5	5
Manganese (as Mn)	5	-
Phenolic Compounds (as phenol)	0.2	-
Chlorine (free)	1.0	-
Cadmium, Cd	Less than 1	-
Chromium (trivalent and hexavalent)	Less than 1	-
Copper	Less than 1	-
Lead	Less than 1	-
Tin (as Sn)	10	10
Iron (as Fe)	20	-
Mercury	0.05	-
Nickel	Less than 1	-
Selenium	Less than 1	-
Silver	0.1	-
Zinc	Less than 1	-
Total Metals	3	-
Calcium (as Ca^{2+})	200	-
Magnesium (as Mg^{2+})	200	-
Boron (as B)	5	5

Alkyl Mercury Compounds	Not detectable	Not detectable
Polychlorinated Biphenyls (PCBs)	0.003	0.003
Pesticides (Total)	Less than 0.01	Less than 0.01
Alpha Emitter, uc/ml	10^{-7}	-
Beta Emitters, uc/ml	10^{-6}	-
Coliforms (daily average)	400MP/100ml	500MP/100ml
Suspended Fibre	-	-

INTERNATIONAL FINANCE CORPORATION (IFC) /WORLD BANK POLICIES AND GUIDELINES

Ambient Air

Concentrations of contaminants, measured outside the project boundary, should not exceed the following limits:

Particulate Matter (<10μm)	
Annual Arithmetic Mean	100 $\mu g/m^3$
Maximum 24 hour Average	500 $\mu g/m^3$
Nitrogen Oxides, as NO_2	
Annual Arithmetic Mean	100 $\mu g/m^3$
Maximum 24 hour Average	200 $\mu g/m^3$
Sulfur Dioxide	
Annual Arithmetic Mean	100 $\mu g/m^3$
Maximum 24 hour Average	500 $\mu g/m^3$

Workplace Air Quality

threshold limit values (TLVs):

Arsenic	0.5 mg/m^3
Carbon Monoxide	29 mg/m^3
Copper	1 mg/m^3
Free Silica	5.0 mg/m^3
Hydrogen Cyanide	11 mg/m^3
Hydrogen Sulfide	14 mg/m^3
Lead, Dusts & Fumes, as Pb	0.15 mg/m^3
Nitrogen Dioxide	6 mg/m^3
Particulate (Inert or Nuisance Dusts)	10 mg/m^3
Sulfur Dioxide	5 mg/m^3

Workplace Noise

Ambient Noise levels should not exceed 85dBA

Liquid Effluents

pH	6 to 9
BOD_5	50 mg/l
Oil and Grease	20 mg/l
Total Suspended Solids	50 mg/l
Temperature – at the edge of	Max 5°C above ambient temperature

A designated mixing zone receiving waters – max 3°C if receiving waters>28°C

Residual Heavy Metals

Arsenic	1.0 mg/l
Cadmium	0.1 mg/l
Chromium, Hexavalent	0.05 mg/l
Chromium, Total	1.0 mg/l
Copper	0.3 mg/l
Iron, Total	2.0 mg/l
Lead	0.6 mg/l
Mercury	0.002 mg/l
Nickel	0.5 mg/l
Zinc	1.0 mg/l

Cyanide

In no case should the concentration in the receiving water outside of a designated mixing zone exceed 0.022mg/l

Free Cyanide	0.1 mg/l
Total Cyanide	1.0 mg/l
Week Acid Dissociable	0.5 mg/l

Measures to prevent access by wildlife and livestock are required for all open waters (examples tailings impoundments and pregnant leach ponds) where WAD cyanide is in excess of 50 mg/l.

Ambient Noise

	Maximum Allowable L_{eq} (hourly), in dB(A)	
Receptor	Day time 07:00 – 22:00	Night time 22:00 – 07:00
Residential; Institutional; Educational	55	45
Industrial; Commercial	70	70

APPENDIX 3

(FMENV LABORATORY CERTIFICATE)

Accreditation No: [illegible] 3279

FEDERAL MINISTRY OF ENVIRONMENT

ACCREDITATION TO OPERATE AS ENVIRONMENTAL CONSULTANT

The Permanent Secretary of the Federal Ministry of Environment (FMENV), hereby accredits the bearer whose particulars appear below to operate as Environmental Consultant pursuant to an Application for Registration/Renewal dated 3RD day of MAY 2018

1. Full Name of Consultant: CENTRAL SCIENCE LABORATORY OBAFEMI AWOLOWO UNIVERSITY
2. Location of Business Premises/Laboratory: OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, OSUN STATE
3. Year of Incorporation of Business: 1961
4. Area(s) of Competence: ENVIRONMENTAL LABORATORY SERVICES

This Accreditation is granted subject to compliance with all regulations, Guidelines, Standards and Control criteria as may be issued by the Federal Ministry of Environment from time to time.

Date of Issue: 14TH NOVEMBER, 2018 Expiry Date: 13TH NOVEMBER, 2023

Seal of the Federal Ministry of Environment

FMENV shall not be liable to any claim(s) under this permit

Permanent Secretary