PAN AFRICA SOLAR LIMITED (PASL)

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF PROPOSED 80 MEGA WATT (MW) PHOTOVOLTAIC POWER PLANT PROJECT AND ASSOCIATED TRANSMISSION IN KANKIA, KATSINA STATE, NIGERIA

(DRAFT REPORT)

SUBMITTED TO

FEDERAL MINISTRY OF ENVIRONMENT, ABUJA, NIGERIA

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OF

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PREPARED BY (ON BEHALF OF PASL)

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LIST OF ACRONYMS AND ABBREVIATIONS

µg	Micro gram
µg/g	Micro gram per gram
µg/m^3	Micro gram per meter cube
µS/cm	Micro Siemens per centimeter
^{0}C	Degree Celsius
AAS	Atomic Absorption Spectrophotometer
AC	Alternating Current
ACGIH	American Conference of Governmental Industrial Hygienists
AIPs	Affected and Interested Parties
ALARP	As Low As Reasonably Practicable
AoI	Area of Influence
APHA	American Public Health Association
a-Si	Amorphous silicon
ASTM	American Society for Testing and Materials
BOD	Biological Oxygen Demand
Bscf	Billion standard cubic feet
CdTe	Cadmium telluride
CIGS	Copper indium gallium selenide
cm	Centimeter
CO	Carbon monoxide
CO_2	Carbon dioxide
COC	Code of Conduct
COD	Chemical Oxygen Demand
CSR	Corporate Social Responsibility
CSP	Concentrated Solar Power
CTMP	Construction Traffic Management Plan
Cu	Copper
dB	Decibel
DC	Direct Current
DCD	Development Control Department
DFIs	Development Finance Institutions
DO	Dissolved Oxygen
EA	Environmental Assessment
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EnvAccord	Environmental Accord Nigeria Limited
EPC	Engineering, Procurement and Construction
EPSRA	Electric Power Sector Reform Act
ESA	Environmentally Sensitive Areas

ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
Fe	Iron
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FGN	Federal Government of Nigeria
FMEnv	Federal Ministry of Environment
g	Gram
g/m^2	Gram per meter square
g/m^3	Gram Per Meter Cube
GGJSS	Government Girls Junior Secondary School
GHG	Greenhouse Gases
GPS	Global Positioning System
GRA	Government Reservation Area
Ha	Hectares
H_2S	Hydrogen Sulphide
HC	Hydrocarbon
HIV	Human Immunodeficiency Virus (HIV)
HSE	Health, Safety and Environment
HR	Human Resources
HUB	Hydrocarbon Utilizing Bacteria
HV	High Voltage
ICEED	International Centre for Energy, Environment and Development
IFC	International Finance Corporation
IHR	International Health Regulations
ILO	International Labour Organization
ISO	International Organization for Standardization
ITCZ	Inter-Tropical Convergence Zone
ITDZ	Inter-Tropical Discontinuity Zone
IUCN	International Union of Conservation of Nature
kg	Kilogram
kg/cm^2	Kilogram per centimeter square
km^2	Kilometer square
KVA	Kilovolt Ampere
KW	Kilo watt
KATSEPA	Katsina State Environmental Protection Agency
LEMP	Labour and Employment Management Plan
LFN	Law of the Federal Republic of Nigeria
LGA	Local Government Area
m	Meter
mb/d	Million barrels per day

Max.	Maximum
mg	Milligram
mg/l	Milligram per litre
MW	Mega watt
MWp	Megawatt peak
Min	Minimum
ml	Millilitre
mm	Millimetre
mc-Si	Multi-crystalline
mS/cm	Milli Siemens per Centimeter
MSDS	Material Safety Data Sheet
MV	Medium voltage
MW	Mega watt
MWp	Mega Watt nominal power
NAAQS	Nigerian Ambient Air Quality Standard
NBET	Nigerian Bulk Electricity Trading
NEC	National Energy Council
NEP	National Policy on the Environment
NEPP	National Electric Power Policy
NERC	Nigerian Electricity Regulatory Commission
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGEP	Nigerian German Energy Partnership
NGO	Non-Governmental Organizations
NH_3	Ammonia
Ni	Nickel
NIMET	Nigerian Meteorological Agency
NPC	Nigerian Population Commission
NO_x	Oxides of Nitrogen
NO_2	Nitrogen dioxide
ODS	Ozone Depleting Substance
OPC	Organic Photovoltaic Cells
OSH	Occupational Safety and Health
Pb	Lead
pH	Potential of Hydrogen (Hydrogen ion Concentration)
PM	Particulate Matter
Poly-Si	Poly-silicon
PPE	Personal Protective Equipment
ppm	Parts per million
ppt	Parts per trillion
$P0_4$	Phosphate
PS	Performance Standard
PV	Photovoltaic

Q	Quarter
REM	Renewable Energy Masterplan
ROW	Right of Way
SCADA	Supervisory Control and Data Acquisition
SHE	Safety, Health and Environment
SPM	Suspended Particulate Matter
SO_X	Oxides of Sulphur
SO_2	Sulphur dioxide
SOP	Standard Operating Procedures
STDs	Sexually Transmitted Diseases
TCN	Transmission Company of Nigeria
TDS	Total Dissolved Solids
THB	Total Heterotrophic Bacteria
THF	Total Heterotrophic Fungi
ToR	Terms of Reference
tfsc	Trillion standard cubic feet
TFSC	Thin-film solar cell
TSP	Total Suspended Particulate
UN	United Nation
UNEP	United Nations Environment Programme
USEPA	United State Environmental Protection Agency
UV	Ultra-Violet
WHO	World Health Organization
WMP	Waste Management Plan
Zn	Zinc

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The EIA team consists of the following:

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EXECUTIVE SUMMARY

Introduction

Pan Africa Solar Limited (PASL) proposes to construct, install and operate a Photovoltaic (PV) solar power plant and associated transmission infrastructure in Kankia, Kankia Local Government Area (LGA) of Katsina State, Nigeria. The proposed total capacity of the power plant is 80 Megawatt peak (MWp).

The site that has been identified for the establishment of the power plant is 120 hectares (ha) of land, located approximately 2.5 km away from Kankia town. The site was owned by the Katsina State Government until rights were granted to PASL in return for equity stake in the Project ownership. It was acquired in two tranches of 50 and 70 ha. Currently, the site is not enclosed or fenced.

In line with the requirements of the Environmental Impact Assessment (EIA) Act No 86 of 1992, the EIA Act CAP E12 Law of Federal Republic of Nigeria (LFN), 2004 and the requirements of the Development Finance Institutions (DFIs) such as the International Finance Corporation (IFC), a member of the World Bank Group, an EIA[1] study has been undertaken for the proposed Project.

The EIA is an upgrade of the previous assessment conducted by PASL in 2013 for a proposed 20 MWp PV Solar Power Plant within the same project area. An EIA approval for the 20 MWp Power Plant was issued by the Federal Ministry of Environment (FMEnv) on June 16, 2014.

This study covers the entire life cycle of the Project (i.e. design, construction, operation, decommissioning, and closure) and it involves scoping and key issues identification, baseline environmental and socio-economic data gathering, identification and evaluation of impacts (including cumulative impacts, project risks and hazards), mitigation/management plan and stakeholder consultations.

Legal and Administrative Framework

The EIA has been carried out in line with the applicable legal and administrative framework. Some of these include EIA Act No 86 of 1992; EIA Sectoral Guidelines for Power Sector, 2014; Electric Power Sector Reform Act, 2005; IFC/World Bank Group Environmental, Health and Safety (EHS) Guidelines; IFC Performance Standards on Environmental and Social Sustainability, 2012, and the World Bank Operational Policy (OP) 4.03 on the use of Performance Standards for Private Sector Activities.

[1] EIA is a nomenclature adopted in Nigeria in line with the requirements of the Federal Ministry of Environment. The term is, however, synonymous with Environmental and Social Impact Assessment (ESIA). This study covers both biophysical and socio-economic environment of the project site.

Overview of Project Proponent

PASL is a limited company incorporated in Nigeria in July 2012. The Company is a partnership between JCM Capital Limited and some individuals in Nigeria. JCM Capital is a Canadian-based private equity firm that focuses on the development of utility-scale clean power projects.

JCM has invested in and developed over 120 projects in Canada, South America and Africa. It works with a diverse set of stakeholders in the solar PV industry that makes the company an ideal partner for delivering utility-scale PV solar power.

Need for the Project

The proposed Project is justified primarily on the basis of the need by the Nigerian Government to improve efficiency, reliability and sustainability of the electricity industry as well as generate electricity from a renewable energy source in an environmentally sustainable manner. Countries worldwide are being strongly encouraged to increase their share of renewable energy generation due to concerns related to climate change and the unsustainable exploitation of natural resources such as gas, oil, and coal. Grid connected renewable energy is currently the fastest growing sector in the global energy market.

Renewable energy is recognized internationally as a major contributor in protecting the climate as well as providing a wide range of environmental, economic, and social benefits that will contribute towards long-term global sustainability.

Project Benefits

The potential benefits of the proposed Project include, amongst others:

- Use of renewable energy technology with no or minimal Greenhouse Gases (GHGs) emission.
- Increased electricity generation to the national grid.
- Direct and indirect employment opportunities (local and regional).
- Acquisition of new skills through technology transfer.
- Increased local and regional economy through award of contracts for Project development.
- Revenue generation to Nigerian Government at Federal, State and Local levels through, for example, taxes.

Envisaged Sustainability of the Project

Technical Sustainability: The design, construction and operation of the proposed Project will be handled by properly trained and experienced personnel according to the pre-established standards and procedures.

Environmental Sustainability: All Project facilities shall be designed and constructed to keep environmental impacts at the minimum and acceptable levels;

all operations shall be carried out to conform to all relevant international and local environmental regulations and standards. Handling, storage and disposal of wastes shall be in accordance with the applicable local and international regulatory requirements.

Economic Sustainability: The design, construction and installation of the Project shall be funded by PASL with financial support from potential lenders. There are market opportunities for electricity that will be generated. The Project will provide employment opportunities and support the local communities. Revenue that would accrue from sales of power (electricity) generated from the Project would serve for the payment of staff and the procurement of maintenance materials and services.

Social Sustainability: A detailed Stakeholder consultation process has been carried out throughout the EIA process to assist in ensuring that all the identified stakeholders have had the opportunity to provide input into the Project planning process. This has also assisted in laying a good foundation for building long term relationships with the stakeholders.

PASL shall ensure that the stakeholder consultation process is sustained throughout the life of the Project. This will also include periodic reporting to the stakeholders including the potentially affected communities on the environmental and social performance of the Project.

Project Alternatives

The alternatives considered for the proposed Project include site alternatives, technology alternatives, alternative energy sources, no project option, delayed project option and go-ahead option.

Description of Proposed Project

The proposed Project entails the installation and operation of 80 MWp Photovoltaic power plant and associated transmission in Kankia, Kankia LGA of Katsina State, Nigeria. The Project will be a ground mounted solar PV module using polycrystalline silicon, or thin film PV technology on a fixed tilt mounting structure.

The Project is planned to be built in 2 phases. Phase 1 will have a capacity of approximately 34 MWp and Phase 2 is approximately 46 MWp. Construction of Phase 1 is planned to commence in Quarter 1 (Q1) 2016 and be in full operations in Q3 2016. Phase 2 is anticipated to be operational a year later (2017).

Electricity generated from the Project will be evacuated via a proposed high voltage power (transmission) line to the nearby existing Kankia substation (situated approximately 4 km from the Project site) for transmission and distribution via the national network.

The key components associated with the PV power plant are as follows:

- PV modules
- Mounting structures
- Cabling
- DC-AC current inverters
- Transformers
- Medium Voltage (MV) & High Voltage (HV) Switchgear
- Electrical connection cabin
- Supervisory Control and Data Acquisition (SCADA) System
- Associated infrastructure and utilities, including:
  - Site security, including fencing
  - Buildings, including onsite substation, connection building, control building, guard cabin, and spare parts storage.
  - Access road and internal road network
  - Stormwater infrastructure and drainage system
  - Water supply infrastructure
  - PV power facility monitoring equipment
  - Telecommunication links
  - Meteorological station to record irradiation and site conditions

In addition, the Project will include construction of a dedicated project transmission line connecting the power plant to the Kankia substation. The line will extend approximately 1.1 km from the Project site to the existing Kano-Katsina 132 kV power line corridor and will follow this route for approximately 4 km to the Kankia substation.

The general development phases for the Project are categorised as follows:

- Pre-construction: mobilisation of equipment, materials and personnel to project site; establishment of laydown areas and construction camp; and site clearing and preparation.
- Construction and Installation: including civil works, electrical works, and installation of PV modules and associated infrastructure.
- Operation: Plant operation and routine maintenance.
- Decommissioning: Dismantling of equipment and associated facilities and site restoration.

It is anticipated that each construction phase of the Project will take approximately 8 months. Once the power plant is complete and operational, it is expected that it will have a lifespan of approximately 25 years. Measuring the performance of the PV power plant will be done remotely through the use of telemetric monitoring. The proposed PV power facility would be decommissioned at the end of its projected 25 year operational life time. Alternatively, with regular maintenance, the facility could be upgraded, with the useful lifespan of the project extending beyond the design lifespan (25 years). At the end of Project life, all panels and major electrical components will be recycled. The disturbed land areas will be rehabilitated and replanted with indigenous vegetation.

It is envisaged that during each construction phase of the Project, about 200 people will be employed for a period of approximately 8 months. A total of about 20 job opportunities will arise during operation phase, including skilled and semi-skilled labour for a period of approximately 25 years. PASL will ensure that the workforce is engaged and managed in accordance with the requirements of the Nigerian Labour Act (1990), as well as the requirements of IFC Performance Standard 2 – Labour and Working Conditions. A Worker Health and Safety Plan will be developed for all phases of the Project and will be regularly updated and made appropriate to the project activities undertaken during each phase. A specific Waste Management Plan will also be developed as part of the implementation of the proposed Project.

Environmental Description of the Project Area

The description of existing biophysical and socio-economic environment of the Project's area of influence covers the following: climate and meteorology; air quality and noise; geology and soil; hydrology and hydrogeology; groundwater quality; soil; terrestrial flora; terrestrial fauna; landuse; and socio-economic and health. Data and information for the description of the existing environmental conditions of the study area were obtained from desktop studies and field data gathering undertaken from October 17 to 21, 2014 (wet season survey) as well as subsequent laboratory analyses of field samples. Additional site visit was conducted from March 17 to 20, 2015. The existing environmental and social condition of the Project's area of influence is summarized as follows:

Climate and Meteorology: The climate of Katsina State is the tropical wet and dry type (tropical continental climate). The wet season period is usually between April and October, while the dry season is experienced between November and March. The average annual rainfall in the area is about 600 mm. The mean monthly temperature in Katsina State is generally high, with the highest value of about 39.2^{0}C. The lowest mean monthly wind speed in the Project area is about 4.92 m/s recorded in the month of October while the highest annual mean value of 8.78 m/s was recorded in the month of June. The maximum wind speed recorded in the Project area between 1989 and 2013 was 15.7 m/s.

Geology and Geomorphology: Kankia is underlain by Pre-cambrian complex. The initial geotechnical survey of the Project site revealed that the near-surface ground of the area was formed of compacted fine-grained sediments, such as clays and silts and a conglomerate with lateritic matrix.

Hydrology and Hydrogeology: The Project area is generally lacking in natural surface water bodies or seasonal river beds. The surface run-off is largely expected to readily penetrate the surface soil locally or drain along the surface terrain through the central depression in the Project site.

Vegetation (Terrestrial Flora): The study area lies within the Sudan Savannah vegetation belt of Nigeria. The existing vegetation at the Project site and the surrounding environment is mostly characterised by shrubs, grasses and herbs which are typical of the Sudan Savannah ecosystem. Herbaceous species dominate the Project site; no farmlands are present on the project site. Based on the IUCN (International Union of Conservation of Nature) Red List of Threatened Species (IUCN, November 2014.3) classification, no critically endangered or endangered species were recorded in the Project area.

Wildlife (Terrestrial Fauna): Fauna species recorded in the Project's area of influence include: insects, arachnids and myriapods. The amphibian encountered in the wider study area of the Project site includes frog *Rana species, Xenopus species* and toads *Bufo regularis.* The reptilian fauna includes lizard *Agama agama, Snakes Natrix anoscopis* and mammals such as cattle, *Bos bos.* No spawning sites were encountered on the Project site. None of the fauna species recorded in the Project site and the surrounding environment belongs to the IUCN threatened category.

Air Quality and Noise: The concentrations of air quality parameters recorded in the Project site were generally below the national ambient air quality standards, and the World Health Organization (WHO) Air Quality Guidelines. The ambient noise level recorded in the study area ranged from 51.50 dBA to 70.90 dBA with an average value of 58.38 dBA.

Soil Quality: The dominant soil type within the project site is sandy clay based on the grain size analysis. The top and sub soil samples collected at twelve (12) sampling stations in the study area generally recorded low nutrient values. Heavy metals and hydrocarbon concentrations in the soil samples were either recorded in trace amount or below the detection limit of 0.001 mg/kg indicating the absence of heavy metal or hydrocarbon pollution.

Groundwater Quality: Groundwater samples were collected from four (4) existing boreholes and hand dug well in the study area. The results of physico-chemical and microbial properties of the water samples were compared with the FMEnv limits for drinking water and the WHO standards limits for potable water. The concentrations of parameters analyzed in the groundwater samples were generally within the FMEnv and WHO prescribed limits. Heavy metals in the groundwater samples were recorded in trace concentrations.

Land Use: The land use cover of the Project site is majorly of two classes namely: bare soil and vegetation. The bare soil covers approximately 60 per cent of the total site and includes the drying bed (flood plain), footpaths and unpaved road. The soil varies from fine sandy to clay and lateritic.

The current land type along the proposed transmission corridor route (30 m width) consists of bare soil, grasses, shrubs, and a few farmlands (close to the Kankia substation, which is approximately 4 km from the Project site).

Heritage Sites: There were no culturally significant sites or heritage assets within the Project site and the immediate surrounding environment based on the information gathered from the local communities and Katsina State Ministry of Culture and Tourism, chance find survey, and desktop review of existing reports related to the project area.

Socio-economic and Health: The potentially affected communities within the proposed project's area of influence in Kankia Local Government and their locations away from the Project site are as follows:

- Kafin Dangi (3.74 km north east),
- Kauyan Maina (2.98 km east),
- Galadima (1 km south west),
- Gachi (2.32 km south east), and
- Kankia (2.46 km south).

The main language spoken in the study area is Hausa, which is largely the general language of the northern Nigeria. Although, the Fulani people in the LGA speak both Fulani and Hausa languages. The population of the communities is predominantly made up of Hausas (95 per cent) and the dominant religion in the area is Islam. With the exception of Kankia and Galadima communities, the settlement pattern in the study area is largely rural in nature. The estimated population of each of the communities based on the information gathered during community engagement is as follows: Kauyan Maina (5,000), Kafin Dangi (10,000), Gachi (12,000), Galadima (25,000) and Kankia (28,000).

The communities have similar traditional systems of administration. Monarchies are a common form of government in Hausa land. The traditional head is usually referred to as the 'Magajin', and is supported by a number of village/ward heads. The communities in the study area are majorly into farming including arable and livestock farming. The crops usually planted include maize, millet, guinea corn, cowpea and groundnut, most of which are in subsistence and commercial scales.

Katsina State Environmental Protection Agency (KATSEPA) is the authority in charge of waste management in the study area. The Agency is responsible for the collection, transportation and disposal of household wastes. On the whole, the rate of generation from households far exceeds the rate of collection of waste by KATSEPA. The results are that there is the presence of heaps of undisposed refuse. In order to reduce the volume of wastes, the local residents usually engage in open burning of the wastes. Some of the wastes are sometimes collected and taken to the farm and used as organic manure.

The major healthcare facility in the project area is the General Hospital in Kankia town. However, there is a Primary Health Care Centre in each of the remaining communities.

Impact Evaluation and Mitigation Measures

Potential environmental and social impacts (including health and safety) associated with the proposed Project were assessed. Impact significance was also determined. In determining the significance of impacts, the factors considered included: magnitude of impacts (which is a function of the combination of the following impact characteristics: extent, duration, scale and frequency); value/sensitivity/fragility and importance of relevant environmental and social receptors; legal/regulatory requirements; and public perceptions (based on stakeholders' consultation).

Recommended mitigation measures required to complement those incorporated in the Project design for the significant negative impacts were proffered while enhancement measures for the identified positive impacts were similarly presented. PASL will have principal responsibility for all the recommended mitigation and enhancement measures, but may delegate responsibility to its contractors where required and monitor the implementation.

The summary of the identified potential impacts and the recommended mitigation measures is provided as follows:

Potential Impact on Soil Quality: These include removal of top soil, soil compaction and instability, increased erosion and potential contamination from spills.

Mitigation Measures: Recommended measures to minimize soil degradation and soil contamination include:

- Topsoil that is removed during the construction activities shall be reused within the site for ground levelling or backfilling.
- Excavation works shall not be executed under aggressive weather conditions.
- Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion.
- Disturbed areas shall be rehabilitated as soon as possible to prevent erosion.
- Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.
- Fuel, oil and used oil storage areas shall be contained in bunds of 110 per cent capacity of the stored material.
- Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of.

Potential Impact on Hydrology and Groundwater: Potential impacts to hydrology and groundwater include: increase in runoff from hardstanding areas, decrease in infiltration, increased sediment load along drainage channels as a result of erosion, potential contamination from spills, and decrease in groundwater quality.

Mitigation Measures: Recommended measures to prevent contamination of underground water resources include:

- The Engineering, Procurement and Construction (EPC) Contractor will be required to design appropriate drainage system that takes due regards of the natural drainage system. Where roads intersect natural, defined drainage lines, suitably sized pipe culverts or drive through causeways shall be installed or constructed;
- Fuel, oil and used oil storage areas will be contained in bunds of 110 per cent capacity of the stored material.
- The EPC Contractor shall be required to develop a water conservation plan to identify opportunities to reduce water consumption, for both construction and operation phases of the project, and to reduce abstraction rate.
- Waste receptacles shall be provided within a secured area for collection of solid wastes.

Potential Impact on Visual Amenity: Potential impacts to visual amenity include landscape alterations resulting in unpleasant changes in the visual character of the project area, obstructive increase in ambient lightning levels especially at night time.

Mitigation Measures: Recommended measures to prevent impacts to visual amenity include:

- PASL shall adopt responsible construction practices aimed at containing the construction activities to specifically demarcated areas, thereby limiting the removal of natural vegetation to the minimum.
- PASL shall rehabilitate all disturbed areas to acceptable visual standards.
- PASL shall maintain the general appearance of the facility in an aesthetically pleasing way.
- PASL shall ensure proper planning is undertaken regarding the placement of lighting structures, the usage of security and other lighting objects.

Potential Impact on Terrestrial Flora, Fauna and Avifauna: Loss of terrestrial flora and impacts on the population, specie composition, and distribution of fauna and avifauna species.

Mitigation Measures: Measures to minimize impact to terrestrial flora, fauna and avifauna include:

- PASL shall restrict vegetation clearing to areas required for construction activities and power plant installation.
- PASL shall ensure that a reasonable portion of the project site is left unclear to serve as a greening buffer zone.
- PASL shall revegetate impacted areas as soon as practical.
- PASL shall ensure that construction workers implement a ‘no deliberate kill’ policy of fauna throughout the construction period.
- PASL shall ensure that all new above ground transmission lines are marked with bird flight diverters along their entire length, to increase the visibility of the power lines;
- PASL shall use bird-safe transmission structures including insulation of electrical components thereby minimising the risks of collision and electrocution of birds.
- Disruption of any nest of avifauna species along the transmission route shall be avoided.
- The site fencing (where required) will be constructed in a manner which allows for the passage of small and medium sized mammals, at least at strategic places, such as along drainage lines or other areas of dense vegetation. The fence will be designed to protect the solar PV plant but also withstand any animal conflict.
- All construction and construction related activity will be restricted to demarcated areas.
- No unauthorized persons shall be allowed to the site.
- In order to reduce collisions of vehicles with fauna, a 30 km/hr speed limit will apply to all vehicles using the site.

Potential Impact on Air Quality: Impact on air quality of the project area may occur due to emission of gaseous and particulate pollutants to the atmosphere during construction activities. During operation, the PV Power Plant has negligible or minor impact on the ambient air quality of the Project area. PV panels do not generate GHG emissions.

Mitigation Measures: Recommended mitigation measures to minimize air emissions especially during construction phase include:

- PASL shall ensure that vehicles sizes are optimised to reduce the number of journeys required and most suitable delivery routes are identified.
- PASL shall ensure that site clearing equipment is shut down when not in use for extended period of time.
- PASL shall implement dust control methods such as the use of water suppression to minimize dust.
- PASL shall as much as possible ensure that EPC contractor operate only modern and well-maintained equipment and machinery for construction activities.

Potential Noise Impact: Impact on noise and vibration include general construction noise, annoyance and disturbance effects at noise sensitive receptors etc. Noise impact associated with the plant operation is considered minor.

Mitigation Measures: Recommended measures to minimize noise pollution and its attendant effects on the nearby sensitive receptors in the Project area especially during the construction include:

- PASL shall ensure construction vehicles and equipment are turned off when not in use.
- Ensure that engines and other noise making equipment are in good working order and well maintained, and that all have original noise suppression equipment (e.g. mufflers) intact and in good working order.
- Ensure that equipment and general construction activities are limited to normal working hours (8.00hr to 17.00hr during weekdays; and Saturdays between 10.00hr-16.00hr).
- Ensure that the major construction activities are limited to a particular area within the site.

Social Impacts: Potential social impacts include disruption of family structure and social networks; increase in level of crime and drug and alcohol abuse, increase in incidence of sex workers, casual sexual relations which may result in Sexually Transmitted Infections (e.g. HIV/AIDS) and unwanted pregnancies, and general elevated safety risks.

Mitigation Measures: Measures to minimize or prevent social impacts include:

- The EPC Contractor will develop an induction programme, including a Code of Conduct (CoC), for all workers (including contractors and their workers) prior to construction activities.
- A copy of the CoC will be presented to all workers and signed by each person. Adequate training/explanations will be provided to workers on its contents. The CoC will address the following aspects, amongst others:
  - respect for the norms and values of local communities;
  - no hunting or unauthorised taking of products or livestock;
  - zero tolerance of illegal activities by construction personnel including: unlicensed prostitution and/or solicitation; illegal sale or purchase of alcohol; sale, purchase or consumption of drugs; illegal gambling or fighting;
  - compliance with the Traffic Management Plan and all road regulations;
  - description of disciplinary measures for infringement of the CoC.
- Grievance procedure that is easily accessible to local communities shall be developed, through which complaints related to contractor or employee behaviour can be lodged and responded to. A Community Liaison Officer shall be engaged.
- PASL shall ensure that the EPC Contractor develops a means of monitoring access to the site, prohibiting unauthorized access to the site and ensuring that all visitors report to the site office.
- No employment will take place at the entrance to the site. Only formal channels for employment will be used, and recruitment shall take place only at designated times and locations.
- PASL through its EPC Contractor shall develop and implement an HIV/AIDS policy and information document for all workers directly related to the project. The information document will address factual health issues around the transmission and infection of HIV/AIDS.
- Warning and safety signs shall be installed at strategic locations within the Project site.
- A 24-hour security arrangement shall be put in place to prevent unauthorized access to site.
- PASL shall ensure that only competent contractors are employed for construction activities, while at the same time effecting adequate supervision of project during and after installation.

Impacts on Existing Infrastructure (Road): Anticipated impacts on infrastructure (road) include disruption to road access from project vehicles; traffic accident.

Mitigation Measures: PASL shall develop and implement a Construction Traffic Management Plan to mitigate the potential impacts arising from the anticipated changes in the traffic pattern of the area due to the proposed project activities.

Health, Safety and Welfare of Workers and Staff: Risk of injury, health and safety related issues including poor welfare conditions, exposure to injuries, electric shock, rights denial etc.

Mitigation Measures: Health and Safety issues will be managed through the development and implementation of a robust Health and Safety (H&S) Management Plan by the EPC Contractor, including emergency plan. Staff shall be trained on emergency preparedness and responses. The H&S Plan will be developed following all relevant national and international standards, including applicable IFC Performance Standards.

In addition, human resources policy and procedures relevant to the scale of the Project will be developed and implemented. The HR policy will include the following key issues, among others:

- Provision of clear and understandable information regarding rights under national labour and employment law, and any applicable collective agreements, including those related to hours of work, wages, overtime, compensation, etc.
- Provision of employment, compensation/remuneration and working conditions, including working hours, terms of employment, based on equal opportunity and fair treatment, avoiding discrimination on any aspects.
- Retrenchment policy including alternatives analysis prior to decision.
- Implementation of a grievance mechanism.
- Adoption and implementation of a sexual harassment policy.
- Adoption of open attitude towards freedom of association.

Environmental Management Plan[2]

An Environmental Management Plan (EMP) has been developed to satisfy long term objectives of managing and monitoring the environmental and social impacts (including health and safety) of the proposed Project. The EMP has been developed to meet international and national standards on environmental and social management performance. It covers the pre-construction, construction, operation and decommissioning phase of the Project. The plan details the mitigation and enhancement measures PASL has committed to implement throughout the life span of the proposed Project and also includes desired outcomes; performance indicators; monitoring; timing for actions; responsibilities and cost estimates required for implementation of recommended mitigation measures, monitoring of the performance indicators and capacity building. The estimated cost for EMP implementation is in the range of 50,000 – 80,000 US Dollar.

[2] EMP is a nomenclature adopted in Nigeria in line with the national (local) guidelines and regulations. The EMP however covers both the biophysical and socio-economic environment and it is synonymous with ESMP (Environmental and Social Management Plan)

Additional detailed policies and plans will be developed to support the implementation of the EMP. The timing of the development of the plans may be staged, ensuring that the appropriate focus and level of detail is provided for construction and operational activities. Where required, the documents will be finalized by PASL in consultation with FMEnv, Katsina State Ministry of Environment, KATSEPA and other key stakeholders. The documents will be prepared strictly in line with the requirements set out in the relevant IFC Performance Standards and the World Bank/IFC EHS policies and guidelines as well as other applicable local regulations and guidelines.

The additional management plans required for the proposed Project include:

- Local and Employment Management Plan;
- Waste Management Plan
- Site Security Plan
- Construction Traffic Management Plan
- Health and Safety Management Plan
- Human Resources Management Plan
- Corporate Social Responsibility (CSR) Plan
- Emergency Response Plan
- Land Acquisition Plan for Transmission Right of Way
- Site Closure and Restoration Plan.

A Stakeholder consultation process has been executed throughout the EIA process to assist in ensuring that all stakeholders relevant to the project including affected communities have had the opportunity to provide input into the Project planning process. A Stakeholder Engagement Plan has been developed and included as part of this report. PASL will sustain the on-going consultation and engagement with the stakeholders throughout the life cycle of the project.

Decommissioning and Abandonment

Decommissioning refers to the process of dealing with the dismantling and/or removal of all operating assets of the Project after completion of the operating life cycle. The proposed 80 MWp PV Power Plant is being developed for a projected 25-year operational lifetime. In the event of decommissioning, PASL shall ensure that the decommissioned site is returned to its original environmental condition or better, following the dismantling and removal of equipment and plant structures. All panels and major electrical equipment will be recycled at the end of their useful lives. The decommissioning and abandonment programme shall be managed by a team of competent personnel including the representatives of Katsina State Ministry of Environment and other relevant stakeholders.

Conclusion

The EIA of the proposed PV power plant and associated transmission infrastructure has been undertaken in line with the local and international regulations and guidelines. The study identified both potential positive and negative impacts associated with the proposed development.

The positive implications of establishing the solar power plant project on the identified site in Kankia, Kankia LGA of Katsina State include:

- The potential to harness and utilize solar energy resources.
- The National electricity grid in Katsina State would benefit from the additional 80 MWp power (electricity) to be generated.
- Promotion of clean, renewable energy.
- Creation of local employment, business opportunities and skills development in the Project area.

The potential negative effects identified were mostly of minor to moderate significance. The significance of the majority of identified negative impacts can generally be reduced by implementing the recommended mitigation measures including good industry practices. There are no human uses of the Project site that will be permanently displaced and no relocation of community residents is required. There are no culturally significant sites or heritage resources within the project area that would be negatively impacted. No environmental fatal flaws were identified with the establishment of the proposed power plant. The most significant threat to avifauna communities would be from collisions with the overhead power line. The loss of habitat, disturbance, or any interaction with the facility is not anticipated to have a significant negative impact on bird communities in the area. The anticipated visual impact is not, considered to be a fatal flaw from a visual perspective, considering the low incidence of visual receptors in the contained area of potential visual exposure.

Based on the nature and extent of the proposed Project, the local level of disturbance predicted as a result of the construction and operation of the solar power plant and associated infrastructure, the findings of the EIA, and the understanding of the significance of the potential environmental impacts, it is believed that the potential negative impacts associated with the proposed Project can be mitigated to an acceptable level. Also, an EMP has been established to assess the efficiency and the effectiveness of the mitigation measures and long-term monitoring of the Project.

PASL will ensure the proposed Project is developed and operated in an environmentally sustainable manner by properly managing the processes/activities that may bring about disturbances to the environment through the implementation of the recommended mitigation measures.

CHAPTER ONE:

INTRODUCTION

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Pan Africa Solar Limited (PASL) proposes to construct, install and operate a Photovoltaic (PV) Power Plant in Kankia, Kankia Local Government Area (LGA) of Katsina State, Nigeria (the Project). The Project will be built in two (2) phases with a proposed total capacity of 80 Megawatt nominal power (MWp). Phase 1 of the Project will have a capacity of approximately 34 MWp and is planned to commence in Quarter 1 (Q1) of 2016 with full operation in Q3 of 2016. Phase 2 is anticipated to be operational a year later (2017).

The Project site, occupying approximately 120 hectares (ha) of land, was owned by Katsina State Government until rights were granted to PASL in return for equity stake in the Project ownership. The site was acquired in two tranches of 50 ha and 70 ha. A copy of certificate of occupancy for the site issued by the State Government is provided in Appendix 1.

Under the provision of the Nigeria Environmental Impact Assessment (EIA) Act No 86 of 1992 (EIA Act CAP E12 Law of Federal Republic of Nigeria, 2004) and the requirements of the Development Finance Institutions (DFIs) such as the International Finance Corporation (IFC), an EIA study has been undertaken for the Project. This report documents the findings of the EIA study.

The EIA is an upgrade of the previous study conducted by PASL in 2013 for a proposed 20 MWp PV Solar Power Plant within the same project area. An EIA approval for the 20 MWp was issued by the Federal Ministry of Environment (FMEnv) on June 16, 2014 (refer to Appendix 2).

However, between the time of the previous EIA in 2013 and now (2015), there have been modifications to the proposed Project which include:

- An increase in the capacity of the PV Solar Power Plant from 20 MWp to 80 MWp;
- An increase in the Project land take from 30 ha to 120 ha; and
- A change in the Project design.

In view of these modifications, an EIA upgrade is considered necessary to ensure that the potential environmental, social and health issues associated with the Project are identified, assessed and adequately mitigated and monitored.

This EIA study covers the entire life cycle of the Project (i.e. design, construction, operation, decommissioning, and closure).

1.2 Project Proponent

PASL is a limited company incorporated in Nigeria in July 2012. The Company is a partnership between JCM Capital Limited and some individuals in Nigeria. JCM Capital is a Canadian-based private equity firm that focuses on the development of utility-scale clean power projects. Basically, JCM:

- Has invested in and developed over 120 projects in Canada, South America and Africa. It works with a diverse set of stakeholders in the solar PV industry that make the company an ideal partner for delivering utility-scale PV solar power. It credits its success to identifying key renewable energy markets and building long-term strategic partnerships.

- Works with local development teams to take solar projects from concept to construction. It has a strong solar development track record, with experience developing over 70 ground mount and rooftop projects and more than 400 MWp in Africa, Latin America and North America.

- Plays an important role in the development of solar generation in emerging markets.

- Works with local teams in Africa and Latin America at the earliest stages of project development. It leverages its extensive financial, operational, development, legal and regulatory experience in order to take projects through the entire development, construction and operational life-cycle.

OST Energy is providing technical advisory services to PASL/JCM to assist in the development of the proposed Project. The Company is an award winning, independent technical consultancy firm specialises in solar, wind, biomass and renewable energy projects. OST Energy is at the cutting edge of multi MW solar photovoltaic (PV) development and portfolios with the directors and employees, having advised investors on over 6 GW of under construction and operational plants worldwide.

1.3 Project Location

The Project is planned to be sited on a 120 ha of land in Kankia, Kankia LGA of Katsina State, Northwest geo-political zone of Nigeria (Figures 1.1 to 1.3). The Project site is located approximately 100 m west away from Katsina-Kano

Expressway (popularly known as IBB Way) in Kankia. The site can easily be accessed through the Expressway as illustrated in Figure 1.4.

The Kankia community, the major town in the Project area, is located approximately 2.5 km south of the Project site. There are no residential buildings and farmlands within the entire 120 ha site. Details of the Project site description are provided in Chapter 3 of this report.

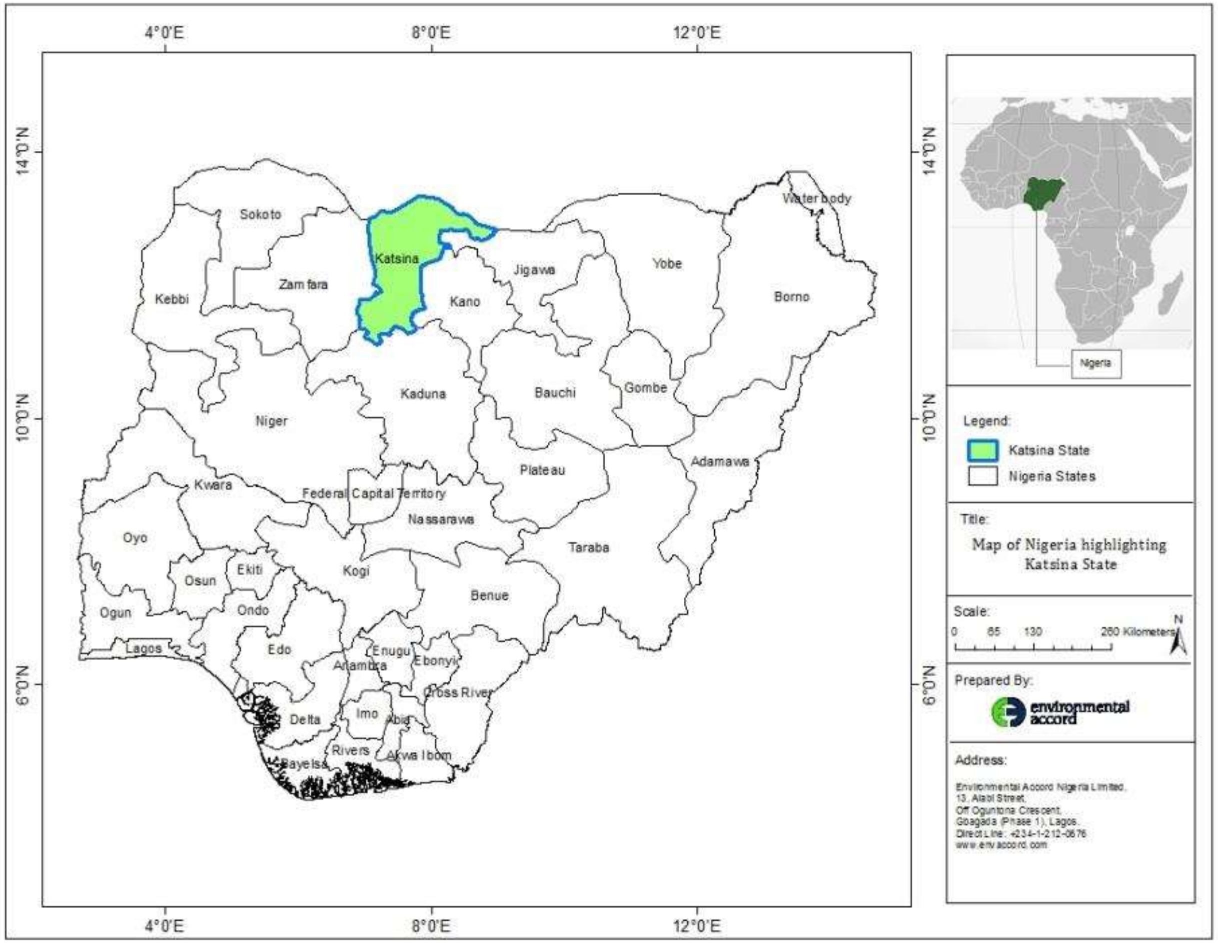

Figure 1.1: Administrative Map of Nigeria highlighting Katsina State

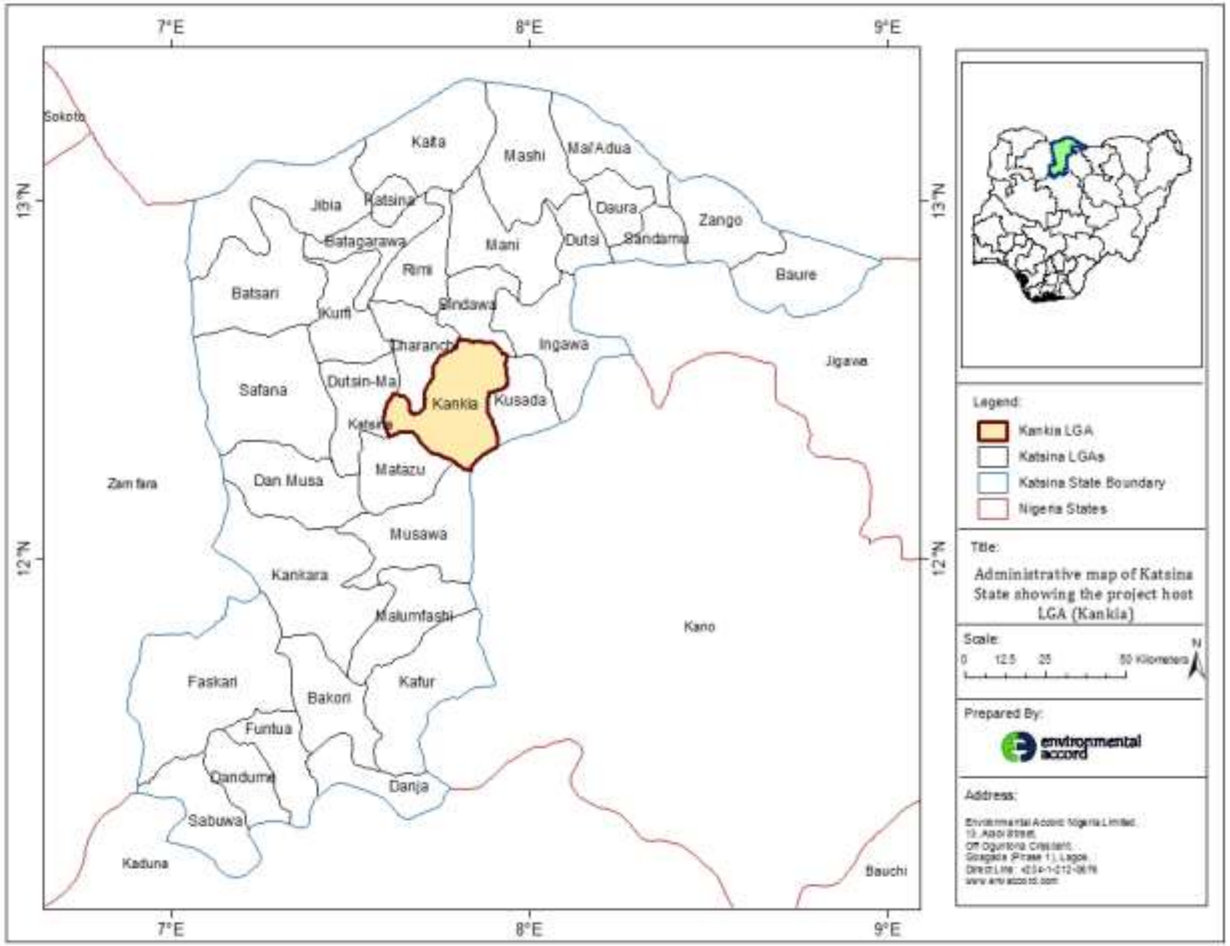

Figure 1.2: Administrative Map of Katsina State highlighting Kankia LGA

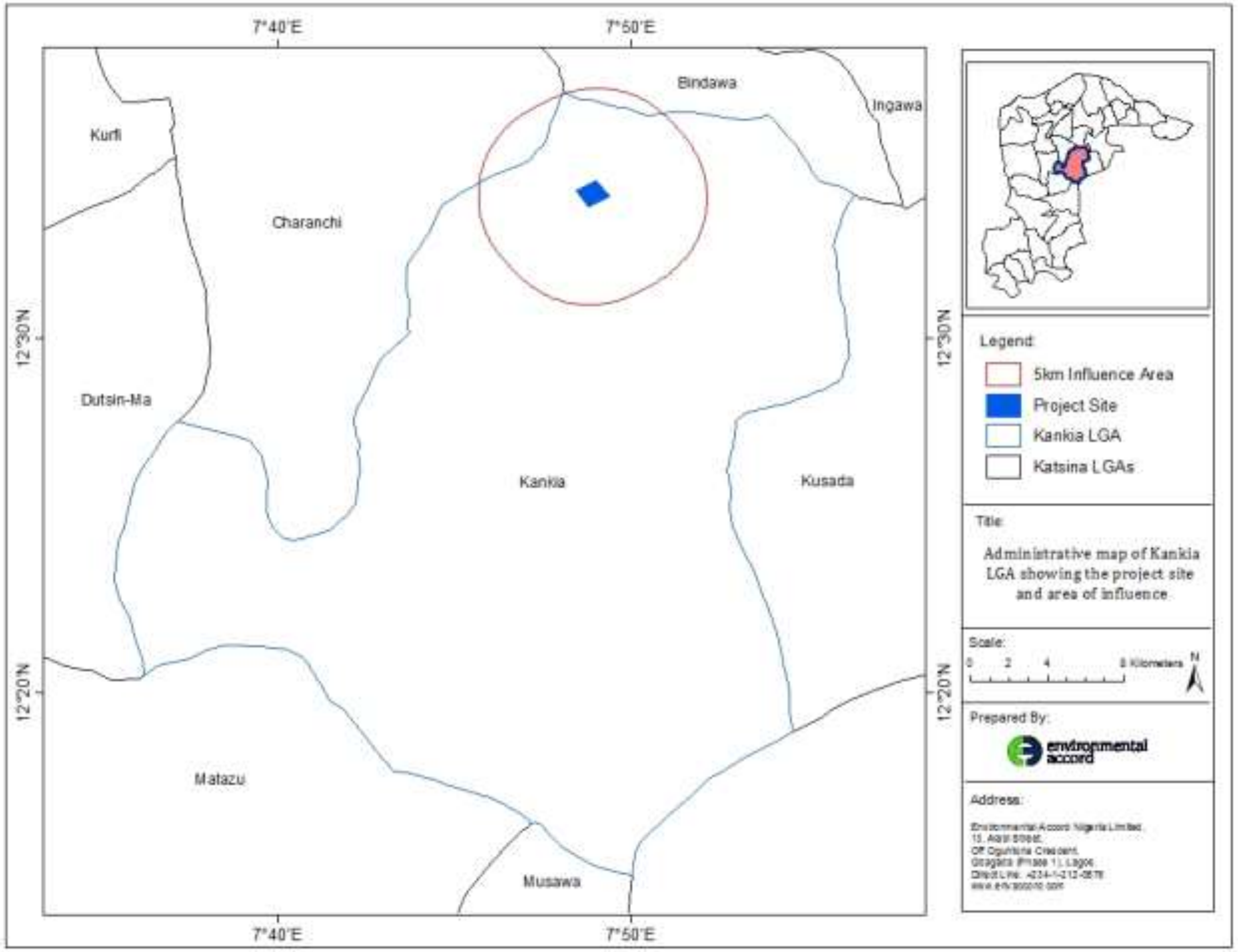

Figure 1.3: Administrative Map of Kankia LGA showing the Project Site

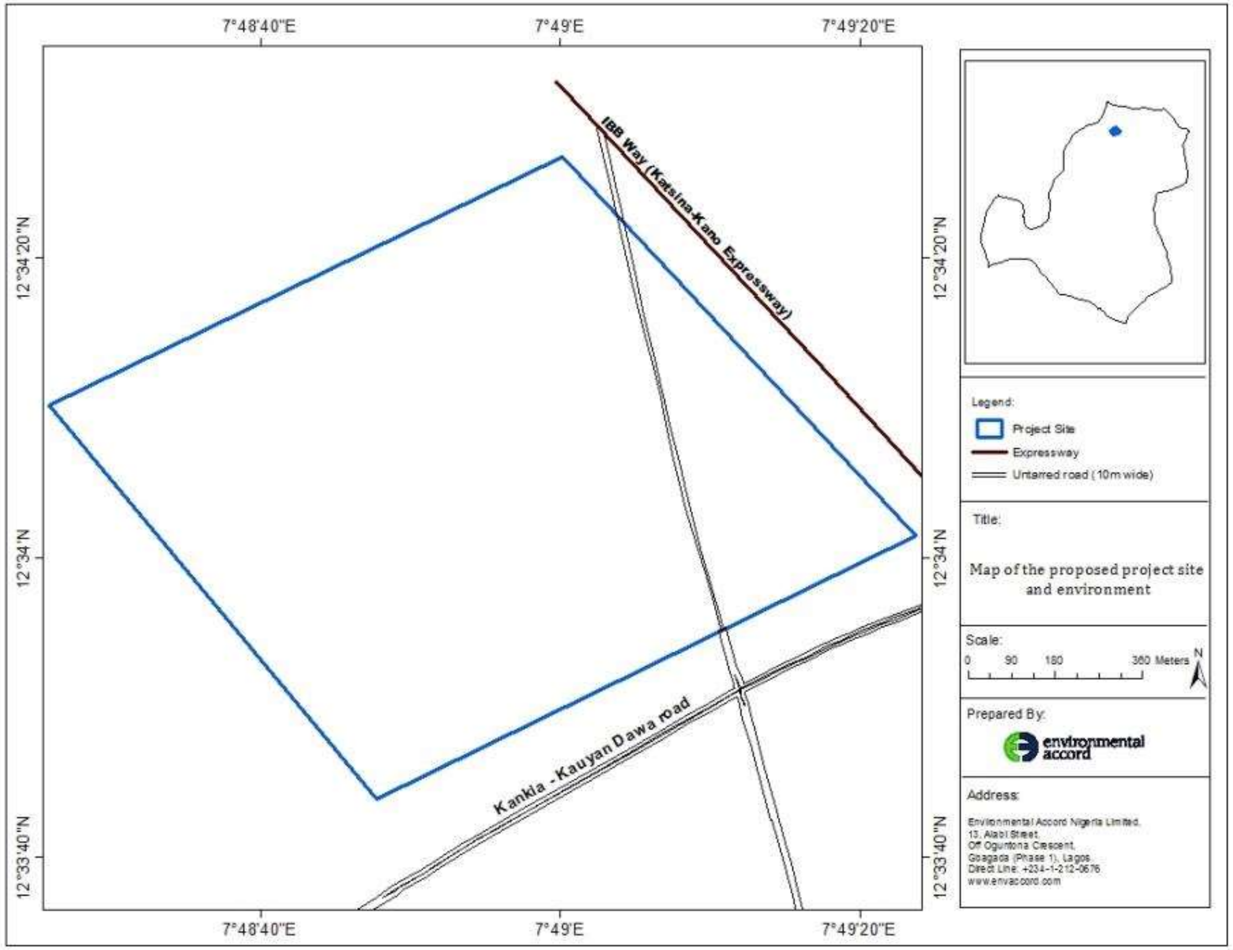

Figure 1.4: Map of the Project site and the nearby existing roads

1.4 EIA Objectives

The EIA study has been carried out to identify and evaluate potential environmental, social and health impacts associated with the entire life cycle of the proposed Project with a view to mitigating the identified negative impacts and enhancing the beneficial impacts. This will ensure that the Project is developed and operated in a sustainable manner.

Specifically, the objectives of the EIA are to:

- Assist Project design and planning by identifying and quantifying those aspects of location, construction, operations and decommissioning which may cause adverse environmental, social, health and economic effects.
- Establish the existing state of the Project environment and identify any sensitive components of the environment.
- Recommend measures during construction, commissioning, operations and decommissioning to avoid and mitigate adverse effects and enhance beneficial impacts.
- Develop an appropriate Environmental Management Plan (EMP) for the Project including monitoring programme.
- Provide the basis for co-operation, consultation and compliance with regulatory authorities and other stakeholders.
- Prepare a detailed report presenting clear and concise information on the findings of the EIA.

1.5 EIA Process

Where applicable at this stage of the study, the EIA has been carried out in line with the National EIA Procedural Guidelines issued by the FMEnv. The entire process is summarized below in Figure 1.5.

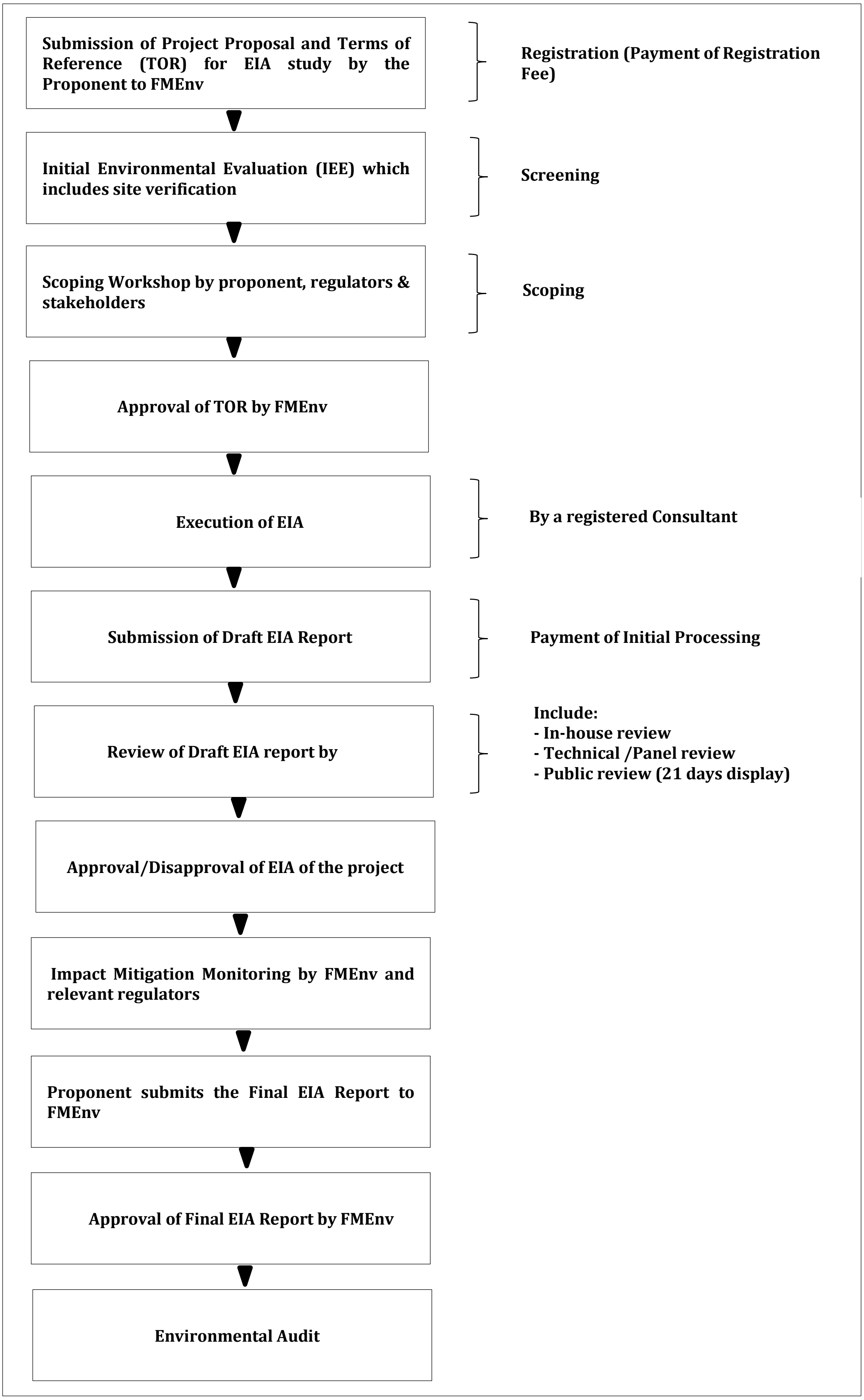

Figure 1.5: Overview of Nigeria EIA Process
(Source: FMEnv 1994)

The EIA is carried out in a stepwise manner through a number of key phases as follows:

- Scoping;
- Baseline studies;
- Stakeholder engagement;
- Potential impact identification and evaluation; and
- Mitigation and management plan.

1.5.1 Scoping

Scoping is an essential element of a standard EIA. It helps to identify the potentially significant environmental and social issues relating to the design, construction, operation, and decommissioning of a project that should be addressed as part of EIA. This will enable the developer to address the key issues from the onset and also allow early recognition of these issues in the design and evolution of the project.

The process also facilitates the 'scoping out' of aspects that would not be expected to experience significant adverse impacts. Ultimately, it helps define the scope for the EIA, which will examine and report the full suite of impacts associated with the project. Scoping also provides opportunity for early consultation with stakeholders.

The objectives of scoping undertaken as part of the EIA study for the proposed Project are to:

- Provide an overview description of the Project;
- Identify the key stakeholders, their concerns and values;
- Review the existing environmental and socio-economic characteristics of the Project area and identify data gaps;
- Undertake a preliminary assessment of the potential environmental and socio-economic impacts associated with the Project;
- Set requirements for additional baseline environmental data;
- Obtain early input from key stakeholders in the identification of potential impacts and mitigation measures.

The stakeholders that were consulted during the scoping phase of the EIA are highlighted in Table 1.1. A scoping workshop was held on October 16, 2014 at Al-Bhustan Hotels, 15 Yahaya Madaki Way, Katsina, Katsina State. The workshop provided opportunities to the stakeholders to contribute to the EIA scope of work. In addition, a town hall meeting was held on October 20, 2014 at the palace of "Kankia Magajin" (the district head of Kankia). Detailed information about the scoping workshop and other stakeholder engagement activities carried out during the EIA study is documented in Chapter 4.

Table 1.1: List of Stakeholders consulted during Scoping

Stakeholder Group and Interest in the proposed Project	Stakeholder Name	Stakeholder Level			Connection to the Project
		National	Regional	Local	
Government Authorities	Federal Ministry of Environment (FMEnv)	✓			National government authorities are of primary importance in terms of establishing policy, granting permits or other approvals for the Project, and monitoring and enforcing compliance with Nigerian law throughout all stages of the Project life-cycle.
	Nigerian Electricity Regulatory Commission (NERC)	✓			
	Nigerian Bulk Electricity Trading (NBET) Plc.	✓			
	Transmission Company of Nigeria (TCN), Kankia, Katsina	✓			
	Katsina State Ministry of Environment		✓		Katsina State and Kankia local authorities were informed of progress and plans in their areas to consider the Project in their regulatory functions.
	Katsina State Ministry of Lands, Housing and Urban Development		✓		
	Kankia Local Government Authority			✓	
Potentially Affected Communities[3]	Kafin Dangi, Kauyan Maina, Galadima, Gachi and Kankia communities within the Project's area of influence.			✓	Communities that may be directly or indirectly affected by the proposed Project and its activities.
Non-Governmental Organizations (NGOs)	International Centre for Energy, Environment and Development (ICEED)	✓			NGOs with direct interest in the Project, and its social and environmental aspects that are able to influence the Project directly or through public opinion.

Source: EnvAccord Scoping Study, 2014

[3] The distance and orientation of each of the potentially affected communities to the Project site is as follows: Kafin dangi (3.74 km north east); Kauyan Maina (2.98 km east), Galadima (1 km south west), Gachi (2.32 km south east) and Kankia (2.46 km south). Details about the socio-economic characteristics of the communities are provided in Chapter 4.

1.5.2 Baseline Studies/Field Survey

The objective of baseline studies is to characterize the existing environmental and socio-economic resources and conditions of the Project site and the surrounding environment. The baseline field survey of the Project area was conducted from October 17 to 22, 2014 (wet season survey) to complement the previous study carried out in 2013 within the project area. Additional site visit was also conducted from March 17 to 20, 2015. The detailed information on the existing environmental and socio-economic conditions of the Project area is presented in Chapter 4.

1.5.3 Impact Identification and Evaluation

The potential and associated impacts of the Project were assessed and documented in Chapter 5. The impact assessment approach has the following main components:

- Identification of potential impacts associated with the planned Project activities (including unplanned events) on the environmental and social receptors;
- Evaluation of the significance of the potential impact (which is a function of impact magnitude and sensitivity/importance of receptors;
- Development of mitigation measures to manage potentially significant impacts; and
- Evaluation of the significance of the potential residual impact.

1.5.4 Mitigation and Management Plans

Mitigation measures provided for the identified potentially significant adverse impacts were based on scientific conclusions, professional judgement, and applicable guidelines and regulations. Similarly, the EMP provided in this EIA consists of the set of management, mitigation and monitoring measures to be implemented throughout the life cycle of the Project.

1.6 Legal and Administrative Framework

This section presents the legislation and policy context as well as environmental and social standards that are deemed applicable to the Project and the EIA study. Specifically, this section provides a summary of:

- Relevant administrative structures;
- Relevant environmental and social policies and legislations;
- Applicable environmental regulations and standards; and
- Relevant international conventions and standards.

1.6.1 Administrative Structures

1.6.1.1 Federal Ministry of Environment (FMEnv)

In Nigeria, the FMEnv is the primary authority for the regulation of environmental laws, specifically the National Policy on the Environment (NPE) 1989, (revised 1999). The NPE is the overarching legislative framework for environmental management in Nigeria.

In furtherance of its mandate to ensure the overall protection of the environment and conservation of natural resources, the FMEnv has developed environmental guidelines and regulations on various sectors of the national economy. These include, amongst others:

- National Environmental Protection (Effluent Limitations) Regulations 1991.
- National Environmental Protection (Pollution Abatement in Facility and Industry Generating Wastes) 1991.
- National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations 1991.
- National Environmental Impact Assessment Procedural Guidelines, 1994.
- Environmental Impact Assessment Sectoral Guidelines for Power Sector, 2014

1.6.1.2 National Environmental Standards and Regulations Enforcement Agency (NESREA)

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 by the Federal Government of Nigeria as a parastatal of the FMEnv. The Agency is charged with the responsibility of enforcing all environmental laws, guidelines, policies, standards and regulations in Nigeria, specifically during operation phase of development projects.

The NESREA regulations relevant to the proposed Project are:

- National Environmental (Electrical/Electronic Sector) Regulations, 2011
- National Environmental (Sanitation and Wastes Control) Regulations, 2009
- National Environmental (Noise Standards and Control) Regulations, 2009
- National Environmental (Soil Erosion and Flood Control) Regulations 2011
- National Environmental (Surface water and Groundwater Quality Control) Regulations 2011
- National Environmental (Protection of Endangered Species in International Trade) Regulations, 2011

1.6.1.3 Federal Ministry of Power

The Federal Ministry of Power is the policy making arm of the Federal Government with the responsibility for the provision of power in the country. The Ministry is guided by the provisions of the National Electric Power Policy (NEPP) of 2001, the Electric Power Sector Reform (EPSR) Act of 2005, and the Roadmap for Power Sector Reform of August 2010.

1.6.1.4 Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory agency inaugurated on October 31, 2005. The Commission is mandated to carry out the following, amongst others:

- Monitor and regulate the activities of the electricity industry in Nigeria,
- Issue licenses to market participants, and
- Ensure compliance with market rules and operating guidelines.

1.6.1.5 Nigerian Bulk Electricity Trading Plc. (NBET)

The Nigerian Bulk Electricity Trading Plc. (NBET) is a Federal Government of Nigeria (FGN) owned public liability company. NBET (also called the Bulk Trader) was incorporated on July 29, 2010 to engage in the purchase and resale of electrical power and ancillary services from independent power producers and from the successor generation companies.

1.6.1.6 Transmission Company of Nigeria (TCN)

TCN oversees the transmission of generated power to the national grid. In the Project location, Kankia TCN is responsible for the transmission of electricity in Kankia LGA of Katsina State. Details on the power evacuation process for the Project are presented in Chapter 3.

1.6.1.7 Katsina State Ministry of Environment and Katsina State Environmental Protection Agency

Katsina State Ministry of Environment is the state regulatory authority in charge of environmental protection. A parastatal of the Ministry is the Katsina Environmental Protection Agency (KATSEPA), which is responsible for the collection and disposal of domestic and industrial wastes, amongst other functions. The KATSEPA was established by Edict No 4 of 1994.

Other functions of the Ministry include:

- Ensuring that all development projects comply with EIA and other relevant regulations guiding development activities in the state.
- Co-operate with the FMEnv and other relevant regulatory agencies in the promotion of environmental education.

- Routine liaison and ensuring effective harmonization with the FMEnv in order to achieve the objectives of the National Policy on the Environment;

1.6.1.8 Kankia Local Government Area

The Project site is primarily under the jurisdiction of the Kankia LGA of Katsina State. The LGA has an Environmental Health Department which ensures compliance with environmental sanitation law.

1.6.2 Nigerian Environmental Policy and Legislation

The local environmental policy requirements applicable to the Project are summarized in the following paragraphs:

1.6.2.1 National Policy on the Environment (NEP) 1989 (Revised 1999)

Environmental management in Nigeria is based on the National Policy on the Environment (1989), revised in (1999). The Policy states that Nigeria is committed to safeguarding the country's natural and built environment for the use of present and future generations. This commitment demands that efficient resource use and the reduction of environmental impacts is a core requirement of all developmental activities. The strategic objective of the NEP is to coordinate environmental protection and natural resources conservation for sustainable development. This goal is to be pursued by the following objectives:

- Securing a quality of environment adequate for good health and well-being;
- Promoting sustainable use of natural resources and the restoration and maintenance of the biological diversity of ecosystems;
- Promoting an understanding of the essential linkages between the environment and economic development and encouraging individual and community participation in environmental improvement initiatives;
- Raising public awareness and engendering a national culture of environmental preservation; and
- Partnering among stakeholders including governments at all levels, international institutions and governments, non-governmental agencies and communities.

The action plans to achieve these policy objectives include considering environmental aspects in major economic decision making processes, building an integrated environmental management approach into major development projects and employing suitable economic instruments and environmental reporting.

In addition, the policy requires that the best practicable environmental technology is applied in major economic activities. The policy also specifies that an EIA is mandatory for major development projects.

1.6.2.2 EIA Act No 86 of 1992

The EIA Act No 86 of 1992 is the primary regulation governing EIAs in Nigeria. The Act was promulgated in order to enable the prior consideration of an EIA on specified public or private projects. The Act sets out the procedure to be followed and methods to be used in undertaking an EIA. Section 2 (2) of the Act requires that where the extent, nature or location of a proposed project or activity is such that it is likely to significantly affect the environment, an EIA must be undertaken in accordance with the provisions of the Act.

1.6.2.3 Environmental Impact Assessment Sectoral Guidelines for Power Sector, 2014

These guidelines have been developed by the FMEnv to assist proponents in conducting detailed environmental assessment with regards to power projects in Nigeria. Amongst others, the guidelines include potential impacts associated with solar power projects and the suggested mitigation measures.

1.6.2.4 Harmful Waste (Special Criminal Provisions) Act No 42 of 1988

The Harmful Waste (Special Criminal Provisions) Act No 42 of 1988 prohibits and declares unlawful all activities relating to the purchase, sale, importation, transit, transportation, deposit, storage of harmful wastes. Appropriate penalties for contravention are prescribed.

1.6.2.5 The Nigerian Urban and Regional Planning Act 1992

Act 88 of 1992 established a Development Control Department (DCD) charged with the responsibility for matters relating to development control and implementation of physical development plans at Federal, State and Local Government levels within their respective jurisdiction.

The Katsina State Ministry of Lands, Housing and Urban Development is charged with the responsibility for land related matters in the state. The Ministry requires that a land permit is obtained for any physical development in Katsina State. The Certificate of Occupancy for the proposed Project site is contained in Appendix 1 to this report.

1.6.2.6 Endangered Species Act 1985

The Federal Government of Nigeria enacted the Endangered Species (Control of International Trade and Traffic) Act 11, 1985 which makes amongst others, provisions for the conservation, management and protection of some of the country's endangered species. Section 1 of the Act prohibits the hunting, capture and trade of endangered species.

1.6.3 Nigeria Power Sector Laws

1.6.3.1 Electric Power Sector Reform Act 2005

The Electric Power Sector Reform Act No. 6 of 2005 provides for the licensing and the regulation of the generation, transmission, distribution and supply of electricity.

Part IV of the Act contains requirements for licensing and stipulates that no person may construct, own or undertake any of the following activities without a license, unless the generating capacity and distribution capacity is below 1 MW and 100 kilowatts (KW) respectively for electricity generation, excluding captive generation, electricity transmission, system operation, electricity distribution and trading in electricity.

1.6.3.2 Electricity Amendment Act No 28 of 1998

The Electricity Amendment Act No. 28 of 1998 was promulgated in order to deregulate the power sector in Nigeria and allows for competition in the power sector of Nigeria. The Act provides for both national and international investors interested in the sale of electricity to compete favourably in power generation, distribution and supply.

1.6.3.3 National Energy Policy 2003

The provisions of this Policy relevant to the proposed Project are:

- The Nation shall aggressively pursue the integration of solar energy into the energy mix;
- The Nation shall keep abreast with worldwide developments in solar energy technology; and
- Development of the market for solar energy technologies.

1.6.4 Nigerian Social Legislation

The summary of Nigerian social legislation applicable to the Project is provided as follows:

1.6.4.1 The Nigerian Cultural Policy (1996)

The national cultural policy is generally regarded as an instrument of promoting national identity and Nigerian unity.

Katsina State has no listed United Nations Environment Programme (UNEP) World Heritage sites. In addition, there are no known nationally protected cultural resources within the Project site and its surrounding environment up to approximately 5 km radius based on desktop review, reconnaissance survey and baseline field survey.

1.6.4.2 Labour Act

The Labour Act (1990) is the primary law protecting the employment rights of individual workers. The Labour 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*".

1.6.4.3 Factories Act

The Factories Act 1990 is the primary law regulating the health, safety and welfare of workers in the country's factories.

With respect to safety, there are general provisions as to the securing, fixing, usage, maintenance and storage of machinery, unfenced machinery, and other lifting machines. There are, in addition to these, standards set for the training of 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.

1.6.4.4 Land Use Act

The Land Use Act of 1978, the Constitution of 1999 and the Public Lands Acquisition Laws of the relevant states constitute the governing policy for land acquisition in Nigeria. As it is the case with most National and State laws on acquisition of land in the public interest or for a public purpose, the legislation enables the state to acquire 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 affected people.

The proposed Project does not involve physical and economic resettlements. Details of land acquisition process for the Project are provided in Chapter 2.

1.6.4.5 Public Health Law

This provides justification for the execution of developmental projects under guidelines that promote health by protecting the environment and safeguarding the humans' health. The Public Health Laws empower Medical Officers of Health (operating at the local government council, under the supervision of the State and Federal Ministries) to ensure the promotion of good health.

1.6.4.6 Public Participation and Disclosure

To a large extent, public authorities are required to inform the public of environment-related issues. Section 55 of the EIA Act 86 of 1992 provides for the maintenance of a Public Registry for the purpose of facilitating public access to records relating to environmental assessments.

Also, members of the public and persons requiring clarifications on environmental issues can visit the offices of the FMEnv or the relevant State environmental agency for environment-related information. Public hearings to which interested members of the public are invited are a key part of the approval process for EIA reports by the FMEnv.

1.6.5 National Regulations and Standards

The national regulations and standards relevant to the implementation of activities under the Project are:

1.6.5.1 <u>National Environmental Protection (Effluent Limitation) Regulations, 1991</u>

The National Environmental Protection (Effluent Limitation) Regulations, S.I.8 of 1991 make it mandatory for industries to install anti-pollution and pollution abatement equipment on site. The regulation is specific to each category of waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem.

1.6.5.2 <u>National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991</u>

The National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, S.I.9 of 1991 (No. 42, Vol. 78, August, 1991) highlights restrictions on the release of toxic substances, and requirements for use of pollution monitoring equipment; requirements for use of machinery for combating pollution; development of contingency plans.

1.6.5.3 <u>National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991</u>

The National Environment Protection (Management of Solid and Hazardous Wastes) Regulations, S.I.15 of 1991 (No. 102, Vol. 78, August, 1991) defines the requirements for groundwater protection, surface impoundment, and waste piles. Hazardous chemical products and dangerous waste constituents are also described.

1.6.5.4 <u>National Environmental (Sanitation and Wastes Control) Regulations, 2009 (S.I.28)</u>

The purpose of this regulation is the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution.

1.6.5.5 National Environmental (Ozone Layer Protection) Regulations, 2009 (S.I.32)

This regulation prohibits the use, emission, storage and disposal of stratospheric ozone depleting substances (ODS) and articles which contain those substances.

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

This regulation highlights the permissible noise levels to which a person may be exposed; control and mitigation of noise; permits for noise emissions in excess of permissible levels; and enforcement.

1.6.5.7 National Environmental (Soil Erosion and Flood Control) Regulations, 2010 (S.I.12)

The overall objective of this regulation is to check all earth-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.

1.6.5.8 National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, 2010 (S.I.15)

The principal thrust of this regulation is to prevent and minimize the destruction of ecosystem through fire outbreak and burning of any material that may affect the health of the ecosystem through the emission of hazardous air pollutants.

1.6.5.9 National Environmental (Surface and Groundwater Quality Control) Regulations, 2010 (S.I.22)

The purpose of this regulation is to enhance and preserve the physical, chemical and biological integrity of the groundwater and surface water resources.

1.6.5.10 National Environmental (Protection of Endangered Species in International Trade) Regulations, 2011

The purpose of this regulation is to protect endangered species of fauna and flora and prevent their extinction by controlling international trade in their living specimens, parts and derivatives.

1.6.6 International Guidelines and Conventions

1.6.6.1 International Guidelines

- *World Bank Policy on Environmental Assessment (OP 4.01)*

The World Bank requires Environmental Assessment (EA) of projects proposed for Bank financing to help ensure that such projects are constructed and operated in an environmentally sustainable manner. The World Bank's environmental assessment policy and recommended processing are described in Operational Policy (OP)/Bank Procedure (BP) 4.01: Environmental Assessment. This policy is considered to be the umbrella policy for the Bank's environmental safeguard policies.

❖ *World Bank Policy (OP 4.03) on Use of Performance Standards for Private Sector Activities*

The aim of this policy is to facilitate Bank financing for private sector led economic development projects by applying environmental and social policy standards that are better suited to the private sector, while enhancing greater policy coherence and cooperation across the World Bank Group. The eight (8) IFC Performance Standards have been adopted by the Bank as the World Bank Performance Standards for Projects Supported by the Private Sector ("WB Performance Standards") for application to Bank support for projects (or components thereof) that are designed, owned, constructed and/or operated by a Private Entity.

❖ *World Bank Group Environmental, Health and Safety (EHS) Guidelines*

The World Bank Group EHS Guidelines are technical reference documents that include the World Bank Group expectations regarding industrial pollution management performance. The EHS Guidelines are designed to assist managers and decision makers with relevant industry background and technical information. This information supports actions aimed at avoiding, reducing, and controlling potential EHS impacts during the construction, operation, and decommissioning phase of a project.

The EHS Guidelines serve as a technical reference source to support the implementation of the World Bank policies and procedures, particularly in those aspects related to pollution prevention and occupational and community health and safety.

The World Bank Group EHS guidelines applicable to the proposed Project are:

- World Bank Group Environmental, Health, and Safety General Guidelines (2007);
- World Bank Group Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution (2007)

The General EHS Guidelines provide guidance to users on common EHS issues potentially applicable to all industry sectors. The EHS Guideline for Electric Power Transmission and Distribution provides guidance applicable to the project facilities that will transmit power from the power generation station to the nearby distribution substation.

❖ *IFC Performance Standards on Environmental and Social Sustainability*

The International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012) are a set of standards which the IFC requires its clients to apply while undertaking due diligence for corporate or project financing.

The Performance Standards, totalling eight (8) in number, provide a robust framework for assessing and managing the environmental and social risks and impacts associated with projects to be financed so that development opportunities are enhanced.

The eight (8) IFC Performance Standards and their applicability to the proposed Project are summarized in Table 1.2 below.

Table 1.2: Summary of IFC Performance Standards and their applicability to the proposed Project

Performance Standard	Requirements	Rationale	EIA Reference
PS 1: Assessment and Management of Social and Environmental Risks and Impacts	The PS requires that the Project initiate regular assessment of the potential social and environmental risks and impacts and consistently tries to mitigate and manage these potential impacts on an on-going basis.	The Project has environmental and social aspects[4] which may pose potential E&S risks and/or impacts. These include for example, land clearing, civil work activities, equipment installation, and engagement of labour. Best practice suggests that all projects, as long as E&S aspects exist, should possess systems for assessing and managing the potential risks and impacts resulting from such E&S aspects. Therefore PS 1 is applicable.	Chapter 5 – Potential and Associated Impact Chapter 6 – Mitigation Measures Chapter 7 – Environmental Management Plan (EMP)
PS 2: Labor and Working Conditions	PS 2 requires the Project to conduct its activities in a manner consistent with the four core labour standards (child labor, forced labour, non-discrimination etc.)	The Project will involve engagement of workforce. Therefore, it is necessary for the PASL to maintain appropriate labour and working conditions for these workers. As such, PS 2 is applicable.	Chapter 3 – Project Description Chapter 6 – Mitigation Measures Chapter 7 - EMP
PS 3: Resource Efficiency and Pollution Prevention	Key requirements of PS3 are for the Project to consider ambient conditions and apply	The Project activities will depend on resources and also generates some	Chapter 3 – Project Description

[4] An environmental or social aspect is defined as an element of a project's activities, operations, products, or services that can or does interact with the environment, people, surrounding communities and/or the larger society.

Performance Standard	Requirements	Rationale	EIA Reference
	technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid or where avoidance is not possible, reduce potential adverse impacts on human health and the environment during the entire project life-cycle.	wastes. Therefore PS 3 is applicable.	Chapter 4 – Description of the existing environment Chapter 6 – Mitigation Measures Chapter 7 - EMP
PS 4: Community Health, Safety and Security	The Project is required to evaluate the risks and potential impacts to the health and safety of the Affected Communities during the Project life-cycle and require establishing preventive and controlling measures consistent with good international industry practice.	Although there are no communities within the Project site, the Project may have direct or indirect impacts on the communities in the wider study area of the proposed Project. Therefore PS 4 is applicable.	Chapter 4- Description of the existing Environment Chapter 5 – Impact Assessment Chapter 6 – Mitigation Measures Chapter 7 – EMP
PS 5: Land Acquisition and Involuntary Resettlement	The Project is required to develop a resettlement action plan so that physically or economically displaced individuals have their living conditions and livelihoods restored or improved.	The 120 hectares (ha) Land for the proposed Project was acquired from the Katsina State Government by PASL in return for equity stake in the Project ownership. The site was acquired in two tranches of 50 ha and 70 ha. The project does not require any economic or physical resettlement. There are no settlements or residential quarters within the site. In addition the power transmission line right of way has also be selected to avoid existing structures along the proposed path to the connection point at the Kankia substation in Kankia, Katsina State	Chapter 1 – Introduction Chapter 3 – Project Description Chapter 4- Description of the existing Environment

Performance Standard	Requirements	Rationale	EIA Reference
PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	This PS requires that the project avoid or mitigate potential impacts to biodiversity arising from their operations as well as incorporate sustainable management of renewable natural resources.	Although there are no protected or conservation areas within the Project site, the site is characterized by shrubs. PS 6 is considered applicable.	Chapter 4 - Description of the Environment Chapter 5 – Potential and Associated Impacts; Chapter 6- Mitigation measures Chapter 7 – EMP
PS 7: Indigenous Peoples	Where indigenous people may potentially be affected then an indigenous people plan is required that identifies risk, potential impacts, and management measures.	To identify, potential environmental and social risk and impacts on indigenous people within the project area of influence. Based on the field studies, no indigenous communities as described by IFC PS 7 were found within the proposed project area of biophysical influence	Chapter 1 – Introduction Chapter 4- Description of the existing Environment
PS 8: Cultural Heritage	The PS requires the project comply with relevant national law on the protection of cultural heritage, including national law implementing the host country's obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage and other relevant international law.	To protect cultural heritage from the potential adverse impacts of the proposed project activities and to support the preservation and promote equitable sharing of the benefits from the use of cultural heritage Based on the field studies. No culturally important sites of artefacts as described by IFC PS 8 were found within the proposed project area of biophysical	Chapter 1 – Introduction Chapter 4- Description of the existing Environment

1.6.6.2 International Conventions

The Nigerian Government is an important player in the International support for the protection of the environment. As such, the country is a signatory to some International laws and conventions, which are targeted towards conservation and protection of the environment in order to ensure sustainable development.

Some International conventions and regulations that are applicable to the proposed Project include:

- *African Convention on the Conservation of Nature and Natural Resources*

The African Convention on the Conservation of Nature and Natural Resources was adopted in Algiers, Algeria, on September 15, 1968 and entered into force on June 16, 1969. The Convention stipulates that the contracting States shall undertake to adopt the measures necessary to ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interests of the people.

- *Convention Concerning the Protection of the World Cultural and Natural Heritage*

The Convention was adopted in Paris, France on October 17, 1972. The Convention sets aside areas of cultural and natural heritage for protection. It places obligations to each State Party to recognize that the duty of ensuring the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage situated on its territory, belongs primarily to that State.

- *Convention on the Conservation of Migratory Species of Wild Animals*

This Convention also known as the Bonn Convention was adopted in 1979 and entered into force in 1983. It stipulates actions for the conservation and management of migratory species including habitat conservation.

- *Vienna Convention for the Protection of the Ozone Layer*

The Vienna Convention was adopted in 1985 and entered into force on September 22, 1988. It places general obligations on countries to make appropriate measures to protect the environment against adverse effects resulting from human activities which tend to modify the ozone layer.

- *The Montreal Protocol on Substances that Deplete the Ozone Layer*

The Protocol was adopted on September 16, 1987 as an international treaty to eliminate ozone depleting chemicals production and consumption.

- *Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal*

The Convention was adopted on March 22, 1989 and entered into force on May, 1989. It focuses attention on the hazards of the generation and disposal of hazardous wastes. The Convention defines the wastes to be regulated and controlled in order to protect human and environmental health against their adverse effects.

- *The United Nations Convention on Biological Diversity*

The convention was adopted in 1994. The objectives of the Convention include the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

- *The United Nations Framework Convention on Climate Change*

The Convention on Climate Change was adopted in 1992 during the Rio Earth Summit in Rio De Janeiro, Brazil and entered into force in 1994 to limit Greenhouse Gas (GHG) emissions which cause global warming.

- *International Health Regulations (2005)*

The International Health Regulations (IHR) is an international legal instrument that is binding on 196 countries across the globe, including all the Member States of World Health Organisation (WHO). This binding instrument of international law entered into force on 15 June 2007. The purpose and scope is "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks and which avoid unnecessary interference with international traffic and trade".

- *Declaration of the United Nations Conference on Human Environment*

The principles of this Declaration relevant to the Project are summarized below:

Principle 2: The natural resources of the earth, including the air, water, land, flora and fauna especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate.

Principle 3: The capacity of the earth to produce vital renewable resources must be maintained and, wherever practicable, restored or improved.

Principle 4: Nature conservation, including wildlife, must receive importance in planning for economic development.

Principle 15: Planning must be applied to human settlements and urbanization with a view to avoiding adverse effects on the environment and obtaining maximum social, economic and environmental benefits for all.

Principle 18: Science and technology, as part of their contribution to economic and social development, must be applied to the identification, avoidance and control of environmental risks and the solution of environmental problems and for the common good of mankind.

- *International Labour Organisation (ILO): ILO-OSH 2001 - Guidelines on Occupational Safety and Health (OSH) Management Systems*

These guidelines call for coherent policies to protect workers from occupational hazards and risks while improving productivity. The guidelines present practical approaches and tools for assisting organizations, competent national institutions, employers, workers and other social partners in establishing, implementing and improving occupational safety and health management systems, with the aim of reducing work-related injuries, ill health, diseases, incidents and deaths.

At the organizational level, the guidelines encourage the integration of OSH management system elements as an important component of overall policy and management arrangements. Organizations, employers, owners, managerial staff, workers and their representatives are motivated in applying appropriate OSH management principles and methods to improve OSH performance. Nigeria ratified the guidelines in 2001.

- *International Labour Organisation (ILO) Conventions Treaties and Recommendations*

The International Labour Organization (ILO) is the United Nations (UN) agency that deals with labour issues, particularly international labour standards and decent work conditions for all. The agency formulates standards which are legal instruments that set out the basic principles and rights at work. They include conventions treaties and recommendations.

ILO has created a total of 190 conventions. Of these, eight are fundamental Conventions which are binding on all member countries. The other Conventions are only binding on member countries that have ratified them. The enforcement of conventions is vested on the jurisprudence of domestic courts as ILO does not take up this responsibility.

Nigeria has ratified a total of 40 ILO convections. These include: all 8 Fundamental Conventions, 2 of the 4 Governance Conventions and 30 of the 177 Technical Conventions. The full list of ILO conventions ratified and not ratified by Nigeria is provided in Appendix 3.

1.7 PASL's Health, Safety and Environment (HSE) Policy

PASL is committed to constructing and operating the Project in line with the local and international guidelines and standards on health and safety including the IFC requirements on Occupational Health and Safety as well as Community Health and Safety. This will be achieved through the following, amongst others:

- Identification and evaluation of all HSE hazards or aspects and the management of those risks to reduce their impacts to acceptable levels;
- Compliance with all applicable local and international applicable HSE legislations;
- Prevention of incidents, injuries, and pollution;
- Intolerance of the conditions and behaviour that contribute to incidents and injuries;
- Reduction of waste and conservation of resources; and
- Continual improvement of HSE performance.

1.8 EIA Report Structure

In line with the provisions of the FMEnv EIA Procedural Guidelines, the EIA report is structured as follows:

- Preliminary Sections: These include Table of Contents, List of Tables, Figures and Plates, and Executive Summary
- Chapter One: Introduction containing an overview of the Project, the EIA objectives and process and applicable legal framework.
- Chapter Two: Project Justification containing a rationale for the Project as well as the analysis of Project alternatives.
- Chapter Three: Project Description containing the technical elements of the Project.
- Chapter Four: Description of existing environmental conditions of the Project area.
- Chapter Five: This presents the potential and associated impact of the Project including impact assessment approach.
- Chapter Six: Mitigation measures for the identified significant impacts.
- Chapter Seven is the Environmental Management Plan for the Project.
- Chapter Eight: Decommissioning/Abandonment Plan presenting a decommissioning and remediation plan to be applied after the Project closure.
- Chapter Nine: presents the conclusions
- References
- Appendices

CHAPTER TWO:

PROJECT JUSTIFICATION

CHAPTER TWO

PROJECT JUSTIFICATION

This chapter presents the rationale for the proposed Project as well as the description of the Project alternatives.

2.1 Need for the Project

The erratic nature of power supply in Nigeria may not guarantee any meaningful industrial development and can also not lead the country to the realization of her vision of becoming one of the top 20 industrialized nations in the world by the year 2020, except progressive measures are taken. The current situation of the country's electricity supply remains a high risk factor in the nation's economic instability, since no commercial venture, manufacturing or international business could thrive well without stable power (electricity) supply.

In Nigeria, electricity generation and consumption is expected to grow due to the nation's pursuit of industrialization and development. In the quest to meet the urgent demand for electricity in the country, many Independent Power Plants that rely mostly on diesel or natural gas-fired turbines or generating engines are currently being established. The combustion of these fuels (natural gas and diesel) generates air emissions including greenhouse gases (GHGs) which can be significant. Alternative to this environmental issue is the use of a cleaner energy (renewable energy) source.

A reliable and cost-effective power supply is a key driver for a profitable and sustainable business. Katsina State is rapidly becoming industrialized as more companies are being established in the state. There is a great need for regular electricity supply so as to improve individual Company's operations and production which in turn will lead to an overall increase in the local economy.

The proposed Project is justified primarily on the basis of the need by the Nigerian Government to improve efficiency, reliability and sustainability of the electricity industry as well as generate electricity from clean energy in an environmentally sustainable manner.

2.2 Project Benefits

The potential benefits of the proposed Project include, amongst others:

- Use of renewable energy technology with minimal GHGs emissions.
- Stimulation of socio-economic activities thereby promoting industrial growth.

- Increased electricity generation to the national grid.
- Direct and indirect employment opportunities (local and regional).
- Acquisition of new skills through technology transfer.
- Increased local and regional economy through award of contracts for Project development.
- Revenue generation to Nigerian Government at Federal, State and Local levels through taxes

2.3 Value of the Project

The anticipated cost of the proposed Project is One Hundred and Seventy Million US Dollars ($ 170, 000,000.00). A significant amount of this fund will be injected into the local and regional economy through various contracts and sub-contracts. In addition, the Project has local and national economic values in terms of employment opportunities for various categories of Nigerian professionals, skilled and semi-skilled craftsmen, and technicians.

2.4 Envisaged Sustainability

2.4.1 Technical Sustainability Measures

The Solar Power Plant design, construction and operations shall be handled by properly trained and experienced personnel according to the pre-established standard methods and procedures. The geo-technical survey of the Project site has been conducted and the findings of the survey will inform the type of foundation work that will be selected for the Project.

Technical sustainability will be assured through adherence to high standards for construction/installation and operation, including safety. The design and construction of the proposed Project will be overseen by JCM and OST Energy. JCM has a strong solar development track record, with experience developing over 70 ground mount and rooftop solar projects and more than 400 MWp in Africa, Latin America and North America.

In addition, PASL will develop operating manuals and appropriate documentation regarding the proper operation and maintenance of the project facilities. These materials will be used as the basis for providing facility-specific training to relevant personnel prior to start-up to further ensure technical sustainability of the project.

2.4.2 Environmental Sustainability Measures

- The use of renewable source of energy for electricity generation rather than non-renewable energy sources such as oil/diesel or coal.

- All Project facilities shall be designed and constructed to keep environmental impacts at the minimum and acceptable levels.
- All operations shall be carried out to conform to all relevant international and national environmental regulations and standards.
- Handling, storage and disposal of wastes shall be in accordance with the regulatory requirements and the Company's relevant Standard Operating Procedures (SOPs).

2.4.3 Economic and Commercial Sustainability

- The design, construction and installation of the Project shall be funded by PASL with financial support from potential lenders.
- There are market opportunities for electricity that will be generated. The proposed PV power plant is expected to improve electric power availability at affordable price to industrial and domestic users.
- Revenue that would accrue from power sales would serve for the payment of staff and the procurement of maintenance materials and services.
- The Project will provide employment, support the local communities and the national economy as a whole.

2.4.4 Social Sustainability

A detailed Stakeholder consultation process has been executed throughout the EIA process to assist in ensuring that all stakeholders have had the opportunity to provide input into the Project planning process. This has also assisted in laying a good foundation for building relationships with the stakeholders.

PASL shall ensure that the stakeholder consultation process is sustained throughout the entire life cycle of the Project. This will also include periodic reporting to the potentially affected communities on the environmental performance of the Project.

In addition, the social sustainability of the Project will be achieved through continuous implementation of a Corporate Social Responsibility (CSR) Plan (refer to Chapter 7) which will be developed to fit the need of the Project's socio-economic environment.

2.5 Project Alternatives and Development Options

The analysis of alternatives and development options considered for the proposed Project is presented below:

2.5.1 Project Alternatives

2.5.1.1 Project Site Alternative

The preferred Project site for the PV Solar Plant is a plot of 120 ha of land located approximately 2.5 km from the town of Kankia in Katsina State, Northern Nigeria and lies approximately 3 km from the existing Kankia substation. The site is situated in a Government Reserved Area (GRA[5]) along Kankia-Ingawa road, in Kankia Local Government Area (LGA). Although the site is currently not enclosed, there are no residential buildings and farmlands on it.

The total land area (120 ha) was acquired from the Katsina State Government in two tranches of 50 ha and 70 ha. The land valuation document is presented in Appendix 4 to this report.

Factors which make this site advantageous include the following:

- Proximity to existing infrastructure (Kankia substation): The site is located less than 4km from the existing Kankia substation for power evacuation.
- Land use: The site would not require any physical or economic relocation or resettlement.
- Government-owned land: The project site was owned by the Katsina Government before rights were granted to PASL.
- Environmental condition: The portion of the site to be developed has no significant ecological constraints

Alternatives to the current Project site will include siting the proposed Project within the urbanized area in Katsina town or areas that are extensively known for agricultural use. This option is not considered viable since it is evidently more environmentally and socially vulnerable. Locating the Project in an urbanized area may result into significant physical resettlement as a result of land take. There are also the difficulties of obtaining private land from individuals. Therefore, the best option for the project siting is the Kankia area in the Kankia LGA, Katsina State as selected by the State Commission.

2.5.1.2 Technology Alternative

Solar power is rapidly gaining popularity throughout the world as the technology keeps on improving and the issues associated with GHGs and global warming are diverting attention away from fossil fuel generated power. Solar energy facilities operate by converting solar energy into a useful form (i.e. electricity). The use of solar energy for electricity generation is a non-consumptive use of a natural resource and consumes no fuel for continuing operation. Solar power produces an insignificant quantity of GHGs over its lifecycle as compared to conventional

[5] Government Reserved Areas (GRAs) are land areas owned by the Federal or State Government usually set aside for future development (for example, residential or industrial purpose). They are not technically synonymous to conservation or protected areas under IUCN categorization guidelines.

oil/coal-fired power stations. The operation phase of a solar facility does not produce carbon dioxide, sulfur dioxide, particulates, or any other type of air pollution, as do fossil fuel power generation technologies.

The solar technologies options considered for the proposed Project are:

- Concentrated Solar Power (CSP) Systems; and
- Photovoltaic (PV) Solar Panels

Concentrated Solar Power (CSP): CSP is a solar power generation system that relies on use of mirrors or lenses to concentrate a large area of sunlight or solar thermal energy onto a small surface. The concentrated radiation is then used as heat or heat source for a conventional power plant. CSP technology generates alternating current (AC) which can be easily distributed on the power network.

The three (3) main types of CSP systems are: linear concentrator, dish/engine, and power tower systems.

Linear concentrator systems collect the sun's energy using long rectangular, curved (U-shaped) mirrors. The mirrors are tilted toward the sun, focusing sunlight on tubes (or receivers) that run the length of the mirrors. The reflected sunlight heats a fluid flowing through the tubes. The hot fluid then is used to boil water in a boiler, the steam is then passed through a conventional steam-turbine generator to produce electricity. There are two major types of linear concentrator systems: parabolic trough systems, where receiver tubes are positioned along the focal line of each parabolic mirror; and linear Fresnel reflector systems, where one receiver tube is positioned above several mirrors to allow the mirrors greater mobility in tracking the sun.

A dish/engine system uses a mirrored dish similar to a very large satellite dish, although to minimize costs, the mirrored dish is usually composed of many smaller flat mirrors formed into a dish shape. The dish-shaped surface directs and concentrates sunlight onto a thermal receiver, which absorbs and collects the heat and transfers it to the engine generator. The most common type of heat engine used today in dish/engine systems is the Stirling engine. This system uses the fluid heated by the receiver to move pistons and create mechanical power. The mechanical power is then used to run a generator or alternator to produce electricity.

A power tower system uses a large field of flat, sun-tracking mirrors known as heliostats to focus and concentrate sunlight onto a receiver on the top of a tower. A heat-transfer fluid heated in the receiver is used to generate steam, which, in turn, is used in a conventional turbine generator to produce electricity. Some power towers use water/steam as the heat-transfer fluid.

Photovoltaic (PV) Solar Panels: Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed a number of cells containing a photovoltaic material. Materials presently used for photovoltaic include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium selenide/sulfide.

Photovoltaic is the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. PV technology is made as system designed to capture electron released by an array semiconductors that exhibit photovoltaic effect on exposure to light. PV systems generate DC which is then converted to AC, usually with the use of inverters, in order to be distributed on the power network.

It is widely believed that two factors have contributed the most for the dominance of PV over CSP. These factors are:

- **Market size:** PV can be installed almost everywhere but CSP cannot. Current commercial CSP technology needs higher levels of irradiance, access to water (just like a coal plant) and large-scale deployments (typically more than 20 MW, compared with the few kW of a residential PV system).

- **Technological simplicity:** A PV system is like a quartz watch, whereas a CSP system is like a mechanical watch. The former revolves around the solar cell, while the latter is a combination of equally critical components.

Table 2.1 shows the comparison between CPS and PV Solar Technologies.

Table 2.1: Comparison between CSP and PV Solar Technology

Features	CSP Technology	PV Technology
Description	CSP technology uses concentrated radiation from the sun, to heat a liquid substance which is used to generate steam which in turn passes through a steam-turbine to generate electricity. CSP Technology produces electricity through indirect means. Energy output with CSP technology is of AC type.	PV technology uses sunlight through the 'photovoltaic effect' to generate direct electric current (DC). PV Technology produces electricity through direct means. Energy output with PV technology is of DC type but commonly converted to AC through an inverter.
Applications/Scale	CSP is used for utility scale power generation, mostly for Grid Connections, and also supporting	PV technology is suitable for off grid small and medium-sized

Features	CSP Technology	PV Technology
	conventional thermal power and desalination plants.	applications, and for utility scale applications
Land requirement	CSP technology is best suited for areas of high direct normal solar radiation. CSP technology requires about 5 to 10 acres of land per MW of capacity	PV technology has a wider geographical area of application.
Cost	CSP technology has an high installation and maintenance cost in comparison to PV	PV technology has a low installation and maintenance cost in comparison to CSP
Construction Time	CSP plant construction is technical more complex than PV	Utility scale PV plants are easier to install and require less time than CSP for Plant construction
Water Requirement	Water requirement is variable depending on the CSP technology option adopted. CSP may utilize wet, dry, and hybrid cooling techniques	Typically requires less water than CSP technology. Water is required for cleaning of dust from the panels.
Design Options	Less flexible in comparison to PV technology Can be hybridized with fossil fuels like natural gas.	Highly flexible and adaptable to the project specific requirement
Life Span	> 20 years	> 20 years
Efficiency	Power production efficiency of CSP technology are as high as 45%	Power production fluctuates with the sunlight's intensity. For practical use this usually requires conversion to certain desired voltages or alternating current (AC), through the use of inverters.
Power storage	CSP systems are capable of storing energy by use of Thermal Energy Storage technologies (TES) for use at night or during low irradiation	Batteries are required to provide backup power storage
Environmental Risks	CSP systems have been recorded to pose environmental risks to bird species, which may be killed by the intense heat generated by the concentrated solar radiation which is reflected off the mirrors	PV systems are considered to be generally benign.

The preferred option for the proposed Project is PV technology (consisting of PV cell and PV module or panel) since it does not require liquid substance to operate which could lead to significant process wastewater generation. In addition, the PV technology is highly flexible and requires low installation and maintenance cost in comparison to CSP technology.

PV cells are commonly constructed from mono or poly crystalline (using Silicon) or thin film technology. All PV cells produce direct current (DC). The PV cells that are being considered for the Project are thin film solar cells technology or poly crystalline (due to environmental performance and cost benefits) with emphasis on thin film.

Thin-film solar cells technology consists of depositing one or several thin layers of photovoltaic semi-conductor material (such as cadmium telluride, amorphous silicon, and copper indium gallium selenide) onto a low cost substrate such as glass, stainless steel or plastics. This technology results in lower production costs compared to the more material intensive crystalline technology.

The comparison between Crystalline and Thin film technologies is provided in Table 2.2 below.

Table 2.2: Comparison between Crystalline and Thin film Technologies

Features	Crystalline Technology	Thin Film Technology
Description	Crystalline silicon (c-Si) PV systems are made from slices (wafers) of high purity silicon. Silicon wafers go through a number of processes to be made into cells; these are assembled into modules and electrically connected and encapsulated to form a module. (c-Si) technology includes two major variants: i) mono crystalline silicon (mono -c-Si) ii) multi-crystalline silicon (multi-c-Si) c-Si PV is the oldest and currently most dominant dominant PV technology having up to 85% of the PV market share	Thin films (TF) PV cells are made from the deposition of thin layers of semiconducting material onto inexpensive, large-size substrates such as glass, polymer or metal. TF technology includes three variants: i) amorphous (a-Si) and micromorph silicon (a-Si/μc-Si), ii) Cadmium-Telluride (CdTe), and iii)Copper-Indium-Diselenide (CIS) and Copper-Indium-Gallium-Diselenide (CIGS) Currently account for 10% to 15% of global PV market.
Cost	Approximately $0.6/Wp	Comparable to (c-Si)
Land requirement	Requires less land area than (TF) to produce equal amount of electricity due to the inherent higher efficiency of the technology.	Requires more land area to produce equal amount of electricity due to the its lower efficiency when compared with (c-Si)
Performance	(c-Si) PV suffer a slight loss in efficiency in high temperature operating conditions	(TF) PV produces better performance at high ambient temperature, and reduced sensitivity to overheating.
Appearance and Design Options	(c-Si) PV modules have 60 or 72 distinct, dark-colored cells that are predominantly rectangular in shape and an aluminium frame;	(TF) PV improved appearance, are usually frameless and flexible and can easily adapt to different surfaces building integration
Life span	(c-Si) PV has a proven life span of over 25 years. Backed up by manufacturers' warranties; 10 years workmanship, 25 years 80% maximum power output.	Limited experience with lifetime performances. Similar manufacturers' warranties to (c-Si).
Efficiency	(c-Si) PV modules, however, have efficiencies in the range of 13-19% with more than a 25-year lifetime.	(TF) PV modules offer lower efficiency (6-12) % when compared to (c-Si) PV technology.

2.5.1.3 Transmission Route Alternatives

PASL considered various transmission routes for the evacuation of power (electricity) planned to be generated from the proposed Project. A number of these routes seem not to be the preferred options due to the presence of existing communities along the right of way. Using these routes will result into community resettlement with attendant social and economic implications. Thus, a route that will not involve the resettlement of people (with minimal social impact) was chosen as the preferred route for the proposed Project (Figure 2.1).

A detailed transmission line route survey was undertaken by Pengate Global Services Limited, a registered survey and geo-informatics consultant based in Abuja, Nigeria. With guidance from the Kaduna State Government, a detailed route survey was performed from the proposed Project site to the suggested connection point at Kankia substation. The total length of the detailed route survey is 3.66 km and the route avoids settlements and other sensitive receptors such as schools and markets. The detailed route survey followed the existing 132 kV single circuit transmission line from Kano to Katsina.

The transmission corridor will ultimately be owned by Transmission Company of Nigeria (TCN). The proposed line route and ultimately the corridor/right of way (ROW) for transmission pylons are currently passing through vacant private land owned by some individuals in Gachi community. The list of the landowners has been compiled and the Katsina State Government is working with PASL and the landowners to obtain the necessary rights to pass through the relevant land properties with overhead lines. A detailed Land Acquisition Plan for the transmission right of way will be developed. No settlements are envisaged to be relocated along the proposed route.

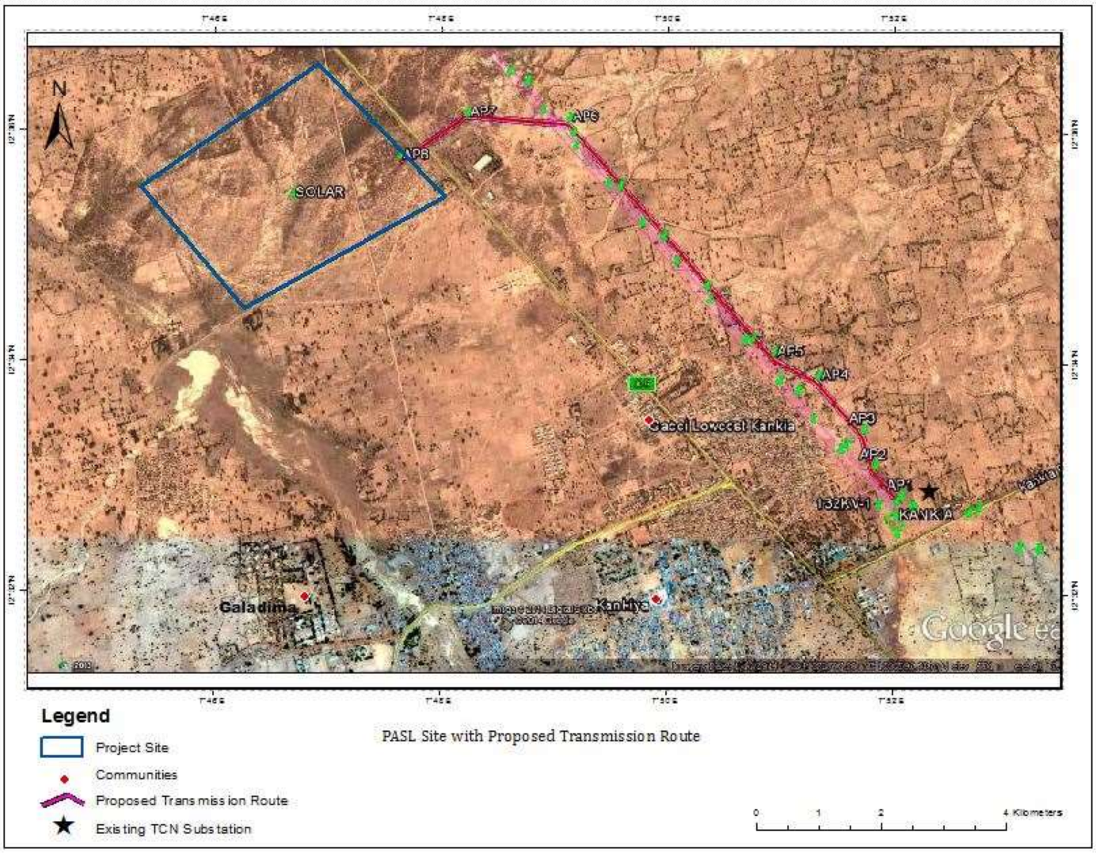

Figure 2.1: Map of the Preferred Transmission Line Route for the proposed Project

2.5.1.4 <u>Alternative Energy Source</u>

The analysis of alternative energy sources considered for the proposed Project with reference to the Nigeria situation is provided in the following paragraphs:

- **Coal Powered Generating Power Plant**

With regard to coal-fired generating power, there are few reliable projections of the potential capacity that could be (economically) extracted from this fuel source. Having reached a peak of just 730,183 tons per annum in 1965, the country's coal production declined. By the early 1990s, coal production had declined to less than 100,000 tons per annum. In 2001, coal-fired power contributed about 0.02% to the commercial energy consumption in Nigeria (Sambo, 2008). In 2005, the proven coal reserves were estimated at about 639 million tons while the inferred reserves are about 2.75 billion tons. For several years, the Federal Bureau of Public Enterprises has been trying to privatize some of the coal mines owned by the Nigerian Coal Corporation; but it appears to have met with little success (Azura EIA 2013). This has thus resulted in limited production and utilization of coal in Nigeria.

The option of using coal as source of energy for the proposed Project is considered not feasible because of the following:

- There is generation of waste bottom and fly ash which would require a large area for storage on site.
- Considering environmental implications; a coal fired power plant is significantly known for emitting air pollutants especially Sulphur (IV) Oxide and Carbon monoxide.

This alternative is therefore not preferred as viable energy source for the proposed Project.

❖ **Oil Powered Energy Plant**

In 2005, Nigeria's crude oil reserves stood at 36.5 billion barrels with projected proven reserves to reach 68 billion barrels by year 2030 (Sambo, 2008). The substantial growth in oil reserves over the years was as a result of improved funding of Joint Venture operations, the emergence of new production sharing arrangements and the opening up of offshore blocks. Nigeria's rate of oil production averaged 2.4 million barrels per day (mb/d) in 2005 with the daily production expected to increase to over 5.0 million per day by 2030. The expected life-span of Nigerian crude oil is about 44 years, based on a production rate of 2mb/d (Sambo, 2008). A high potential production rate can only be achieved with the adoption of high exploration strategic development policies and programs.

In 2008, domestic utilization of oil averaged at 450,000 barrels per day (Sambo, 2008). The capacity of the petrochemical and fertilizer plants established by the Federal Government has dropped significantly due to poor maintenance and operating conditions. Consequently, the annual domestic demand for petroleum products is not fully met by internal production and is supplemented by imports (Sambo, 2008) which would also impact the power output because of some unforeseen delay in getting the imported products.

The oil-fired power scenario is considered to be less financially and environmentally feasible to realize the aims of the proposed Project due to the need for a steady supply of oil resources and because air emissions from the oil-fired station are significantly higher than the gas-fired station as they are regarded as the highest emitters of GHGs.

❖ **Natural Gas-fired Power Plant**

Approximately 75% of the gas produced from oil exploration and production activities has been flared historically. Gas flaring was reduced by 36% due to government flaring policies (Sambo, 2008). Nigeria's proven natural gas reserves, estimated at about 187.44 trillion standard cubic feet (tscf) in 2005, are considered to be significantly larger than its oil reserves in energy terms.

Natural gas is used primarily for power generation which accounted for over 80% of its use in 2005. The expected life-span of natural gas reserves is about 88 years, based on the 2005 production rate of 5.84 billion standard cubic feet per day (bscf/d) (Sambo, 2008).

Although, natural-gas powered plants generate lesser air emissions when compared with oil-powered plant, they also contribute to GHGs emissions. The natural gas-fired power plants could also lead to significant wastewater generation. This alternative is therefore not considered viable to the realization of the economic and environmental goal of the proposed Project.

- **Wind Energy Plant**

A wind power plant operates by wind energy turning a rotary blade, which powers a turbine to generate electricity. According to Nigeria's Renewable Energy Masterplan (REM) (2006) identifies short, medium and long-term targets for renewable energy contribution to power generation. The target for wind power is 1 MW, 20 MW and 40 MW for the short, medium and long-term respectively. Based on these targets, wind power is not considered to be an energy source alternative that could realize the envisaged generation capacity of the proposed Project. Also, the potential for wind energy generation is highly dependent on long term wind monitoring to be undertaken prior to planning the project.

- **Wave Generation Power Plant**

There is an investigation on the potential for wave generation. The wave power technology is however in its infancy globally and may require a number of years before this technology is suitable for deployment. This alternative energy source is therefore considered not feasible for the proposed Project.

- **Solar Energy**

Solar energy systems produce energy by converting solar irradiation into electricity or heat. Photovoltaic (PV) facilities use PV panels comprising many individual PV cells which absorb solar energy.

Katsina State is regarded as one of the places in Nigeria with high intensity of sunlight. The Katsina State Government has great interest in generation of power through sunlight (solar). The report of long term solar resources assessment of the project area in Katsina State is provided in Appendix 5. Solar energy is an important source of renewable energy. The first and foremost advantage of solar energy is that, beyond panel production, it does not emit any GHGs. Solar power generation is currently one of the fastest growing areas in renewable energy. Solar photovoltaic (PV) technology is well proven and solar panel manufacturers now provide 20 to 25 year production warranties with the panels themselves typically lasting up to 35 years.

Compared to alternative renewable generation technologies such as wind turbines or biofuel generators, solar energy is produced by conducting the sun's radiation – a process void of any smoke, gas, or other chemical by-product. This is the main driving force behind all green energy technology, as nations attempt to meet climate change obligations in curbing emissions. The market opportunity for this technology in Nigeria is also attracting investors.

Solar energy source is considered to meet the objectives of this Project which also informed the location of the Project in Katsina State, the Northwest region of the country.

In summary, coal-fired power, oil and natural gas technology are technically feasible but they are associated with high emission levels that could significantly contribute to global warming effect due to the emission of GHGs compared to the use of sources of renewable energy. Sunlight is considered as the preferred energy source for the proposed Project as a result of its minimal environmental impact especially during operations.

2.5.2 Development Options

2.5.2.1 No Project Option

The no project option implies that the proposed Project will not be executed. This option though is environmentally favourable, but economically unviable, as no economic returns shall accrue to Nigeria Government and the proponent, yet substantial amount of money had already been spent on the feasibility, planning and logistics for the Project.

Choosing the no project option will mean a loss of preliminary investments made by the proponent on the Project. It will also mean that potential benefits to the Federal Government, Katsina State Government and the associated potential employment opportunities will be lost.

In addition, such a decision will not be in accordance with the Federal Government's initiatives to boost energy supply in Nigeria and achieve its target of generating adequate electricity to enhance economic and social status of its citizenry. These and other related issues make it impossible to adopt the no project option.

2.5.2.2 Delayed Project Option

This option implies that the planned Project will be delayed until a much later date. Such option is usually taken when conditions are unfavourable to project implementation such as in war situation, or where the host communities are deeply resentful of the Project. Also, if the prevailing economic climate is not quite favourable to the Project, then delayed project option may be feasible. But none of these conditions is applicable.

Indeed, both the economic and the political environments are most favourably disposed towards the Project. The implication of delayed project option will mean that all the preliminary work and associated efforts/costs incurred would have come to nothing. Also, because of inflationary trends, such a delay may result in unanticipated increase in project costs, which may affect the final profit accruable from the Project. The delayed option is considered unviable for the Project.

2.5.2.3 With the Project Option (Go ahead option)

The inherent benefits of allowing the Project to go ahead as planned (using Solar PV technology) are multifarious both to the proponent and the Nigeria populace. Job opportunities for Nigerian professionals, skilled and semi-skilled craftsmen will increase. The proposed Project will generate additional 80 MWp to the national grid via a renewable energy source with minimal environmental footprint especially during operations.

Thus, given the above mentioned considerations, the preferred option - construction of the proposed Project with efficient technology, cost minimization and environmental friendliness - is considered the optimal one. The option to go ahead as planned does outweigh the other options of no project and delay as clearly highlighted above.

CHAPTER THREE:

PROJECT DESCRIPTION

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Introduction

This chapter presents a description of the proposed Photovoltaic (PV) Solar Power Plant Project, in terms of the following:

- Project overview
- Site description
- PV technology
- Solar project components
- Project development phases
- Water consumption
- Workforce and job opportunities
- Health and safety
- Site security
- Associated waste streams
- Project schedule

3.2 Project Overview

PASL proposes to construct, install and operate a PV Power Plant in Kankia, Kankia Local Government Area (LGA) of Katsina State. The proposed total capacity of the Project is 80 MWp. The Project will be a ground mounted solar PV module using crystalline silicon, or thin film PV technology on a fixed tilt mounting structure.

The Project is planned to be built in 2 phases. Phase 1 will have a capacity of approximately 34 MWp and Phase 2 is approximately 46 MWp. Construction of Phase 1 is planned to commence in Quarter 1 (Q1) 2016 and be in full operations in Q3 2016. Phase 2 is anticipated to be operational a year later (2017).

Electricity generated from the Project will be evacuated via high voltage power (transmission) lines to the nearby existing Kankia substation (situated approximately 3.66 km from the Project site) for transmission and distribution via the national network. PASL is in the process of signing a contract agreement with the Nigerian Bulk Electricity Trading (NBET). NBET is a Federal Government of Nigeria owned public liability company involves in the purchase and resale of electrical power and ancillary services from independent power producers.

Table 3.1 provides an overview of the Project.

Table 3.1: Project Overview

S/N	Item	Detail
1.	Project Name	PASL Katsina PV Plant
2.	Plant Location	Kankia, Katsina State
3.	Size of the Project Site	Approx. 120 hectares
4.	Plant capacity (MWp)	80
5.	Grid operator	Transmission Company of Nigeria
6.	Envisaged commencement date	Q1 2016
7.	Proposed Engineering, Procurement and Construction (EPC) contractor	To be confirmed. Bidding process is on-going.
7.	Project Life Span (average)	25 years

3.2.1 Site Description

The Project will be located on a plot of 120 ha land situated approximately 2.5km from Kankia town in Katsina State. Katsina State is bordered to the south by Kaduna State, to the east by Jigawa and Kano States, and to the west by Zamfara State.

The Project site has a rectangular shape and lies between Latitude 12^{o} 33' 40" N and 12^{o} 34' 30" N and Longitude 7^{o} 48' 30" E and 7^{o} 49' 20" E. It is situated in a Government Reserved Area (GRA) along Katsina-Kano Road, in Kankia LGA. The Kankia LGA is one of 34 LGAs in Katsina State, and is bordered to the Matazu and Musawa LGAs to the south, the Dutsin-Ma and Charanchi LGAs to the west, Kusada LGA to the east and Bindawa LGA to the north.

In addition to Kankia community, there are four (4) additional communities within a 5 km radius of the Project site (Figure 3.1) namely; Gachi, Kafin Dangi, Kauyan Maina, and Galadima. The distance and orientation of these communities to the Project site is as follows:

- Kafin Dangi (3.74 km north east),
- Kauyan Maina (2.98 km east),
- Galadima (1 km south west),
- Gachi (2.32 km south east), and
- Kankia (2.46 km south).

The Project site is characterized by shrubs, grasses and herbs. No farmlands or wetlands (spawning sites) are present within the Project site. The near-surface ground of the Project site is formed of compacted fine-grained sediments, such as clays and silts (Figure 3.2). The cross-sections of the Project site are shown in Plates 3.1 and 3.2. Currently the site is not enclosed/fenced. Site fencing will form part of construction activities.

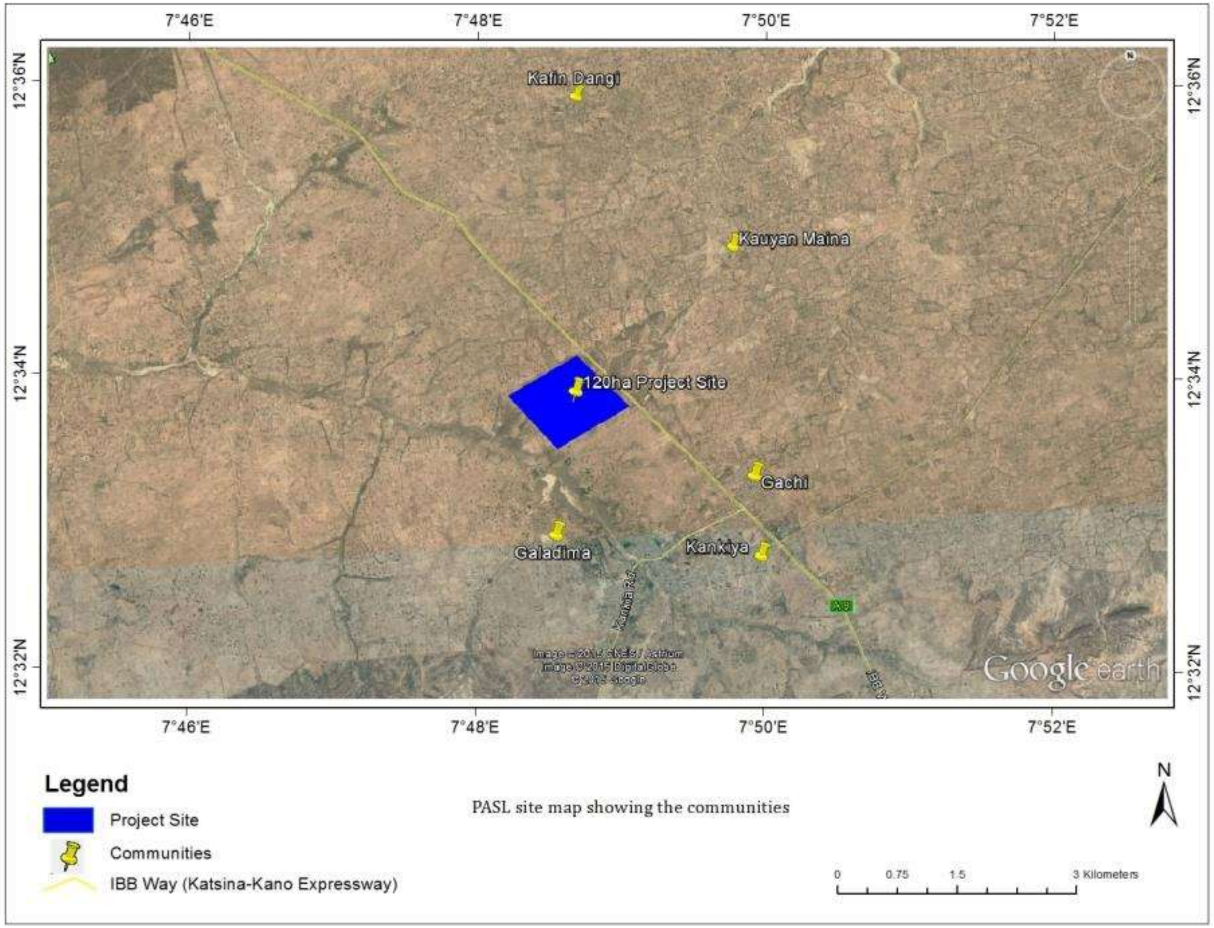

Figure 3.1: Identified communities within 5 km radius of the Project Site

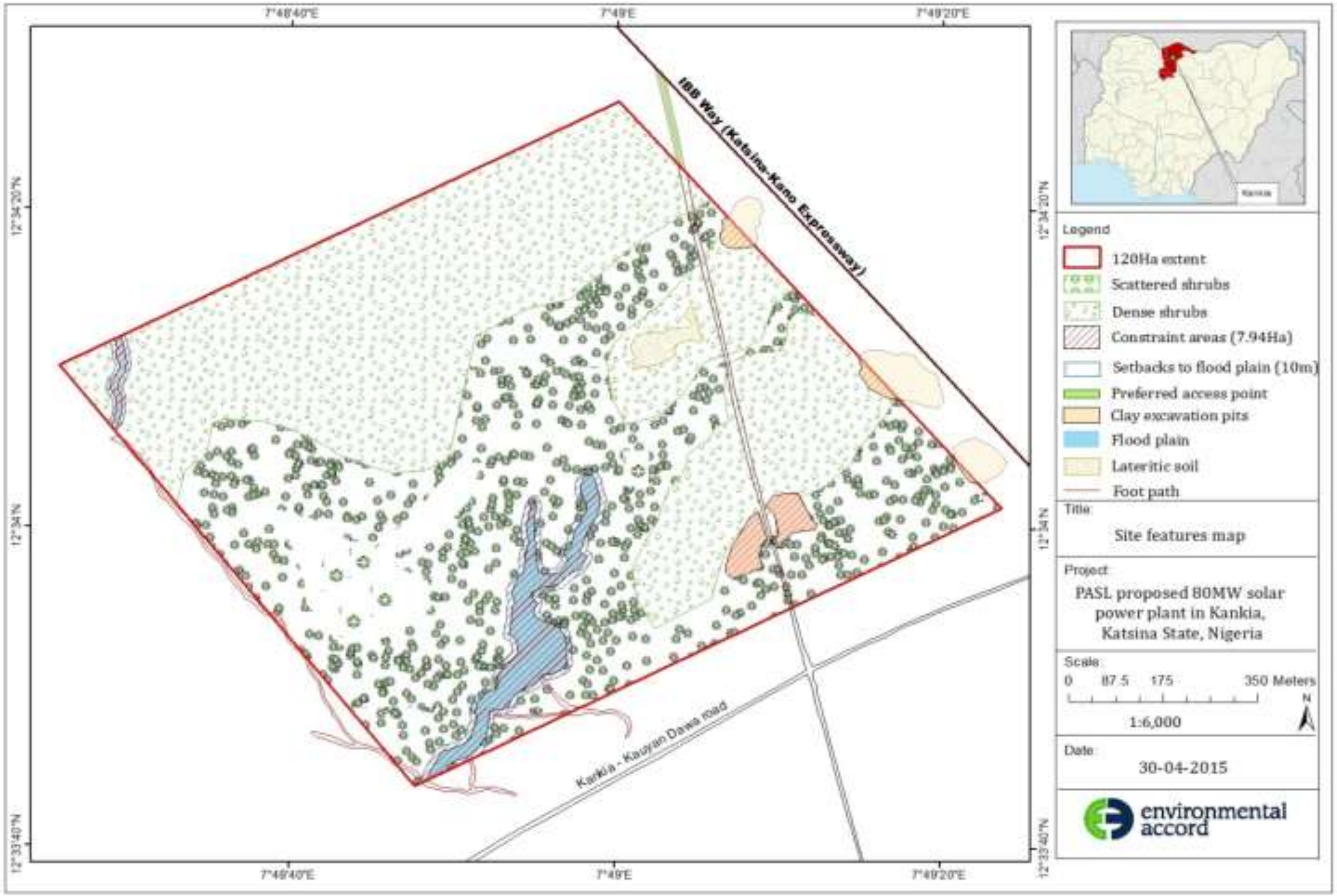

Figure 3.2: Project site features map

Plate 3.1: A cross-section of the proposed Project site

Plate 3.2: An existing untarred road that traverses the Project site

3.3 PV Module Technology

Solar energy systems produce energy by converting solar irradiation into electricity or heat. The proposed Project will utilize photovoltaic (PV) technology to generate electricity.

PV technology consists of the following basic components:

- **PV Cell**: It is a basic photovoltaic device, which generates electricity when exposed to solar radiation due to the photo-electric effect. The absorbed solar energy excites electrons inside the cells into a higher state of energy, producing electrical energy. PV cells are commonly constructed from mono or polycrystalline silicon or thin film technology. Each of these is discussed in detail in the sub-sections below. All photovoltaic cells produce direct current (DC).

- **PV module or panel**: This is the smallest common assembly of interconnected PV cells sold commercially. In the case of crystalline silicon cells, following testing and sorting to match the current and voltage, the cells are interconnected in series and encapsulated between a transparent, anti-reflective front, and a backing material to provide environmental protection to the cells. The module is then typically mounted in an aluminium frame to provide mechanical strength to the assembly.

3.3.1 Mono-crystalline Silicon

Mono-crystalline silicon (mono-Si) PV cells are made out of cylindrical silicon ingots. These are cylindrical in shape due to the '*Czochralski Process*'. This is a method of crystal growth, which involves melting silicon in a crucible before a rod-mounted seed crystal is dipped into the molten silicon. This is then slowly withdrawn, whilst being rotated, forming a large single-crystal cylindrical ingot, up to 2 m in length.

In order to optimize performance and lower the cost of a single mono-crystalline cell, four sides are cut out of the cylindrical ingot, which is then sliced into wafers. This gives mono-crystalline solar panels their characteristic appearance (Figure 3.3).

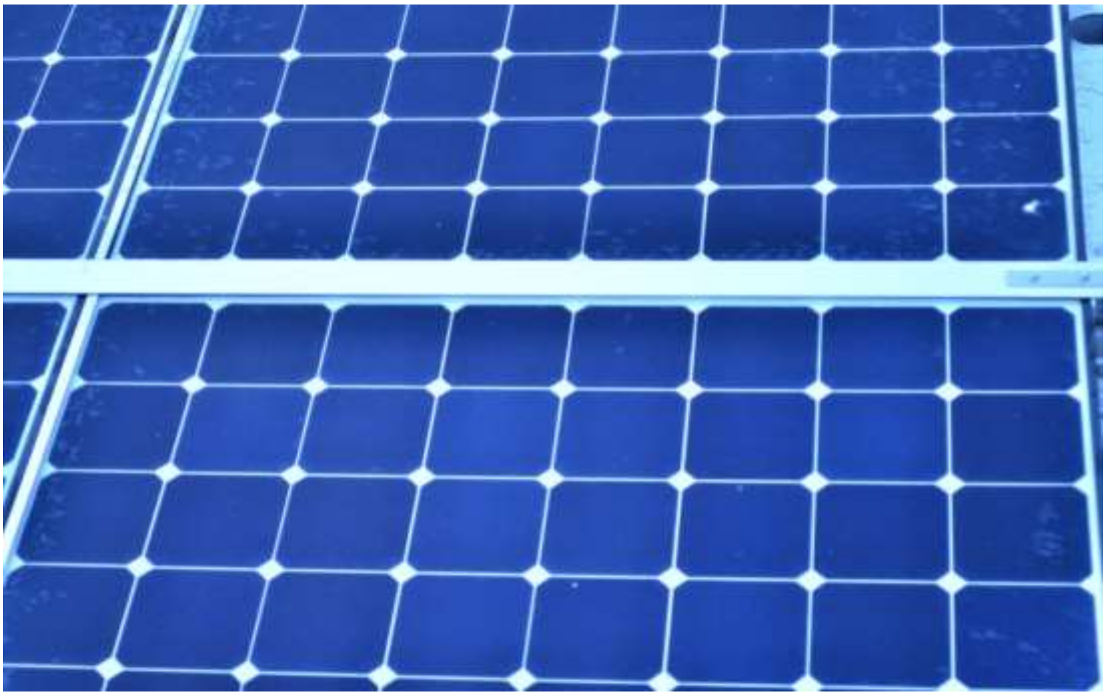

Figure 3.3: Typical appearance of mono-crystalline silicon PV arrays
Source: OST Energy 2015

Mono-crystalline PV panels tend to have higher efficiency ratings than poly-crystalline PV panels. However, as the wafer edges require cutting they have approximately the same level of operating power density as polycrystalline PV modules (discussed below). They are considered to operate slightly better than polycrystalline solar PV modules in warmer temperatures, but are also slightly more expensive to produce.

3.3.2 Poly-Crystalline Silicon

Panels based on polycrystalline silicon, also known as poly-silicon (poly-Si) or multi-crystalline, have been in the market since 1981, in which time the technology has been developed and improved. Raw silicon is melted and poured into square moulds, which are cooled and then cut into square wafers. This process is simpler and cheaper compared to mono-Si PV cell production. Although the poly-Si has a slightly lower efficiency, the modules generally have similar operating power density as mono-Si modules since the wafers are truly square and can be packed together in a module with less wasted space.

Poly-Si modules are recognizable due to their light or dark-blue colouring, which may vary across the module (Figure 3.4). However, non-reflective coating means that less light is reflected and the panels themselves appear less varied in appearance. The front glass of each PV module will be low-iron glass that will have anti-reflective coating, while the back cover will be tedlar; each panel is placed in anodized aluminium alloy frame.

Poly-Si cells tend to be slightly more sensitive to higher temperatures than mono-Si. However, their lower pricing in comparison to mono-Si modules and higher efficiency in comparison to thin-film technology makes them by far the most commonly used solar module technology in the market today.

Figure 3.4: Typical Appearance of Polycrystalline Silicon PV Arrays
Source: OST Energy 2015

3.3.3 Thin Film

Thin-film solar cell (TFSC) technology consists of depositing one or several thin layers of a photovoltaic semiconductor material onto a substrate. TFSCs can be categorized based on the photovoltaic material used in its production, as follows:

- Cadmium telluride (CdTe)
- Amorphous silicon (a-Si)
- Copper indium gallium selenide (CIS/CIGS)
- Organic photovoltaic cells (OPC).

Of these types, the most commonly used TFSC material is CdTe with over 10 GW of CdTe installed to date. CdTe modules utilise a thin layer of semi-conductor in thin-film fixed between front and back glass layers (Figure 3.5).

Cadmium and Tellurium are both rare-earth materials of limited abundance. The CdTe layer is typically 1-3 microns thick and fixed between layers of thick glass, with no vapour or other hazardous products being produced by the solar PV module during its lifecycle. It should be noted that the principal manufacturer of

TFSC CdTe panels takes back panels for recycling at the end of their life span or if damaged.

Figure 3.5: Typical appearance of Thin-Film CdTe Arrays
Source: OST Energy (First Solar) 2015

Due to difference in physical properties CdTe TFSC performs slightly better than crystalline silicon PV technologies when subjected to higher temperatures and shading impacts. However CdTe and most other commercially available TFSC modules have a lower efficiency than poly-Si and mono-Si modules currently on the market. This lower efficiency means that the costs of associated equipment and infrastructure will also increase (e.g. support structures, cables etc.). Also, the TFSCs tend to degrade more quickly than mono and polycrystalline modules. TFSC modules use a continuous layer of PV material which results in a more homogenous appearance than mono-Si and poly-Si modules.

3.4 Solar Project Components

As earlier stated, PV panels convert sunlight to direct current (DC) power. The panels are connected together to form arrays, which in turn are connected to inverters to convert the DC power to alternating current (AC) power. The voltage of the power is stepped up by a transformer to the required voltage of the nearby electricity grid. The electricity is then fed from the site to the closest grid substation for distribution into the wider electricity grid. Figure 3.6 provides a general technical overview for a solar project and its key components.

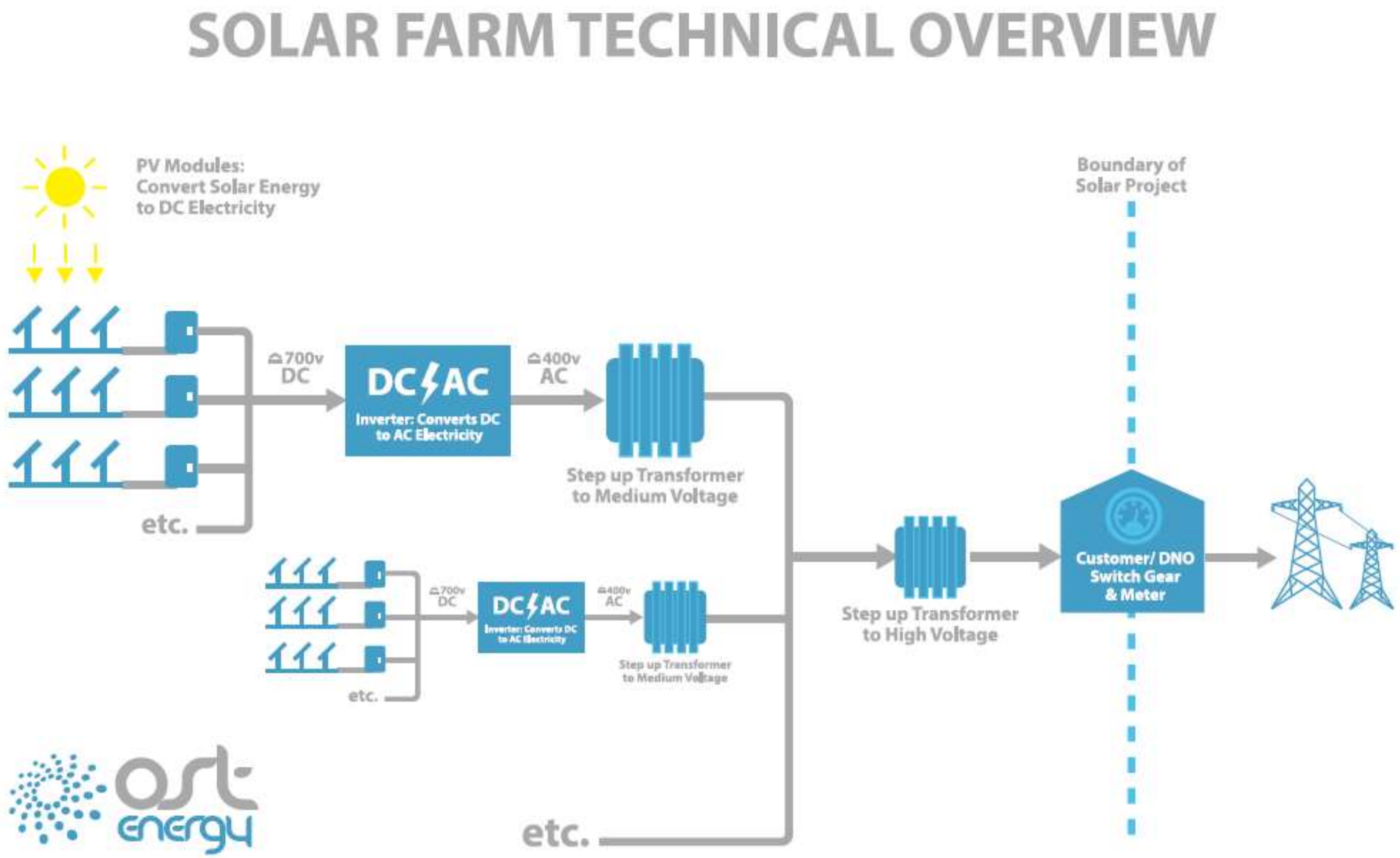

Figure 3.6: Solar Farm Technical Overview
Source: OST Energy 2015

The key components associated with a PV power plant are as follows:

- PV modules
- Mounting structures (and tracking motors where applicable)
- Cabling
- DC-AC current inverters
- Transformers
- Medium Voltage (MV) & High Voltage (HV) Switchgear
- Electrical connection cabin
- Supervisory Control and Data Acquisition (SCADA) System
- Transmission to grid
- Associated infrastructure and utilities, including:
  - Site security, including fencing and CCTV
  - Buildings, including onsite substation, connection building, control building, guard cabin, and spare parts storage.
  - Access road and internal road network
  - Stormwater infrastructure and drainage system
  - Water supply infrastructure

It is anticipated that the proposed Project will have a generation capacity of 80 MWp, exporting around 150 MWh of electricity into the national grid per year.

It is typical for a single Engineering, Procurement and Construction (EPC) Contractor to undertake the majority of the design, construction and management responsibilities for projects of this type. The detailed technical design of the Project will be finalised once the EPC contract has been awarded.

OST Energy, an organization that is currently providing technical support to JCM Capital on the proposed Project, has undertaken initial layout designs for both poly-Si and TFSC modules, to provide an indication of the land area, coverage and generation capacity of each of these technologies. The layout designs are presented below in Figures 3.7 and 3.8.

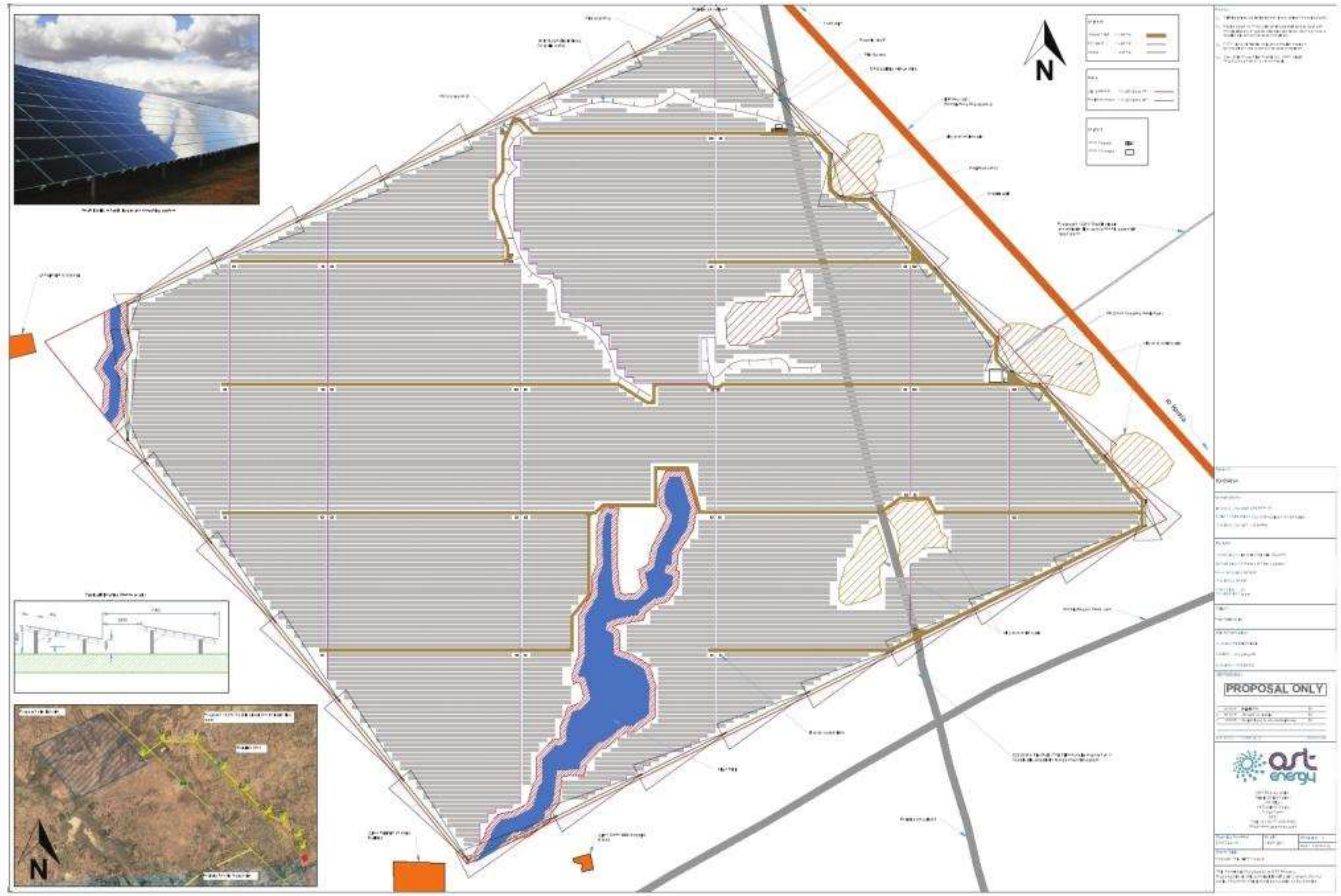

Figure 3.7: Proposed Polycrystalline PV Layout
Source: OST Energy (First Solar) 2015

Figure 3.8: Proposed Thin Film PV Layout **Source: OST Energy (First Solar) 2015**

3.4.1 PV Modules, Tables and Mounting Structure

The PV modules being considered for the proposed Project are either polycrystalline silicon or thin film. It is however very likely that thin-film PV module will be used due to its inherent advantages over the polycrystalline silicon module. This will be clarified after further study on the comparative yield of the technologies is carried out. The PV modules will be on a fixed mounting structure.

For this purpose of this study, the description presented herein covers the thin film and the polycrystalline PV modules.

The PV panels typically have the following dimensions:

- Polycrystalline: 2 m x 1 m by 50 mm thick, with each panel producing a maximum output of around 300 Wp.
- Thin Film: 1.2 m x 0.6 m by 6.8 mm thick; with each panel producing a maximum output of around 100 Wp.

The PV panels are connected and arranged into a series of ‘tables’. Typical tables for poly-Si and TFSC would be as follows:

- Poly-Si: 4 modules high (in landscape) by 19 wide, giving 76 modules per table.
- TFSC: 8 modules high (in landscape) by 10 wide, giving 80 modules per table.

The tables supporting structures will be piled to a typical depth of around 1.5 – 2 m into the ground. Figures 3.9 and 3.10 show the row spacing for polycrystalline and thin film modules respectively.

The total area to be developed for the solar project will cover 120 ha. The panels will be arranged in rows extending across the site facing due south. The collective term for a series of PV panels in rows is sometimes referred to as PV array.

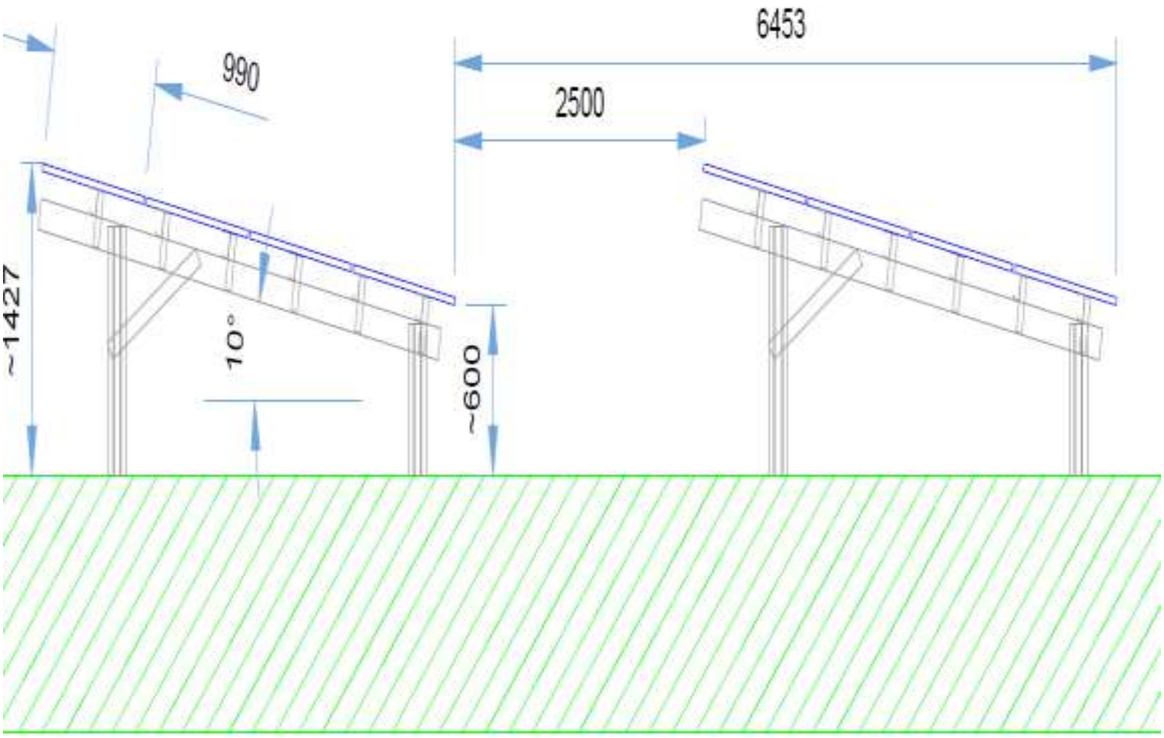

Figure 3.9: Row Spacing for Polycrystalline PV (in mm)

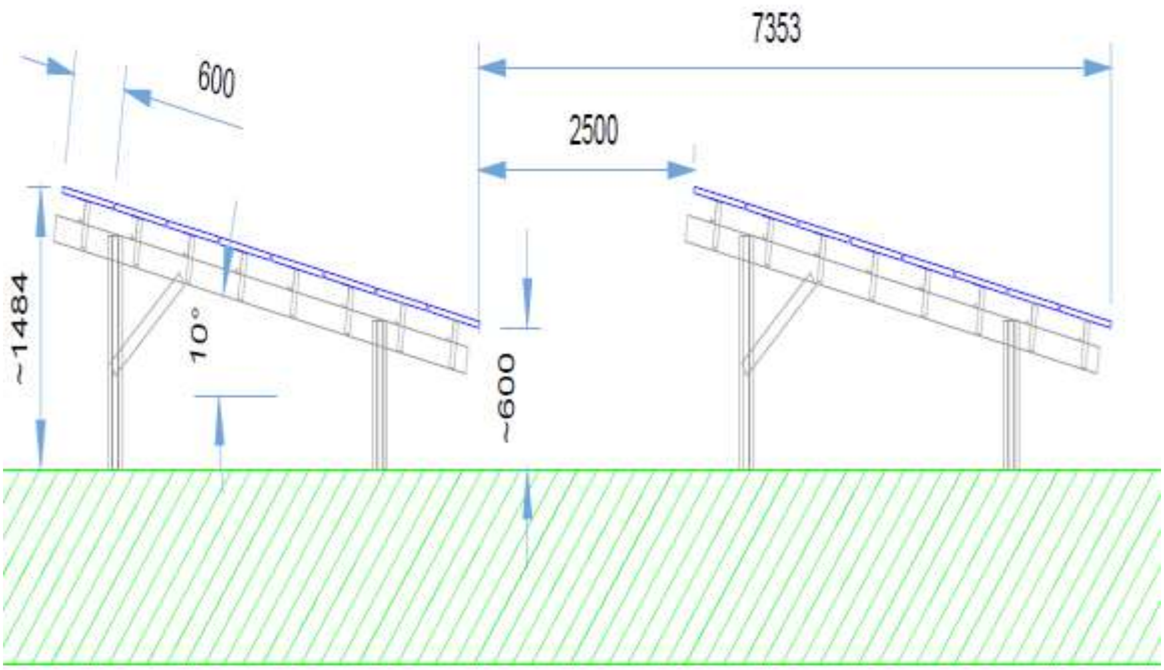

Figure 3.10: Row Spacing for Thin Film PV (in mm)

3.4.2 Cabling and Combiner boxes

The PV arrays will be connected via cables that run either under the PV arrays or underground (at a depth of approximately 1m) to combiner boxes. Combiner boxes combine the power generated by multiple arrays to larger cabling in order to transmit the power more efficiently to the Medium Voltage Power Units. The inverter/transformer enclosures convert the direct current (DC) produced by the PV panels to alternating current (AC).

3.4.3 Medium Voltage (MV) Power Units

The Project will comprise a series of Medium Voltage (MV) Power units. Each MV power unit will have dimension of 6 m x 2.6 m by 2.4 m high and consist of the following components:

- 2 x inverters
- 1 x 400 V/33 kV transformer
- 1 x switchgear

An indicative diagram of an MV unit is shown in Figure 3.11 below.

Figure 3.11: MV Power Unit

Source: SMA MV Power Station

The poly-Si design has been based on 3,610 modules (47.5 tables) per inverter, and the thin-film design on 10,800 modules (135 tables) per inverter. Therefore, there will be a total of one MV Power Unit for around every 2.2 MWp of modules, this equates to a total of 38 MV Power Units for both poly-Si and thin film design options. The function of each component of the MV Power Unit is described below.

3.4.3.1 Inverters

An inverter converts the variable direct current (DC) output of a photovoltaic solar module into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. Inverters are a core component in a PV system, allowing the use of ordinary AC-powered equipment. Solar inverters have special functions adapted for use with PV arrays, including maximum power point tracking, string current monitoring and anti-islanding protection.

3.4.3.2 Transformers

A transformer is an electrical device that transfers electrical energy from one alternating circuit to another with a change in voltage, current, phase and/or impedance, allowing electricity to be distributed more efficiently over long distances. Each MV Power Unit will contain a 400 V/ 33kV step-up transformer.

3.4.3.3 Switchgear

The MV Power Unit switchgear operates, isolates and controls the export power from each 2.2 MWp 'array' before feeding into a ring main within the site.

3.4.4 Connection Cabin

The customer cabin will contain the following equipment:

- Project switchgear: to isolate and control the solar project as a whole.
- Generation Meter: to measure the amount of electricity generated by the Project.
- Project Power Transformer: this steps up the voltage from 33 kV to the required utility grid voltage of 132 kV. The power transformer will be bespoke constructed and site specific to local grid code requirements.
- Auxiliary Transformer: this supplies power to internal facilities within the project and steps down the electricity from MV to low voltage (i.e. 33kV/400 V).
- Project Control Room: this is where the SCADA operating system will be located and where an operator would control the project.

3.4.5 Point of Connection Facility

This facility is where the ownership is transferred from the Project owner to the Transmission Company of Nigeria (TCN) and from where the Project will connect to the national transmission network. The facility will contain the Project's Export Meter and the TCN switchgear, which can isolate the Project in order to protect the national transmission network.

3.4.6 Transmission Line and Substation

The generated power from the Project will be evacuated through a dedicated 132 kV overhead transmission line that will connect the solar plant to the Kankia substation located approximately 4 km southeast of the Project site.

3.4.6.1 Transmission Line

PASL plans to construct a dedicated project transmission line connecting the Project to the Kankia substation (refer to Figure 2.1 in Chapter 2). The transmission line will extend approximately 1.1 km from the Project site to the existing 132 kV power line corridor, and follow this route to the Kankia substation for approximately 4 km. The single line diagram for the power evacuation is provided in Appendix 6.

Transmission lines are used to transmit power, generally using high-voltage three-phase alternating current (AC), over relatively long distances. The lines will be made of high voltage cabling of either copper or aluminium. The transmission of bulk electrical energy is done at high voltages to reduce energy losses in long-distance transmission. It is intended that the proposed transmission line will be a 132 kV double-circuit construction. The transmission lines generally comprise the following components:

- **Support structures:** pylons/poles are used to keep the high voltage conductors separate from each other, and far from the ground and other obstructions. The distance between structures (span) and their height is largely determined by the topography and clearance requirements. Spans may range from 200 to 400 metres. Poles are fabricated in a range of heights but are between 25 and 34 metres, to allow optimum height of a structure to be provided at each site.
- **Conductors/transmission cables**: these conduct/transfer the generated electricity.
- **Optical fibre ground wires**, to provide protection from direct lightning strikes.
- **Insulators and fittings**, provide electrical insulation between the conductors and the (earthed) structure.

The majority of transmission infrastructure for the Project is proposed to follow the existing 132 kV transmission corridor, away from settlements, schools, hospitals and other sensitive receptors as much as possible. The strip of land used by TCN to operate, maintain and repair the transmission line facilities is known as the transmission corridor right-of-way (RoW). The width of a right-of-way usually depends on the voltage of the line and the height of the structures. For a 132 kV power line associated with the proposed Project, a 30 m clearance right of way will be established, i.e. 15 m from the centre on either side of the pylon.

3.4.6.2 Transmission Substation

A transmission substation forms an integral part of an electrical generation, transmission, and distribution system, as it serves as the point where high voltage electricity is stepped down into lower voltage electricity suitable for distribution into commercial and residential areas through distribution lines.

For the purpose of this Project, the existing Kankia substation will serve the purpose of efficiently distributing the electricity generated at the PASL Solar Plant. Thus, no new substation is planned to be constructed as part of the proposed Project infrastructure/utilities. Plate 3.3 is a photograph of the existing Kankia substation.

Plate 3.3: A cross-section of existing Kankia Substation

3.4.7 Other Components

The following additional infrastructure and electrical equipment will be required for the Project:

- PV power facility monitoring equipment and associated telecommunication links;
- Meteorological stations to record irradiation and site conditions;
- Buildings are required for the daily operation of the Project, including:

  - administration /office /control room & security (gate house),
  - control room & workshop,
  - ablution / change room and
  - warehouse / storeroom.
- Site security system, including CCTV, fencing around the site, lighting and 2 security booths near the access points;
- Site access and internal road network to provide easy access to the arrays for operation and maintenance purposes;
- Water supply infrastructure, including groundwater well(s), pipework and storage tanks;
- Stormwater/drainage system to control the movement of water across the site and prevent damage to equipment.

3.5 Overview of Project Phases and Activities

The general development phases for such a large scale solar PV project can be categorised as follows:

- Pre-construction: such as mobilisation of equipment and materials to site and site preparation.
- Construction and Installation: including civil works, electrical works, and equipment installation.
- Operation: Plant operation and routine maintenance.
- Decommissioning: Dismantling of equipment and associated facilities and site restoration.

3.5.1 Mobilisation Phase

The mobilisation phase must take place before installation work can begin at the Project site and the time it takes is largely dependent on the country (regulations) in which the development takes place. This phase may include ordering of materials and equipment, signing contracts with subcontractors and hiring of staff.

This phase involves the mobilization of men, materials and equipment to site. Heavy-duty and other pieces of equipment will be moved to the proposed Project site at the beginning of construction activities for civil work activities and equipment installation. All PV, electrical and structural equipment is planned to be shipped through Lagos port and then trucked to site via road in steel “containers”. It is envisaged that about 500 truckloads transporting 300-400 x 40-foot containers would be required for construction phase.

During the site preparation period, the workforce required for site security, manual labour, civil works, transportation of goods and other similar services will largely be drawn from the local labour pool.

Also included at this phase is the site preparation which involves clearing of vegetation and establishment of on-site facilities, including worker accommodation.

It is anticipated that this phase will take around 2 months.

3.5.2 Construction Phase

The construction phase of the Project will include activities such as:

- Construction/improvement of internal access roads
- Levelling of the ground
- Fencing around the Project site
- Construction of a groundwater system (boreholes)
- Installation of MV Power Units
- Driven piles for mounting structure
- Construction of electrical substation and foundations
- Excavation, trenching and cable laying
- Fixing and wiring of the panels
- Installing CCTV around the fence line and access points
- Installing water tank for staff, and operation and maintenance activities
- Installation of septic tank
- Construction of buildings
- Erection of overhead HV power lines along the transmission route
- Testing and commissioning of equipment and the Project as a whole
- Site clean-up.

During the construction phase, the piles will be driven into the ground to form the structural base of the PV arrays. Once the PV components have arrived on site, technicians will supervise the assembly of the panels and test the facility. The PV panels will be installed on the galvanized steel structures. A phased approach will be adopted.

During the first phase of construction, a highly-skilled team of solar energy technicians will train a number of potential local employees, preferably from Katsina State, where possible. Over this period it is estimated that 200 people will be involved in this phase. A section of the site will be used as a laydown area where shelters, equipment, ablution facilities (portable) and containers will be located.

Accommodation may need to be provided through temporary construction camps onsite for non-locals. However, the Project aims to employ a minimum of 30% (up to 60%) of unskilled and skilled labour from the surrounding communities for construction. About 150 - 180 local skilled, semi-skilled and unskilled workers would be engaged.

To provide access to the site from the nearby highway, a short road will need to be prepared to level that will be acceptable for the transport of equipment, material and people to and from the site. It is estimated that around 5 digger/loaders/bulldozers will be required for land clearing and 5 to 10 trucks with cranes will be required for the construction. Approximately 300-400 x 40-foot container loads would be required to construct the PV solar facility.

The construction activities usually require careful approach and appropriate safety procedures, including:

- Risk assessment
- Personal safety
- Site safety and security
- Ground excavation
- Final clean up.

It is anticipated that the construction activities phase will take up to around 8 months for each phase of the Project.

3.5.3 Operation Phase

Once the facility is complete and operational, it is expected that it will have a lifespan of approximately 25 years. Measuring the performance of the PV power plant will be done remotely, through the use of telemetric monitoring.

Day to day facility operations will involve both regular onsite preventive and corrective maintenance tasks in order to keep the PV power plant in optimal working order throughout the operational period. The preventive maintenance follows a routine service schedule aimed at preventing faults from occurring and keeping the plant operating at its optimum level. The frequency of the preventive maintenance depends on a number of factors such as the technology selected, environmental conditions of the site, warranty terms and seasonal variances. It contains, for example, activities like PV module cleaning, inverter servicing, and checks on structural integrity of the mounting structure. Corrective maintenance will be carried out in response to failures for example, the repair/exchange of damaged or faulty equipment.

3.5.4 Decommissioning Phase

Decommissioning refers to the process of removing all the operating assets of a project after completion of its life cycle from the project site. Typically, the following steps would be followed during the facility decommissioning:

- PV panels will be removed from the fixed aluminium frames.
- Fixed aluminium frame structures will be removed.
- PV panels will be transported to special recycling facilities (alternatively used at other operational sites).

- Electrical equipment (transformers) will either be re-used on other developments/projects or recycled.
- Underground cable runs (where applicable) will be removed and recycled.
- Gravel/chipstone on the access roads, onsite service roads, guardhouse foundations will be removed and reused.
- Buildings, such as the guardhouse can be taken over by the landowner for operational purposes, alternatively all the reusable material will be removed, the structures demolished and the rubble transported to a municipal waste site.
- Disturbed land areas will be rehabilitated, and replanted with indigenous vegetation.

The PV power facility would be decommissioned at the end of its projected 25 year operational life time. Alternatively, with regular maintenance, the facility could be upgraded, with the useful lifespan of the project extending beyond the design lifespan.

PASL shall consider working with PV CYCLE, an association which organises the take-back and recycling of PV modules at the end of the project life span. PV CYCLE operates a comprehensive recycling process, which recovers most of the materials within the PV panel (including glass, semiconductor material, ferrous and non-ferrous metals, etc.) for reuse in new products. All panels and major electrical components will be recycled.

The decommissioning phase is expected to take around 6 months.

3.6 Water Use and Management

The key benefit of the proposed Project in terms of resource use is the generation of electricity using freely available solar energy to produce electricity, reducing the dependence on fossil fuels for the generation of electricity and thereby reducing the carbon footprint associated with the Nigerian electricity network. However, water is required during both the construction and operation phase of the Project. This is further discussed below:

3.6.1 Water Requirements during Construction

During the construction phase, water demand is driven by the following key[6] requirements:

- To make concrete for piled concrete mounting structure foundations; and
- For staff consumption and sanitation.

[6] Water is also required to make concrete foundations for onsite buildings and other civil works but the volume required is considered negligible compared to the other two use cases.

Driven piles will be used for the mounting system; therefore no water will be required for concrete piled mounting structure foundations.

During construction, water will be required for sanitary and drinking purposes by onsite workers. It has been assumed that 25 litres per worker per day will be required to cover this demand. A project of this size would create approximately 200 jobs over an 8 month construction period, with an average of 140 staff on site per day, for each phase. This corresponds to a water requirement of 560,000 litres during each construction phase for worker consumption and sanitation[7] for each phase. The capacity of the proposed water reservoir tank to be installed onsite is 5000 litres.

On the basis of the assumptions and calculations above, total water requirement during each construction phase is estimated at 560,000 litres. The groundwater table at the project area and the rate of water recharge is relatively low compared to the southern part of Nigeria. However, during the rainy season, the water reserve of the aquifer in the project area increases; thus hand dug wells and boreholes yields improve significantly. Based on field survey of the project area, water abstraction for the project is not envisaged to significantly have negative effect on the existing groundwater aquifer of the area. This will be further assessed by the EPC contractor prior to construction activities.

3.6.2 Water Requirements during Operation

The main use of water during operation is for the regular cleaning of solar panels to prevent dust build-up, since dust can affect their performance. Water will also be required for drinking and sanitation purposes for onsite workers.

3.6.2.1 Operations and Maintenance Staff

For the purpose of drinking and sanitation, approximately 25 litres of water per day per onsite staff member is required. An average of 15-20 staff members on site each day is anticipated for the Project. This corresponds to a requirement of around 140,000 litres of water per year for operations and maintenance staff.

3.6.2.2 Washing of Panels

Without regular rainfall, dust and soil build up on the solar panels and inhibit the amount of irradiation that reaches the solar cells. For large PV plants in areas where there are long periods without rain, such as Katsina, manual cleaning of the modules with water is usually undertaken to reduce this effect; a mild, biodegradable and non-abrasive detergent may also be added to the water used. The schedule of cleaning under the operations and maintenance contract should

[7] Based on a 5-day working week.

be set to keep the energy lost due to soiling under an acceptable level that matches the loss used in the energy yield and financial model.

The rainfall pattern in Katsina State is characterised by a long dry season from October to May, which includes the dusty Harmattan winds from the Sahel. The rate of build-up of soil and dust on the PV arrays is impacted by the soil type, wind speeds and the mounting structure used for the PV panels. It has been assumed that 3 manual washes of the arrays per year (in November, January and March) is a suitable cleaning regime for the proposed Project.

Based on previous experience, each MWp of panels would require approximately 2,000 litres of water per cleaning cycle. Based on a proposed capacity of approximately 80 MWp and 3 washes a year it has been estimated that the proposed Project would consume approximately 500,000 litres per year.

3.6.3 Water Supply System

All non-potable water required for use during the construction, operation and maintenance activities of the Project will be sourced from a borehole that will be constructed on the Project site, with potable water tankered and stored on site.

The borehole to be dug during the construction phase will also serve as source of water during the plant operation.

3.6.4 Stormwater drainage

Adequate drainage system will be constructed around the site according to the site conditions. Stormwater will be managed through a combination of open trenches and ditches. Stormwater shall drain away to the natural environment via gravity. Paved and concreted areas will be sloped to allow for proper drainage.

3.6.5 Wastewater

Wastewater from the operations of the proposed Project will primarily be as a result of the cleaning of the PV panels. The panel washing may require the use of gentle detergents, no strong detergents or chemical substances will be used. Therefore, the wastewater is regarded as non-hazardous.

3.6.6 Sanitary Waste

It is proposed that compost toilets will be used throughout the operation of the project. Compost toilets treat human waste material by aerobic processes. They do not require water and produce a compost-like, odourless, dehydrated material that can either be disposed of via municipal waste services or be used for the production of compost.

3.7 Workforce and Job Creation

PASL will have ultimate oversight over labor and working conditions for all phases of the Project. During construction, the majority of workers will be hired and managed by the EPC Contractor and other subcontractors.

It is envisaged that during each of the two construction phases, about 200 people will be employed for approximately 8 months. This would include around 20 experienced engineers, 10 experts and 150 - 180 local skilled, semi-skilled and unskilled workers.

During the site preparation period, the workforce required for site security, manual labour, civil works, transportation of goods and other similar services will be drawn from the local labour pool.

During pre-construction and early stages of construction, a highly-skilled team of solar energy technicians will train potential local employees, preferably from Katsina State, where possible. It is currently expected that some on-site construction workers' accommodation and associated facilities will be required.

A total of about 20 job opportunities will arise during the operation phase, including skilled and semi-skilled labour (such as electrical and mechanical technicians) and unskilled labour (such as module cleaners and security personnel) for a duration of approximately 25 years.

PASL shall ensure that the workforce is managed in accordance with the requirements of the Nigerian Labour Act (1990) as well as the requirements of IFC Performance Standard 2 – Labour and Working Conditions. The proposed Project will neither involve the use of child labour nor forced labour. PASL shall ensure that occupational health and safety plan that commensurate with the level of construction activities planned for the Project is developed and implemented.

A Workforce Management Plan (refer to Chapter 7) will be developed that will apply to direct workers, contract workers, and supply chain workers. The Plan will outline human resource policies and procedures, terms of employment and working conditions, project workforce requirements, recruitment strategies, management of employment contracts, housing and transport of workers. The human resources policies and procedures will also focus on non- discrimination and equal opportunity.

The Workforce Management Plan will be designed to ensure that PASL manage its staff in accordance with the Labor Act (1990) and IFC standards, including allowing freedom of association, recognition of trade unions and respect for collective bargaining agreements, protecting worker's rights in terms of the national legislation.

3.8 Health and Safety

Various health and safety plans specific to employees will be developed as part of the implementation of the proposed Project (see Chapter 7). A Worker Health and Safety Plan will be developed for all phases of the project and will be regularly updated and made appropriate to the project activities undertaken during each phase. The Worker Health and Safety Plan will be designed in line with Nigerian legislative requirements and the IFC/World Bank Group Environmental, Health and Safety Guidelines.

PASL will develop a Project Health and Safety Plan to evaluate the performance of contractors and subcontractors on the project through initial work in progress and end of job evaluations.

Worker activities will be managed through appropriate planning and the application of Permit-to-Work system, Job Hazard/Safety Analysis, Personal Protective Equipment (PPE) requirements and other safety based protocols.

For example, during construction phase, an H&S risk assessment based approach will be taken to manage H&S risks to workers. This would involve assessing all the various risks that are involved in each aspect of the job and educating workers on how to manage these risks. The people working around the project area shall also be warned of the risk involved i.e. warning signs shall be erected for people to see clearly.

All staff, workmen, supplier and sub-contractor working on site shall be informed on the need to ensure their safety and the safety of the people working around them. Every worker will be instructed to always put on PPE whilst on site. Perimeter fencing will be installed, and appropriate warning signs will be erected and checked each day. First aid equipment for workforce will be provided onsite. Daily health and safety tool-box meetings among workforce will be ensured. The safety briefings will be led by the onsite HSE officers.

3.9 Site Security

A Project site security plan, procedures, and contract will be established and implemented. The Security Management Plan (see Chapter 7) will be developed to assess security threats and identify specific measures to be put in place to address such security threats.

PASL will award a contract to an appropriate security company, to provide 24 hour security at the site. The site security contract will be required to comply with the above-mentioned Site Security Plan, Code of Conduct, as well as good international practices, such as IFC Performance Standards on security personnel in terms of the principles of proportionality, hiring, rules of conduct, training, equipping and monitoring of such personnel.

3.10 Associated Wastes Stream

It is the goal of PASL to design, construct, and operate the Project in a sustainable manner. To this end, effective waste management practices shall be implemented through the entire life cycle of the Project. A specific Waste Management Plan will be developed as part of the implementation of the proposed 80 MWp PV Power Project (refer to Chapter 7).

Waste management principles and priorities shall be based on an integrated approach which involves using a combination of techniques and programs to manage wastes. Waste reduction is at the top of the approach, followed by reuse as preferred options to disposal, which will be the last option.

All wastes generated from the Project will be categorised as either non-hazardous or hazardous following an assessment of the hazard potentials of the materials.

The main sources of waste from the proposed Project will largely result from the construction and decommissioning activities. One of the main sources of non-hazardous wastes will be domestic-type solid waste from the personnel during construction. These wastes may be produced daily and comprise the following:

- Domestic-type waste:
  - Residual packaging and food wastes
  - Metal cans (from food and drinks)
- Wooden pallets and cartons
- Scrap metal
- Concrete waste
- Paper and cardboard

The following hazardous wastes could also be associated with the Project.

- Oily rags and absorbents
- Used oil and oil filters - from generators or vehicle maintenance
- Contaminated water - slops and oily water from drip trays; and

The associated waste streams are described in the following paragraphs:

Non-Hazardous Waste

Construction waste will most likely consist of concrete (if concrete foundations are utilised to support the mounting structures in any areas. Driven pile is planned to be used for the PV module mounting system), cleared vegetation and scrap metal. All concrete mixing for onsite buildings foundations and other civil works will be undertaken on impermeable plastic lining to prevent contamination of the soils and surrounding areas. Waste management for the Project will incorporate reduction, recycling and re-use principles.

The development activities for the Project will include site clearing within the area needed for the project development. This activity will generate cleared vegetation which will be disposed offsite in a Government approved dumpsite. Alternatively, the organic wastes will be used for compositing. The site is mostly dominated by shrubs and herbs. The possibility of clearing trees for firewood purpose is very minimal.

All waste that cannot be reused or recycled will be appropriately disposed of. All construction debris will be placed in appropriate onsite storage containers and periodically evacuated from the site to a Government approved dumpsite. The nearest approved dumpsite to the Project site is approximately 3 km. The refuse bins/containers to be used for temporary storage of wastes before they are evacuated to the approved dump site shall be in compliance with local standards and regulations and will comply with ISO 140001. A typical example is shown in Plate 3.4.

Waste evacuation will be carried out by a third party waste contractor licenced by the Katsina State Environmental Protection Agency (KATSEPA), the authority in Kastina State charged with the responsibility for waste collection and disposal. All generated refuse from the designated waste storage areas on site will be evacuated at least once a week.

Plate 3.4: A typical solid waste container to be used

It is estimated that approximately 200 m^3 of construction debris will typically be produced per month, while approximately 0.2 m^3 of solid waste is estimated to be generated per month during the operation phase.

<u>Hazardous Waste</u>

The construction and decommissioning phases may require the use of hazardous materials such as fuel and grease to fuel and maintain equipment and vehicles. These substances will be stored onsite in temporary storage tanks placed on the ground surface. The areas shall be properly demarcated, properly marked as hazardous and secured. Trucks and construction vehicles will be serviced on-site or off-site. The use, storage, transport and disposal of hazardous materials used for the project will be carried out in accordance with all applicable local and international regulations.

Hazardous wastes such as oily rags will be stored in properly labelled and sealed plastic or metal drums that are strategically located within the site where this category of waste may be generated pending disposal by KATSEPA. The waste bins shall be in compliance with local standards and regulations and will comply with ISO 140001. A typical example is shown in Plate 3.5.

Plate 3.5: A typical oil waste container to be used

Oil-impacted stormwater is not envisaged to be generated from the site.

3.11 Project Schedule

Phase 1 of the proposed Project is planned to commence in Quarter 1 (Q1) 2016 and be in full operations in Q3 2016. Phase 2 is anticipated to be operational a year later (2017). The Project will operate for approximately 25 years. The tentative schedule for each of the planned project activities is provided in Appendix 7.

CHAPTER FOUR:

DESCRIPTION OF THE EXISTING ENVIRONMENT

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4.1 Introduction

This chapter presents the existing bio-physical and socio-economic (including health) conditions of the proposed Project area against which the potential and associated impacts of the Project are assessed.

Data and information for the description of the existing environmental conditions of the study area were obtained from desktop studies and field investigations carried out from October 17 to 21, 2014 (wet season survey). Additional site visit was also conducted from March 17 to 20, 2015 to better understand the environmental and socio-economic settings of the Project area.

The study area for the baseline survey (Project's area of influence) (Figure 4.1) covers the following:

- The proposed Project site, occupying approximately 120 ha of land.
- The immediate surrounding environment of the Project site (chosen as a land area within a 1 km distance from the site boundary) which may be exposed to the Project activities.
- The wider area of Project influence which extends up to a 5 km radius of the Project site boundary.

The project's area of influence has been selected based on the understanding of the proposed project activities, review of previous EIA report of the project area, and observations noted during the preliminary/reconnaissance survey of the project site. The project's area of influence is selected to ensure that all sensitive receptors that could potentially be affected by the proposed project are considered.

The description of the existing environmental conditions[8] of the study area presented in this chapter covers the following: Climate and meteorology; air quality and noise; geology and geomorphology; soil quality; hydrology and groundwater resources and quality; habitat and terrestrial flora (vegetation); terrestrial fauna (wildlife); land use; and socio-economic and health.

[8] No natural/perennial surface water body exists on the Project site and the immediate surroundings as noted during the field survey as well as desktop review of report of previous EIA study conducted within the project area.

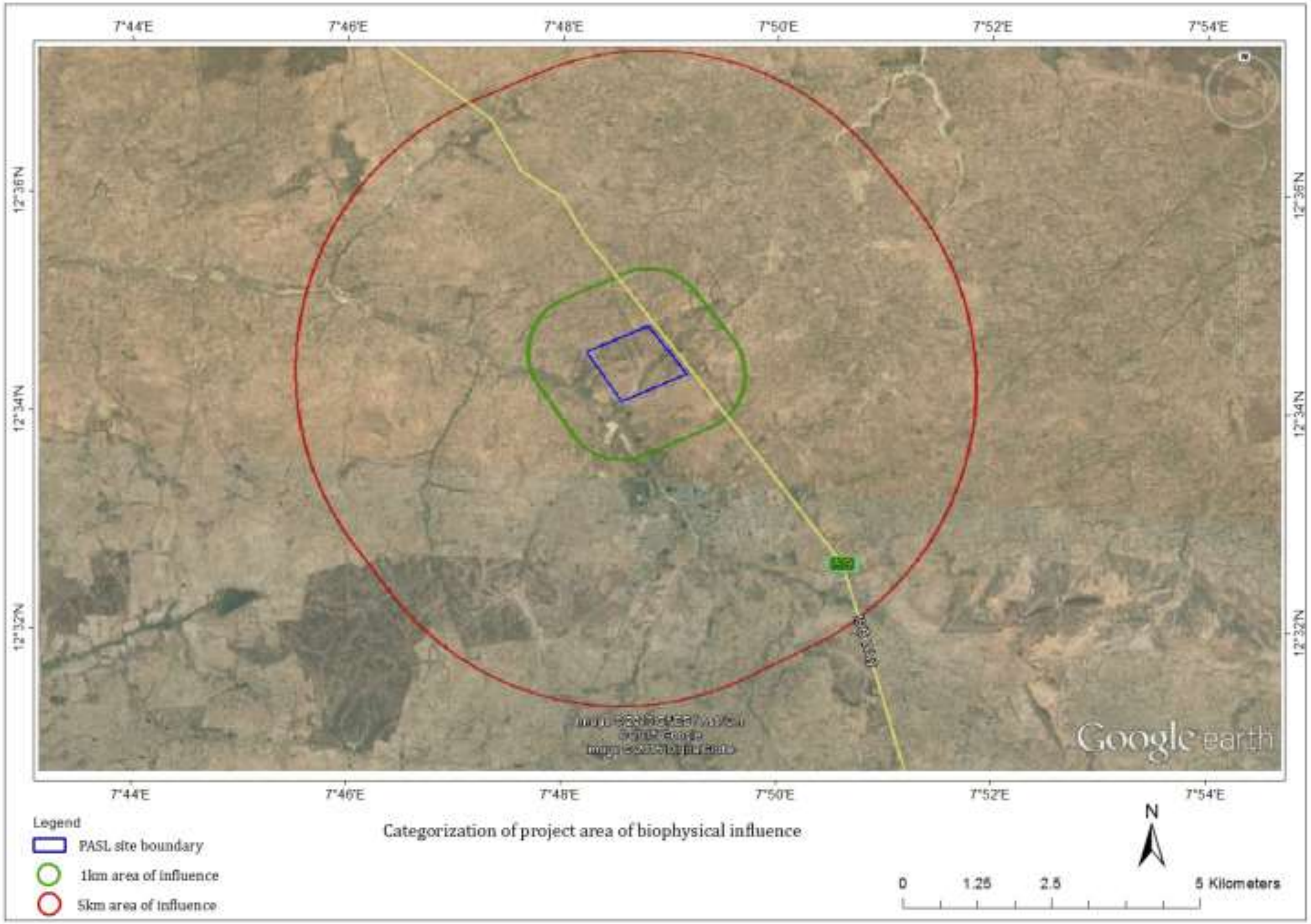

Figure 4.1: Map of the Study Area (direct and indirect project's area of influence)

4.2 Data Collection

Baseline information was collected using the following methods:

- Desktop review of existing reports related to the Project site and the surrounding environment;
- One season (wet season) of field sampling, measurements and laboratory analysis; and
- Additional information gathered from consultation with surrounding communities.

4.2.1 Desktop Study

Desktop studies involved the acquisition of relevant background information on the bio-physical and socio-economic environment of the study area. Information was sourced from the following government authorities:

- Nigerian Meteorological Agency (NIMET);
- Katsina State Ministry of Water Resources;
- Kankia Local Government Area; and
- National Population Commission (NPC)

Other sources of information include; final report of previous EIA study conducted in 2013 within the Project area, publications, textbooks, articles, maps as well as online sources.

4.2.2 Field Sampling and Analysis

In order to effectively characterise the environment of the study area, field sampling was conducted from October 17 to 21, 2014 (wet season survey) to complement the existing dry season data of the project area obtained in 2013. Prior to the field sampling, a reconnaissance survey of the study area was conducted from July 15 to 16, 2014.

Sampling locations were identified using recent satellite imagery of the study area. The basis of the sampling design was informed by a preliminary classification of the habitat types in the study area through desktop research and previous environmental assessment studies.

Sampling locations were selected to cover as much as possible the land area for the proposed Project as well as the existing sensitive receptors (for example, communities that could be indirectly or directly affected by the proposed Project). All sampling locations were geo-referenced using Garmin Map-62 series Global Positioning System (GPS) handsets. The sampling coordinates are presented in Table 4.1 below.

Table 4.1: Sampling Locations Coordinates

Environmental Component	Sampling Code	Coordinates	
		Latitude (N)	Longitude (E)
Air Quality and Noise	AQ1	12.56802	007.81502
	AQ2	12.57307	007.81732
	AQ3	12.56732	007.82198
	AQ4	12.56926	007.81883
	AQ5	12.56940	007.80697
	AQ6	12.56479	007.81748
	AQ7	12.57044	007.81317
	AQ8	12.56390	007.81360
	AQ9	12.56670	007.81048
	AQ10	12.59657	007.82595
	AQ11	12.56191	007.80610
	AQ12	12.59656	007.85348
	A13(Ctrl)	12.59485	007.85125
	AQ14 (Ctrl)	12.51672	007.81082
	AQ15	12.57446	007.80966
	AQ16	12.56315	007.80806
	AQ 17	12.55233	007.83807
	AQ18	12.56189	007.81948
	AQ19	12.55190	007.84564
	AQ20	12.57014	007.82311
Soil	SK1	12.56802	007.81502
	SK2	12.57307	007.81732
	SK3	12.56732	007.82198
	SK4	12.56926	007.81883
	SK5	12.56940	007.80697
	SK6	12.57044	007.81317
	SK7	12.56390,	007.81360
	SK8	12.56670	007.81048
	SK9	12.59657	007.82595
	SK10	12.56191	007.80610
	SK11	12.59656	007.85348
	SK12	12.51672	007.81082
	AP1 (Ctrl)	12.55189	007.84563
	PDKK (Ctrl)	12.57014	007.82311
Groundwater	GW1	12.55243	007.81260
	GW2	12.54833	007.82726
	GW3	12.55525	007.84035
	GW4	12.61065	007.81748
Terrestrial Ecology Flora	E1	7.811727	12.568672
	E2	7.807894	12.56594
	E3	7.816454	12.564671
	E4	7.841816	12.58783
	E5 (Ctrl 1)	7.787525	12.52797
	E6	7.807477	12.55542
	E7	7.823006	12.57452
	E8 (Ctrl 2)	7.781431	12.60512
	E9	7.815325	12.571713

Source: EnvAccord Field Survey, 2014

The field sampling activities were carried out in line with the appropriate quality assurance and quality control procedures. Soil and groundwater samples obtained from the field were transported to the laboratory and analysed for the required parameters. Laboratory analyses were conducted at Environmental Accord Laboratory in Lagos. The Laboratory is accredited by the Federal Ministry of Environment (FMEnv) as well as the National Environmental Standard and Regulations Enforcement Agency (NESREA).

Laboratory analyses were consistent with the approved standard methodologies such as those recommended by ASTM International (formally called American Standards for Testing and Materials) and American Public Health Association (APHA). Some of the analytical methods used are highlighted below in Table 4.2.

Table 4.2: Some of the analytical methods used for field samples analysis

S/N	Parameters	Analytical Methods
1.	Total Suspended Solids	Gravimetric method
2.	Biological Oxygen Demand (BOD)	Dilution method
3.	Chemical Oxygen Demand (COD	Reflux dichromate method
4.	Oil and Grease	Photometric method
5.	Alkalinity	Titration method
6.	Total Hardness	Titration method
7.	Nitrate	Colorimetric method
8.	Sulphate	Turbidimetric method
9.	Phosphate	Colorimetric method
10.	Sodium	Atomic Absorption Spectrophotometer
11.	Potassium	Atomic Absorption Spectrophotometer
12.	Lead	Atomic Absorption Spectrophotometer
13.	Nickel	Atomic Absorption Spectrophotometer
14.	Cadmium	Atomic Absorption Spectrophotometer
15.	Zinc	Atomic Absorption Spectrophotometer
16.	Copper	Atomic Absorption Spectrophotometer
17.	Chromium	Atomic Absorption Spectrophotometer
18.	Manganese	Atomic Absorption Spectrophotometer
19.	Iron	Atomic Absorption Spectrophotometer

Source: EnvAccord Field Survey, 2014

The results of the field measurements and laboratory analyses were compared with the relevant Nigerian regulatory standards, IFC/World Bank Group Environmental, Health and Safety (EHS) Guidelines and World Health Organisation (WHO) guidelines and limits. In line with the FMEnv requirements, the field sampling activities were witnessed by FMEnv and Katsina State Ministry of Environment representatives.

4.2.3 Consultation with Local Communities

Information was gathered during the stakeholder consultation and socio-economic baseline study undertaken within the communities of Galadima, Gachi, Kafin Dangi, Kauyan Maina, and Kankia in the Project area. Information related to the bio-physical aspects of the Project site was also captured through the engagement. The additional information gathered from the local communities relates to ecosystem services and livelihood aspects within the study area.

4.3 Overview of Environmental and Social Setting of the Project Area

The Project site is a 120 ha of land located in Kankia LGA of Katsina State. As indicated in the previous chapters, the site was acquired from the Katsina State Government in two tranches of 50 ha and 70 ha in return for equity stake in the Project ownership. Rights to possess the site have been granted to PASL.

The existing vegetation of the site and the surrounding environment is largely secondary in nature and typifies a Sudan savannah dominated by shrubs, grasses and herbs. The Project site is sparsely vegetated and has a few trees (less than 10 in number). There are no existing structures or farmlands on the site. The topography of the area is gently undulating. No rocky outcrops are present within the Project site based on field observation. Although, grazing activities were observed on site during field activities, the site is not known to fall within any gazeted grazing reserves or grazing routes.

The existing receptors or resources identified in the immediate surroundings (500 m radius) of the Project site boundary (Figure 4.2) are:

- An abandoned fish rearing house (“Gidan Kifi”), located approximately 40 m south of the site. The structure belongs to Kankia LGA.
- An abandoned bee keeping house (“Gidan Zuma”), approximately 75 m south of the site. The structure is owned by Kankia LGA.
- Katsina State Metal Works Factory (not in operation), located approximately 165 m east of the site.
- An abandoned building located approximately 20 m east of the site. The structure belongs to Katsina State Water Board.
- Federal Road Maintenance Agency (FERMA) site building, approximately 300 m east of the Project site.
- Fanga village located approximately 300 m north of the site.
- Kankia dam, approximately 250 m south of the site.
- European Union (EU) old tree seedling nursery site, approximately 210 m south of the site.
- Gandi Primary School located approximately 50 m west of the site. It consists of a 2-block of classroom, one of which was dilapidated as at the time of site visit in March 2015. It was also gathered from the local communities during the visit that the school was still in use.

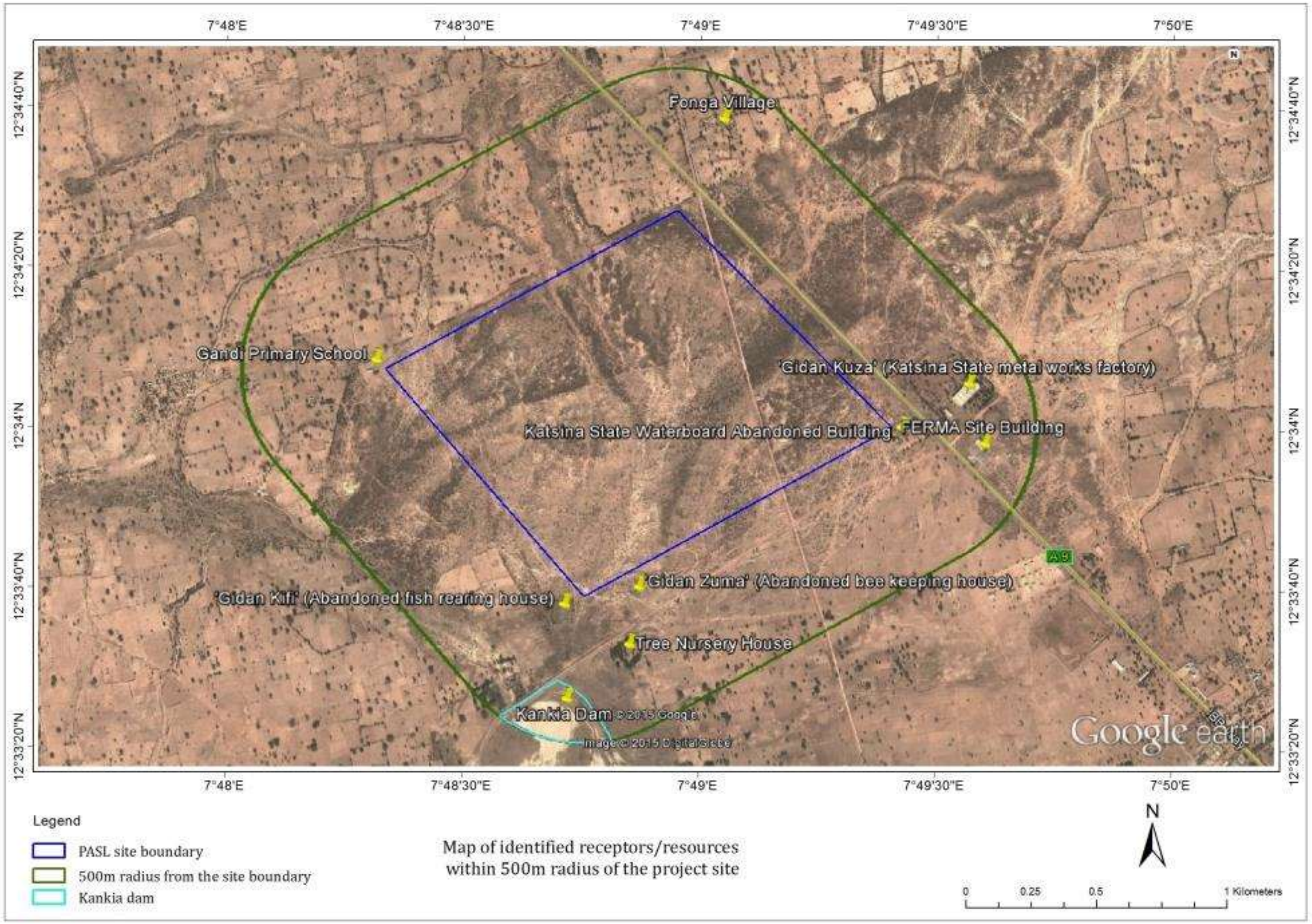

Figure 4.2: Map of existing receptors/resources within 500 m radius of the Project site

4.4 Description of Environmental Characteristics of the Project Area

4.4.1 Climate and Meteorology

The Project site is located in Kankia LGA of Katsina State, Northern region of Nigeria. The description of the climatic characteristics of the Project area presented in this section is based on the long term meteorological data of Katsina State spanning 1989 to 2013. The data were obtained from the Nigerian Meteorological Agency (NIMET).

The climate of Katsina State is the tropical wet and dry type (tropical continental climate). The wet season period is usually between April and October, while the dry season is experienced between November and March. The climate of the study area is tropical and it is under the influence of the Inter-Tropical Convergence Zone (ITCZ) or Inter-Tropical Discontinuity Zone (ITDZ).

The monthly mean climatic characteristics of Katsina State between 1989 and 2013 are summarized below in Table 4.3.

Table 4.3: Summary of Monthly Mean Climatic Characteristics of Katsina State (1989-2013)

Month	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Wind speed m/s)	Sunshine hours
	Min.	Max.	9:00Hr	15:00Hr			
January	12.78	30.28	19.42	12.67	0.00	8.28	8.03
February	15.13	32.25	14.04	10.50	0.00	7.19	8.49
March	19.82	36.74	13.13	9.63	1.05	6.38	7.68
April	23.72	39.18	25.46	14.42	17.18	6.99	7.90
May	24.58	38.08	45.63	26.92	40.54	8.00	8.45
June	23.38	35.49	55.96	37.00	84.09	8.78	8.61
July	21.55	31.87	69.04	52.42	150.91	7.76	7.70
August	20.95	30.60	75.71	60.33	171.66	5.97	7.09
September	21.35	32.59	69.50	52.25	83.40	5.31	8.14
October	20.09	34.82	42.17	26.04	16.59	4.92	8.75
November	15.42	33.20	19.79	14.83	0.00	5.10	8.60
December	12.74	30.49	19.67	14.25	0.00	7.05	8.53

Source: NIMET 2014

Each of the climatic elements of the Project area is briefly described below:

- **Rainfall**

Rainfall pattern in the Project area is between April and October with a peak in August as indicated in Figure 4.3. The average annual rainfall in the area is about 600 mm. The analysis of the data indicates that rainfall in Katsina State is quite lower than what is experienced in most of the states in the southern region of Nigeria such as Lagos and River States.

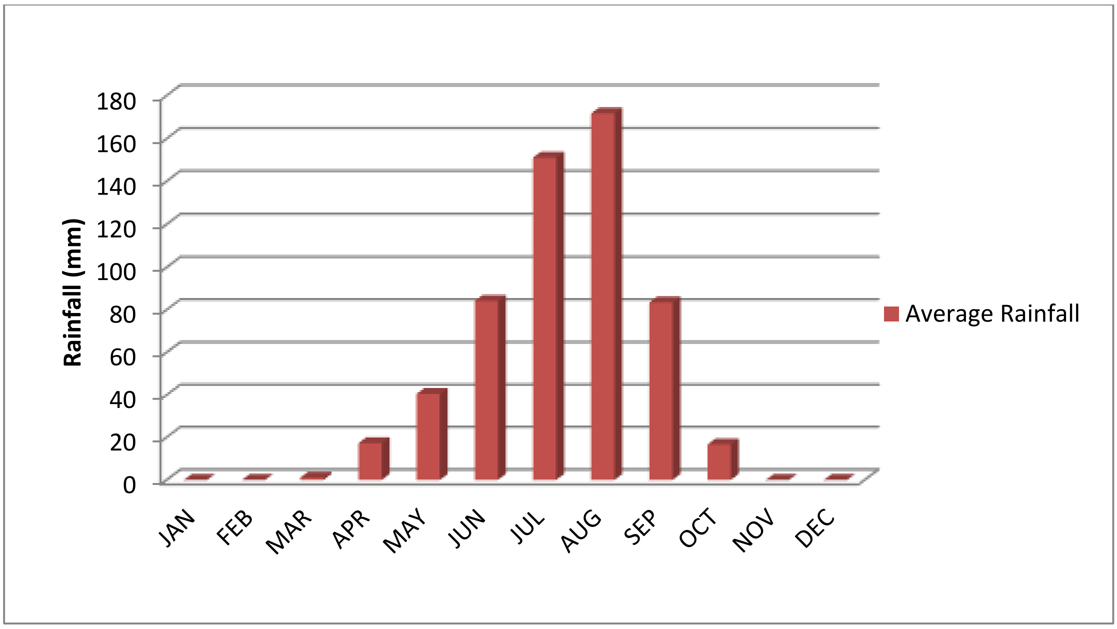

Figure 4.3: Mean monthly rainfall for Katsina State (1989-2013)
Source: NIMET 2014

- **Temperature**

Temperature is a dominant climatic factor which varies from place to place over a period of time. The mean monthly temperature recorded in the Project area between 1989 and 2013 was approximately 35 ^oC in the wet season months (April – October) and 33 ^oC in the dry season (November – March). Figure 4.4 shows the comparison of the maximum and minimum temperature values recorded in the area.

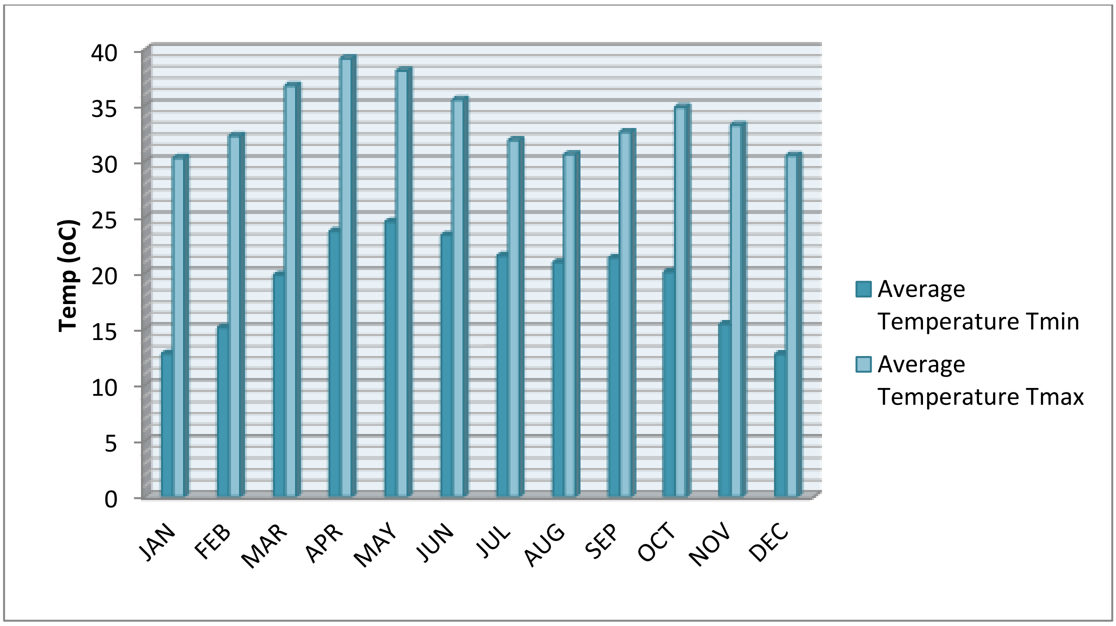

Figure 4.4: Mean monthly minimum and maximum Temperature for Katsina State (1989-2013)
Source: NIMET 2014

- **Relative Humidity**

Relative humidity is the quantitative expression of wetness or dryness (in percentage) of air. The relative humidity profile of the Project area is depicted in Figure 4.5 below. High relative humidity values of approximately 45 % to 75 % were recorded between April and October.

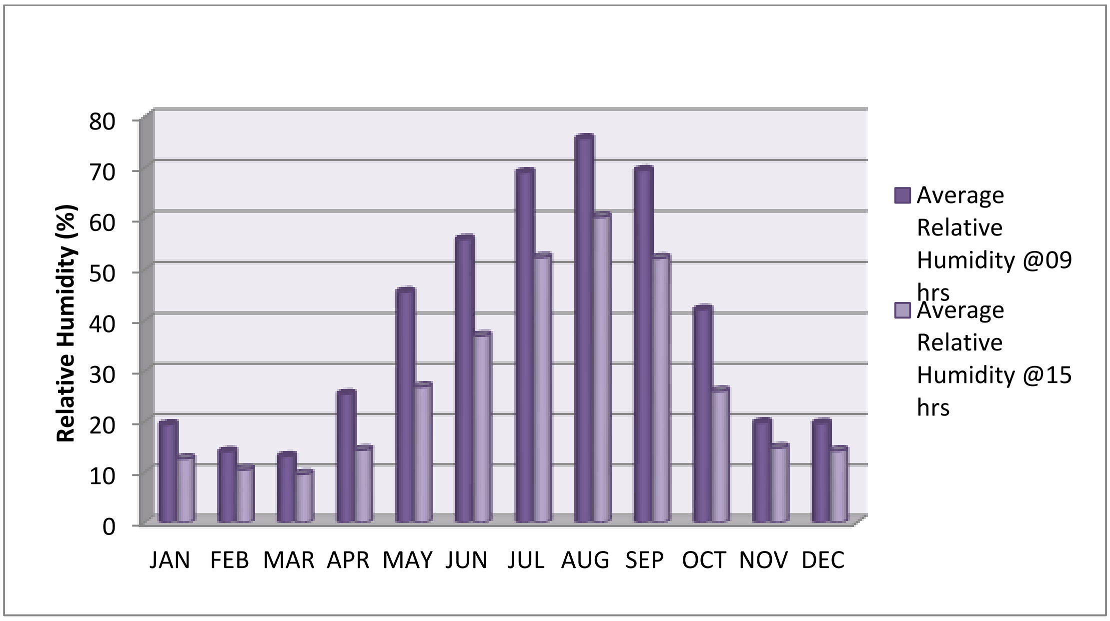

Figure 4.5: Monthly Relative Humidity in Katsina State (1989-2013)
Source: NIMET 2014

- **Wind**

The lowest mean monthly wind speed in the Project area is about 4.92 m/s obtained in the month of October while the highest annual mean value of 8.78 m/s was recorded in the month of June (Figure 4.6). The maximum wind speed recorded in the Project area between 1989 and 2013 was 15.7 m/s in October.

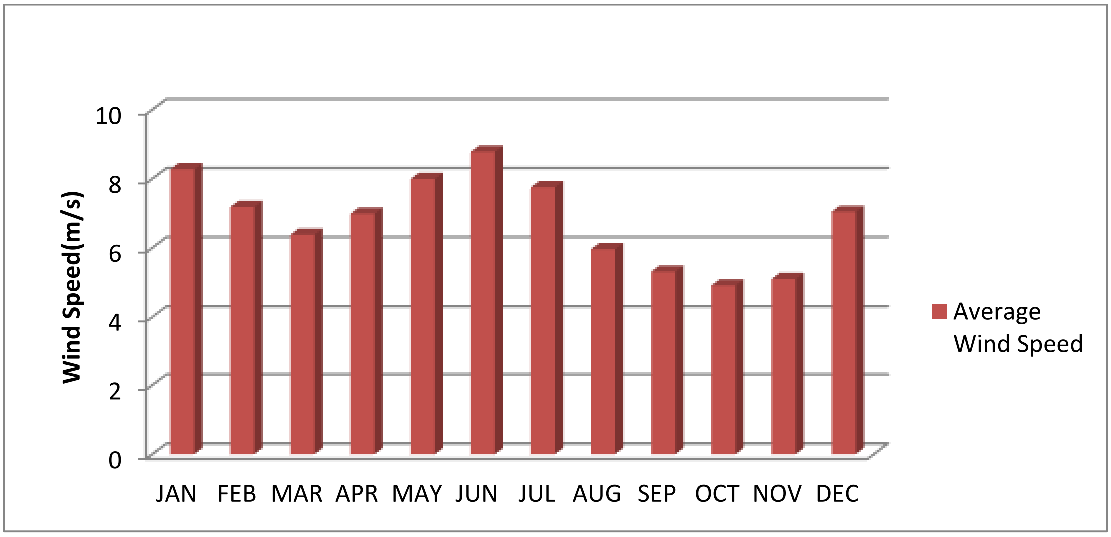

Figure 4.6: Average Wind Speed in Katsina State (1989-2013)
(Source: NIMET 2014)

The prevailing wind directions in the Project area are East and South-West Trade Winds. The East wind predominates during the dry season while in the wet season the dominant wind direction is usually the South-West as shown in Table 4.4. Figure 4.7 below shows a wind rose for the project area.

Table 4.4: Summary of Monthly Wind Direction in Katsina State (1989-2013)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1989	E	NE	S	S	SW	SW	SW	S	S	S	NE	NE
1990	NE	NE	NE	SW	S	W	SW	SW	SW	SW	NE	NE
1991	NE	NE	SW	SW	S	S	S	SW	SW	SW	E	E
1992	NE	NE	NE	SW	SW	SW	S	SW	SW	SW	NE	NE
1993	E	E	E	E	W	W	W	W	W	E	E	E
1994	E	E	E	E	W	W	W	W	W	W	E	E
1995	E	E	E	E	W	W	W	W	W	E	E	E
1996	E	E	E	E	W	W	W	W	W	W	E	E
1997	E	E	E	W	W	W	W	W	W	E	E	E
1998	E	E	E	W	W	W	W	W	NW	NW	SE	SE
1999	E	NE	S	S	SW	SW	SW	S	S	S	NE	NE
2000	E	E	E	E	SW	SW	S	SW	S	E	E	NE
2001	E	NE	E	E	SW	SW	SW	S	SW	S	E	E
2002	E	NE	E	SW	SW	SW	SW	SW	S	E	NE	NE
2003	NE	NE	NE	S	SW	SW	SW	SW	SW	E	E	NE
2004	E	E	E	E	W	SW	SW	SW	W	E	E	E
2005	E	E	E	W	W	W	W	W	W	E	E	E
2006	E	E	E	W	W	W	SW	SW	W	E	E	E
2007	E	E	E	W	W	W	W	W	NW	NW	SE	SE
2008	E	NE	S	S	SW	SW	SW	S	S	S	NE	NE
2009	NE	NE	NE	SW	S	W	SW	SW	SW	SW	NE	NE
2010	NE	NE	SW	SW	S	S	S	SW	SW	SW	E	E
2011	NE	NE	NE	SW	SW	SW	S	SW	SW	SW	NE	NE
2012	E	E	E	E	W	W	W	W	W	E	E	E
2013	E	E	NE	E	SW	SW	SW	Sw	W	E	NE	E

Source: NIMET 2014

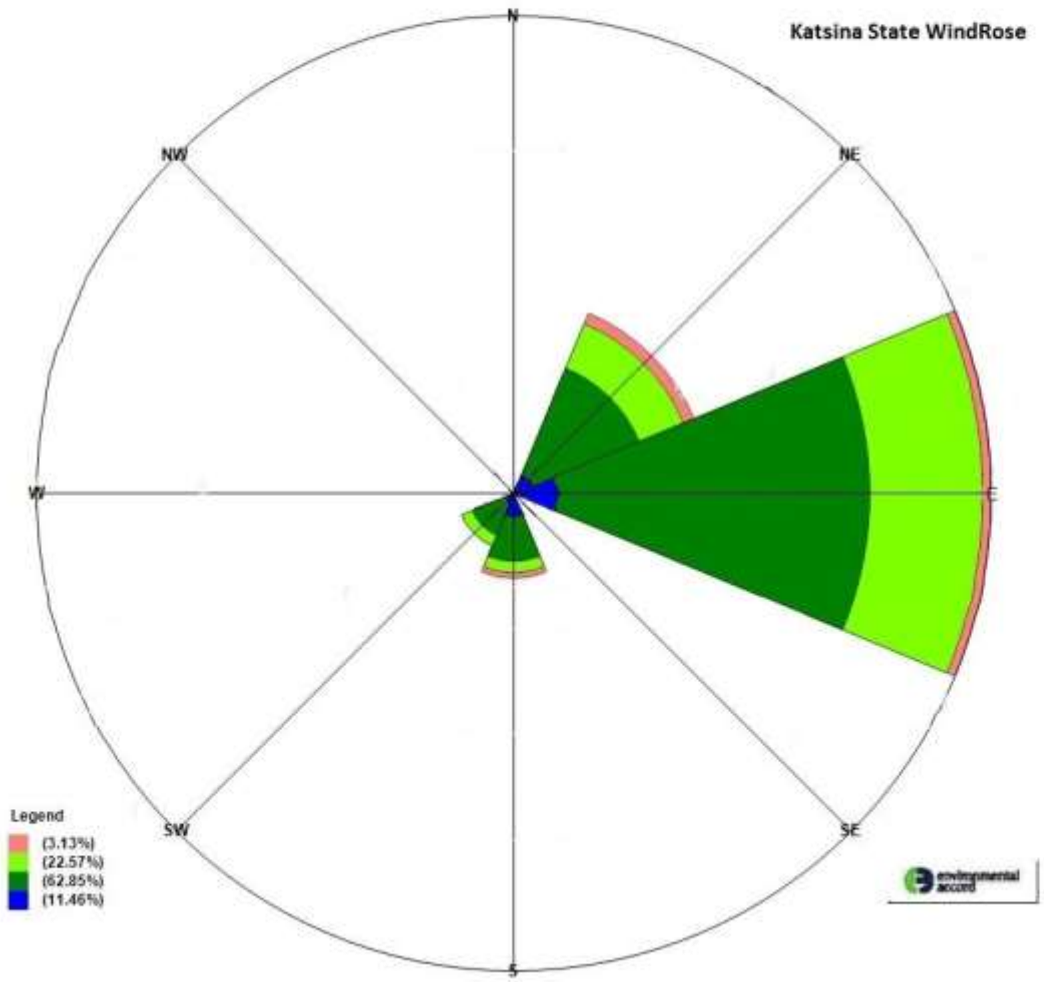

Figure 4.7: Wind Rose for the Project Area

- **Sunshine Hour**

Although, variations do occur, it never exceeds ± 1 hour of daylight or darkness. The mean monthly sunshine hour in the Project area ranges between 7.09 hours in August (peak of the rainy season) and 8.75 hours in October.

Katsina State generally experiences high sunshine hours throughout the year and is regarded as one of the states in Nigeria with high intensity of sunlight. The number of daily sunshine hours is strongly related to the influence of seasonal atmospheric alteration by cloud and rainfall. The mean monthly distribution of sunshine hours in the study area between 1989 and 2013 is shown in Figure 4.8.

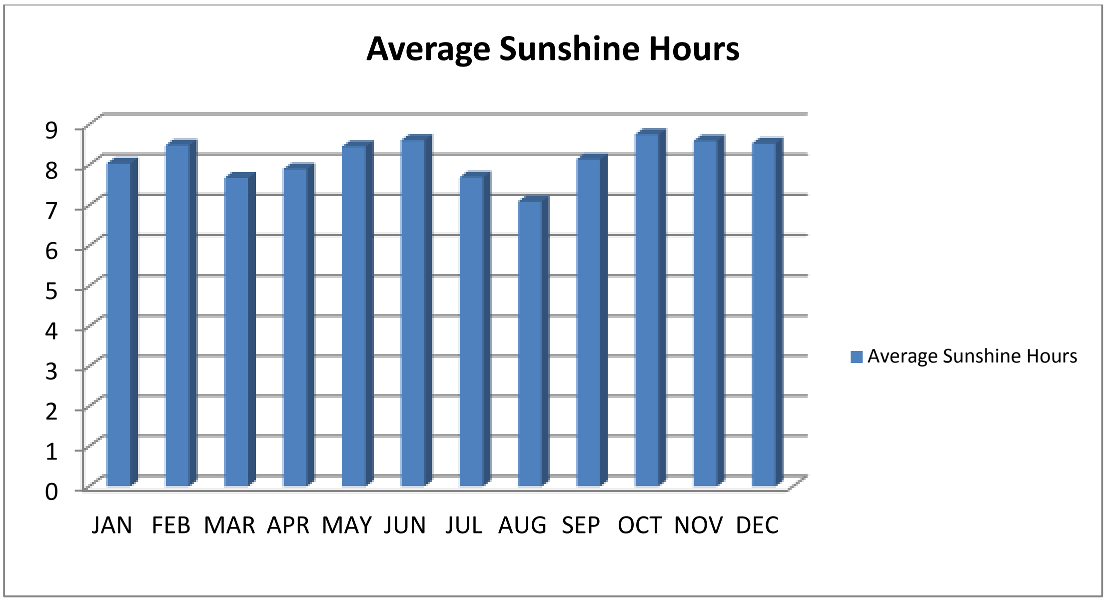

Figure 4.8: Mean monthly distribution of Sunshine Hours in Katsina State (1989-2013)
Source: NIMET 2014

4.4.2 Ambient Air Quality and Noise

A total of twenty (20) locations were sampled in the study area for ambient air quality and noise. The air quality and noise sampling locations maps are shown in Figures 4.9 and 4.10. Sample photographs of activities during the air quality measurements are provided in Plate 4.1.

In-situ air quality measurement was conducted at each of the sampling stations using pre-calibrated Aeroqual 500 and Aerocet 531. The air quality parameters measured include: Sulphur (IV) Oxide (SO_2), Nitrogen (IV) Oxide (NO_2), Carbon monoxide (CO), Carbon Dioxide (CO_2), Ammonia (NH_3), Hydrogen Sulphide (H_2S), and Total Suspended Particulate.

Ambient noise levels were measured using a pre-calibrated Extech Integrated Sound Level Meter (detection range of 30 dBA to 130 dBA) on the A-weighted scale in unit decibels.

The A-weighted sound level measurement is frequently used in the assessment of overall noise emission because it is considered to provide a rating of industrial broadband noises that indicate the injurious effects such noise has on the human ear. As a result of its simplicity in rating the hazard to hearing and its ability to provide reasonably good assessments of speech interference and community disturbance conditions, the A-weighted sound levels have been adopted by United States Environmental Protection Agency (USEPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) as the preferred measurement for assessing noise exposure.

Figure 4.9: Air Quality and Noise Sampling Locations (within the Project Site and its immediate surroundings)

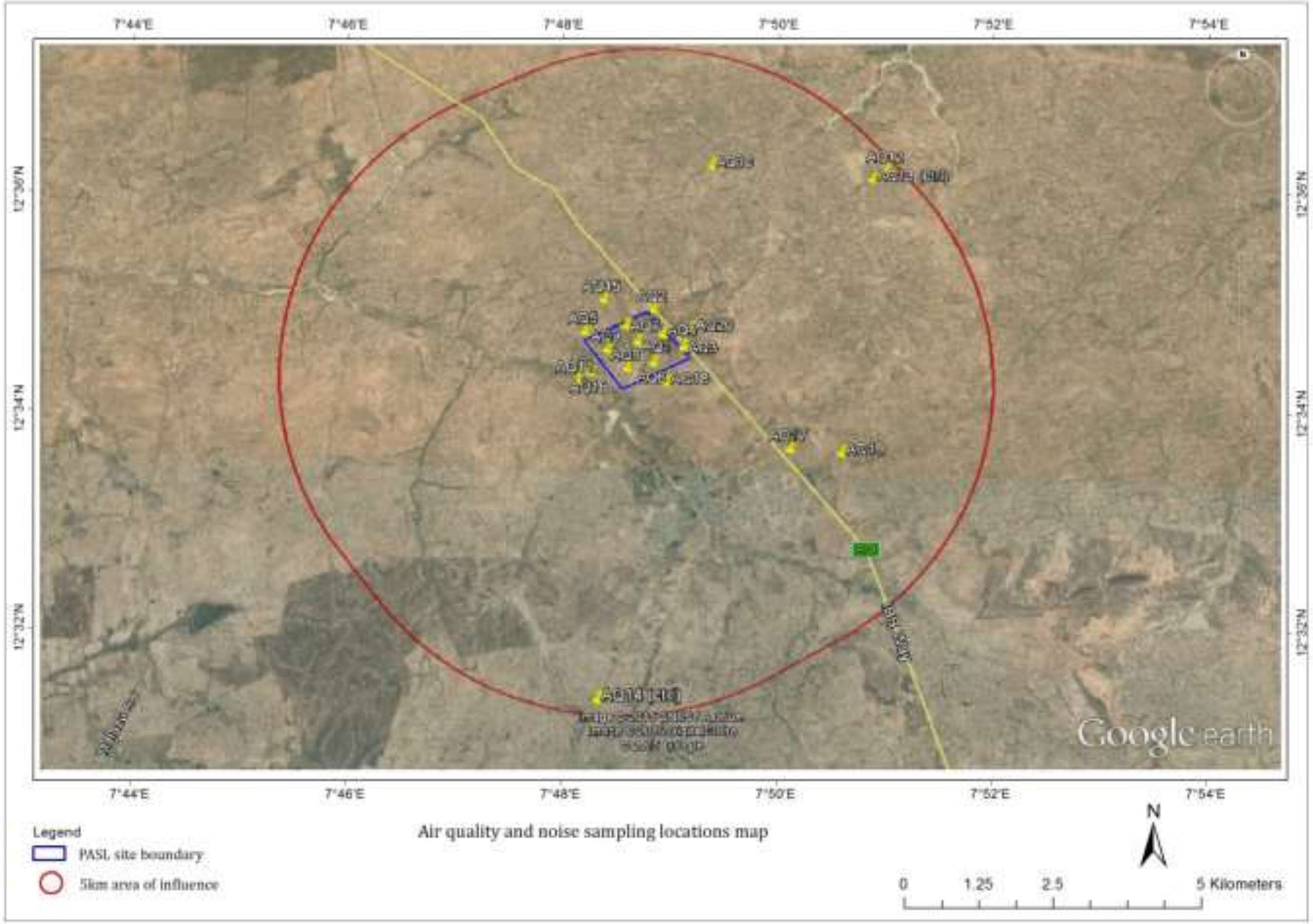

Figure 4.10: Air Quality and Noise Sampling Locations in the entire Study Area

Plate 4.1: Air quality measurements in the study area

The results of air quality and ambient noise level of the study area are summarized in Table 4.5 below. Detailed results for each of the sampling locations are provided in Appendix 6.

Table 4.5: Descriptive summary of air quality and noise results of the study area

Parameter/ Unit	*Wet Season			**Dry Season (data obtained from report of previous study conducted in 2013 within the project area)	
	Range	Mean	Mean Ctrl	Range	Mean
	(ppm)			(mg/m³)	
TSP	0.037-0.174***	0.094***	0.205***	0.5 -0.52	-
CO	0-1.01	0.078	0	0.1-4.5	0.171
SO_2	0-1.13	0.072	0.045	0.1-0.2	0.129
NO_2	0.046-0.241	0.127	0.111	0.2-1.0	1.343
CO_2	312-852	540.722	537	-	-
H_2S	0-0.14	0.014	0	-	-
CH_4,	0-0.14	0.008	0	-	-
NH_3	0-0.25	0.128	0	1-0.02	1
Noise Level, dBA	51.5-70.9	58.62	53.35	55.3-69.7	65.143

Source: *EnvAccord Wet Season Field Survey, October 2014; **EIA of 20 MW Photovoltaic Solar Power Project at Kankia, 2013 * mg/m³**

The concentrations of air quality parameters recorded in the study area were compared with the Nigerian Ambient Air Quality Standards (NAAQS) and the WHO

Air Quality Guidelines. Also, the ambient noise levels recorded in the area were compared with the FMEnv standards and the World Bank Noise Level Guidelines. The summary of these limits is provided in Tables 4.6 to 4.8.

Table 4.6: Air Quality Standards

Pollutant	Averaging Time	FMEnv Limit		WHO Guidelines (μg/m³)
		(μg/m³)	(ppm)	
CO	1-hour	11.4	10	-
NO_2	1-hour	75-113	0.04-0.06	200
TSP	24-hour	250	-	150
SO_2	1-hour	260	0.1	500

Source: FMEnv 1991; World Bank General EHS 2007

Table 4.7: Noise Exposure Limits for Nigeria

Duration per Day, Hour	Permissible Exposure Limit dB(A)
8	90
6	92
4	95
3	97
2	100
1	105

Source: FEPA (now FMEnv), 1991

Table 4.8: World Bank Noise Level Guidelines

Receptor	One Hour LAeq (dBA)	
	Day time (07:00 -22:00)	22:00 -07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Source: World Bank General EHS 2007

The results of air quality measurements carried out in the study area are discussed as follows:

- Wet Season

During the wet season, TSP concentrations recorded in the study area ranged from 0.037 mg/m³ to 0.174 mg/m³ with an average value of 0.0943 mg/m³. The values were below the national ambient air quality standard for TSP in ambient air (0.25 mg/m³). This indicates that the ambient air of the project area could be said to be good in terms of TSP concentration during the wet season.

The SO_2 concentrations recorded at the proposed Project site during the wet season were mostly below the detection limit 0.01 ppm. In contrast however, varied concentrations of SO_2 which ranged from <0.01 – 1.13 ppm were recorded at the sampling locations outside the Project site. In general, the low SO_2 concentrations recorded across the project site was indicative of an unpolluted environment while the high SO_2 values recorded in some sampling locations

(AQ11, AQ16, AQ17 and AQ20) outside the project site could be attributed to vehicular movements as noted during field sampling.

NO_2 concentrations recorded in the study area during the wet season survey ranged from 0.046 to 0.241 ppm with a mean value of 0.126 ppm. For some of the sampling locations, elevated concentrations of NO_2 were recorded, these were found to exceed the FMEnv standard for NO_2 in ambient air (0.04 - 0.06 ppm for 1-hour time weighted average). However, this could be due to vehicular movement.

The concentrations of CO recorded in the study area during the wet season survey ranged from 0.00 ppm to 1.01 ppm with an average value of 0.11 ppm. The CO values obtained were below the FMEnv limit of 10 ppm (1-hour time weighted average) for CO concentration in ambient air.

The ambient noise level recorded in the study area during the wet season survey ranged from 51.50 dBA to 70.90 dBA with an average of 58.38 dBA. The noise levels were generally below the FMEnv limit of 90 dBA.

- <u>Dry Season</u>

The TSP values reported in the study area during the dry season survey ranged from 0.05 mg/m^3 to 0.52 mg/m^3. This maximum TSP value was found to be above the FMEnv prescribed limit for TSP in ambient air (0.25 mg/m^3). This could be attributed to the intense dusty-dry harmattan winds that predominate in the study area during the dry season. The SO_2 concentrations reported for the study area ranged from 0.1 to 0.2 mg/m^3, below the FMEnv recommended limit for SO_2 in ambient air (0.26 mg/m^3). The NO_2 concentration recorded across the study area during this period ranged from 0.1- 0.2 mg/m^3 which is slightly higher than the FMEnv limit for NO_2 in ambient air (0.075 - 0.113 mg/m^3).

The ambient noise level reported in the study area during the dry season ranged from ranged from 55.3 to 69.7 dBA, below the FMEnv limit of 90 dBA.

- <u>Seasonal Variation</u>

The comparison of the ambient air quality results over the dry and wet seasons show that there are no significant seasonal variations in the values obtained. Generally, the concentrations of air quality parameters tend to be higher in the dry season than the wet season due to the prevailing weather conditions in the dry season such as high temperature, low relative humidity and high wind speed which contribute to an increase in ambient pollutants concentrations especially suspended particulate. No significant seasonal variation was also noted in the levels of ambient noise recorded in the study area.

4.4.3 Geology and Geomorphology

4.4.3.1 General Geology of Katsina State

Katsina State is composed of undulating plains which generally rise gently from 360m in the northeast around Daura, to 600 m around Funtua in the southwest. Generally, the state has two geological regions. The south and central parts of the state are underlain by crystalline rocks of the Basement Complex (from Funtua to DutsinMa), but in the northern parts cretaceous sediments overlap the crystalline rocks. Kankia is underlain by Pre-cambrian complex.

4.4.3.2 Geology of the Project Site

The site geotechnical survey (initially undertaken for Phase 1 site) revealed that the near-surface ground of the area was formed of compacted fine-grained sediments, such as clays and silts and a conglomerate with lateritic matrix. The results of a sieve analysis of the fine-grained sediments identified hard sandy clay and sandy clay. Quartzite pebbles of 10 mm were identified as the largest single component in the conglomerate. There are no rocky outcrops within the entire project site covering approximately 120 ha. However, the Pre-cambrian granitic host-rock in form of rocky outcrop is found immediately outside the Project site towards the south.

4.4.3.3 Elevation, Relief and Surface Drainage

The site terrain is wavy with a maximum variation in elevation of 10 m, between approximately +546 m and +535 m msl. The upper-surface lies, mainly, on a lateritic conglomerate matrix. The conglomerate is partly covered by a firm, medium-plastic clay layer. The elevation survey of the area shows a slightly undulating and generally westward sloping surface. The mean elevation of the area was +542 msi. Appendix 7 contains additional information on the geotechnical survey report of the Project area.

There are two major clay excavation pits towards the southeast of the site. The maximum depth of the pits is approximately 3.5 m. The pits are at least in the rainy season partially filled. The natural drainage pattern in the area is towards the south of the Project site where Kankia Dam is located.

4.4.4 Soil

A total of twelve (12) stations within the study area were sampled for soil analysis. The soil sampling locations are presented in Figures 4.11 and 4.12. Soil samples were collected using a stainless steel auger at two depths: 0-15 cm (top soil) and 15-30 cm (sub soil). Once the auger was retrieved, the contents were examined to note the physical characteristics. The soil samples were then stored and transported to the laboratory for physico-chemical and microbial analysis.

Figure 4.11: Soil sampling locations within the Project site and its immediate surroundings

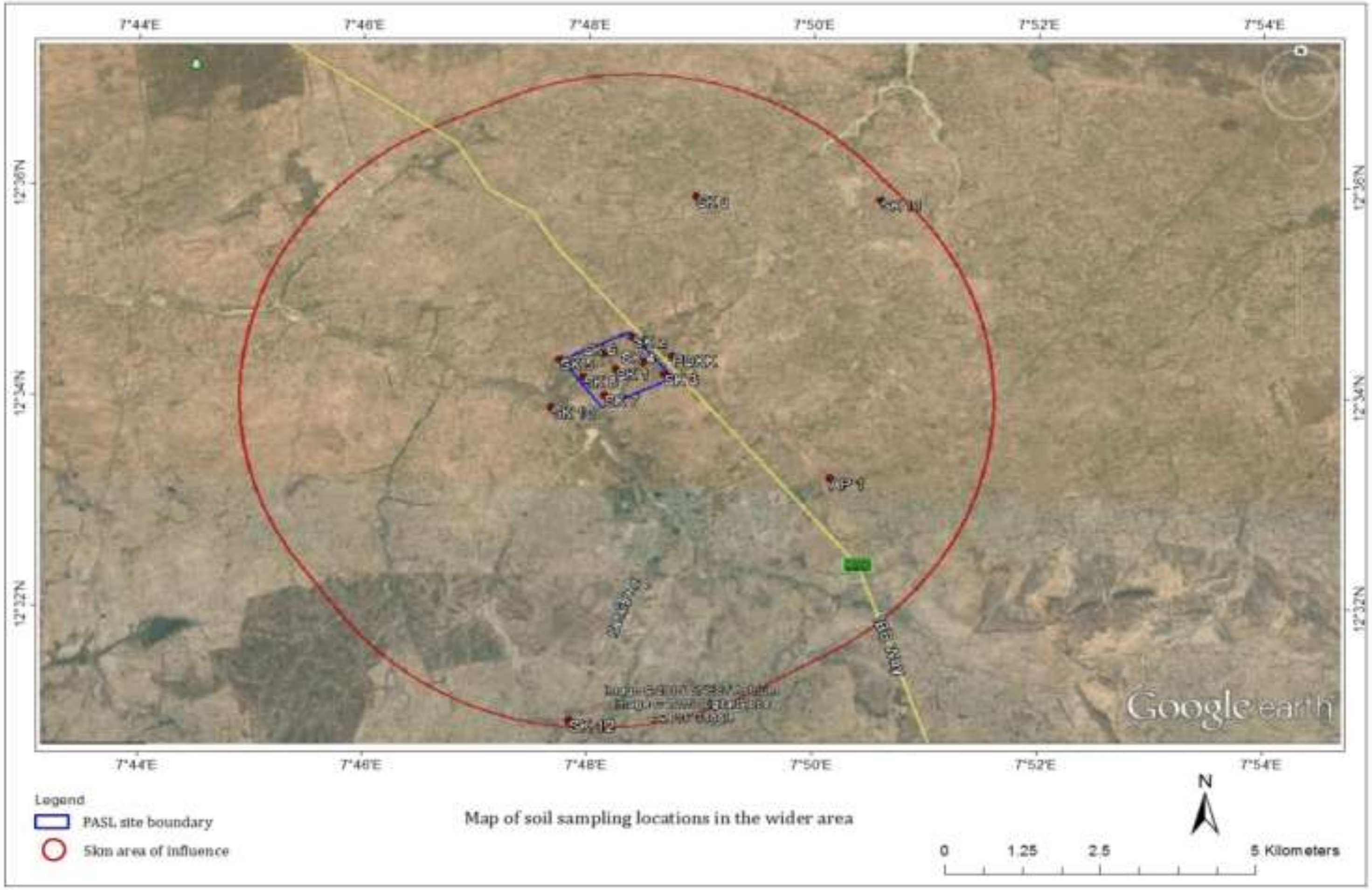

Figure 4.12: Soil sampling locations within the entire study area

4.4.4.1 Soil Texture

The soil texture was determined by the balance of clay, silt and sand particles and by the organic humus content of the soil. For practical considerations, soil texture and related soil structure influence soil workability, drainage and management.

Table 4.9 summarizes the percentage composition of clay, silt and sand recorded in soil samples from the study area. The soil of the Project area can generally be described as sandy clay.

Table 4.9: Summary of Soil texture of the Project Area

Composition (%)	*Wet Season	**Dry Season (data obtained from report of previous study conducted in 2013 in the project area)
	Range	Range
Clay (%)	4.76-20.13	12.00-24.30
Silt (%)	0.93-6.31	16.00-19.50
Sand (%)	74.39-94.17	68.00-69.70
Bulk Density g/cm^3	0.691-1.745	1.50-1.55

Source: *EnvAccord Wet Season Field Survey, October 2014; **EIA of 20 MW Photovoltaic Solar Power Project at Kankia

4.4.4.2 Soil Erodibility

Soil erodibility is an estimate of the ability of soils to resist erosion, based on the physical characteristics of each soil. Generally, soils with faster infiltration rates, higher levels of organic matter and improved soil structure have a greater resistance to erosion.

Larger soil particles such as sand are more easily detached. Coarse-textured soils high in sand are not easily eroded by water because rainfall can infiltrate them easily, so there is little runoff to detach and transport them. However, sandy soils are prone to wind erosion because the individual particles are easy to detach. Sand, sandy loam and loam textured soils tend to be less erodible than silt, very fine sand, and certain clay textured soils.

Based on the results of grain size analysis presented in Table 4.9 above, the Project area is not considered to be prone to erosion that could be significant. However, as observed during the field survey, a section of the Project site (approximately 3 ha) towards the south had in the past been flooded (Plate 4.2). The flood plain area is considered to be lowland characterized by loose sandy soil.

Plate 4.2: A cross section of the flood plain area within the project site

4.4.4.3 Physico-chemical Characteristic of the Soil

Table 4.10 below presents the descriptive summary of the results of some physico-chemical parameters analysed in soil samples collected from the study area. The full results are provided in Appendix 6.

Table 4.10: Descriptive Summary of Some Parameters analysed in the Soil

Parameter	*Wet Season			**Dry Season (data obtained from report of previous study conducted in 2013 in the project area)	
	Range	Mean	Mean Ctrl	Range	Mean
pH	5.02-8.42	6.50	6.04	6.2-6.4	6.28
Moisture (%)	1.33-13.3	4.55	1.33	1.65-1.94	4.55
NO_{3}^{-} mg/kg	1.00-7.00	4.00	2.75	-	-
SO_{4}^{2-} mg/kg	8.00-28.00	12.79	13.50	-	-
PO_{4}^{3-} mg/kg	4.00-31.00	11.39	5.75	1.10-2.01	1.82
Fe, mg/kg	48.89-112.56	79.44	106.70	-	-
Pb, mg/kg	0.00-0.05	0.02	0.06	-	-
Zn, mg/kg	0.00-0.14	0.06	0.12	0.00-0.01	
Ni, mg/kg	0.00-0.10	0.03	0.07	-	-
Cu, mg/kg	0.00-0.31	0.08	0.16	-	-

Source: *EnvAccord Wet Season Field Survey, October 2014; **EIA of 20 MW Photovoltaic Solar Power Project at Kankia

The soil physico-chemical results are briefly discussed in the following paragraphs:

For the wet season sampling, the soil pH ranged from 5.02 to 8.42 (i.e. slightly acidic to alkaline). Soil pH is a measure of the free H^+ and OH^- concentration of soil solutions. The importance of soil reaction lies in the fact that it provides a variety of useful information such as relative availability of plant nutrients, extent of H^+ formation by hydrolysis of aluminium and degree of dissociation of H^+ from cation exchange sites. The pH values recorded in the soil fall within the optimal pH range of 4.5 to 9.0 within which plants can grow well for agricultural purposes.

Moisture Content: The moisture content of the soil is a major constituent of plant protoplasm and is essential for photosynthesis. It is also the medium of nutrients movement into and through plant parts and, provides turgidity, which helps plant parts to maintain proper form and position to be able to capture sunlight. The amount of moisture in soil depends on many factors which include soil type, soil organisms, soil organic matter, and climatic conditions. The moisture contents of soil samples from the study area ranged from 1.05 % to 13.30 % in the wet season.

Anions: The nitrate concentrations in the soil samples (top and sub soil) ranged from 1.00 mg/kg to 7.00 mg/kg while phosphate ranged from 4.00 to 32.00 mg/kg. The soil nutrient in terms of nitrate and phosphate concentration is considered to be low. Sulphate concentrations in the soil samples ranged from 8.00 mg/kg to 28.00 mg/kg.

Heavy Metals: Heavy metals are metals having a mass number greater than 20 and a specific gravity greater than 5.0 g/cm^3. They occur naturally in the environment at low concentrations. However, heavy metal pollution may occur when anthropogenic activities cause the discharge of heavy metal laden waste into the environment. When this occurs, plant and animals may absorb these toxic elements which can impair proper growth and physiological development.

Some heavy metals such as Zinc (Zn) and Iron (Fe) are however needed in trace amounts by plants for physiological activities. For example, Fe is required in plants for chlorophyll formation. At elevated concentrations beyond the naturally occurring level or permissible limit, heavy metals pose threat to plants.

The concentrations of heavy metals recorded in soil samples from the study area during the wet season sampling are provided as follows:

Copper (Cu): Cu concentrations in the soil samples ranged from 0.01 mg/kg to 0.31 mg/kg which fall within the recommended limit 50-100 mg/kg for tropical arable soils as prescribed by Alloway 1990.

Lead (Pb): Pb concentrations ranged from <0.001 mg/kg to 0.05 mg/kg. The values of Pb recorded in the soil samples were below the prescribed limit of 2-20 mg/kg for unpolluted soil (Alloway 1990).

Iron (Fe): Fe had the highest concentration among the heavy metals analyzed in the soil samples. Its concentration ranged between 48.89 mg/kg and 132.70 mg/kg. Fe is regarded as one of the most abundant heavy metals in the earth crust.

Zinc (Zn): The concentrations of Zn recorded in the soil samples ranged from <0.001 mg/kg to 0.14 mg/kg. The values are below the prescribed limit of 10- 50 mg/kg for Zn in unpolluted soil.

Nickel (Ni): Ni concentrations in the soil samples ranged from <0.001 mg/kg to 0.1 mg/kg, below the prescribed limit of 5-500 mg/kg (Alloway 1990).

For the dry season results, the physico-chemical characteristics of soil environment of the project area were based on the findings of previous EIA study conducted in 2013 within the project area. The pH values reported ranged from 6.2 to 6.4, indicating slightly acidic. Calcium ranged from 0.45 mg/kg to 2.25 mg/kg, Potassium ions ranged from 1.10 mg/kg to 2.09 mg/kg, and Magnesium ions ranged from 0.13 mg/kg to 1.00 mg/kg. The concentrations of the cations were similar to the levels often recorded in soil environment in tropical areas. No heavy metal pollution was reported in the soils. The concentrations of heavy metals reported in the soil samples from the Project area during the dry season survey are generally within the naturally occurring limits (refer to Appendix 6).

4.4.4.4 <u>Soil Microbiology</u>

The population of total heterotrophic bacteria (THB) and total heterotrophic fungi (THF) counts in soil samples from the study area is summarized in Table 4.11. Micro-organisms are ubiquitous and also present in the soil environment.

The THB and THF counts in the soil are similar to those occurring in natural level. THB and THF in the soil samples ranged from 1.25 x 10^8 to 2.99 x 10^8 cfu/gm and 3.0 x 10^4 to 13.0 x 10^4 cfu/gm respectively. The percentage of hydrocarbon utilizing bacteria (HUB) in the soil samples is less than 1 % of the total heterotrophic bacteria recorded in the study area. This indicates that the soil environment is not polluted with hydrocarbon compounds that could serve as substrates for the HUB to thrive well.

Table 4.11: Descriptive summary of the Microbiological Content of Soil Samples from the study area

Parameter/Unit	Wet season	
	Range	Mean
Total Heterotrophic Bacteria/Total Plate Count x 10^8 cfu/ml	1.18-2.99	1.99
Total Heterotrophic Fungi x 10^4 cfu/ml	3.00-13.00	7.36
Total Coliforms	0.00-1.50	0.35
Hydrocarbon Utilizing Bacteria x 10^2 cfu/ml	12.00-32.00	21.14
Hydrocarbon Utilizing Fungi x 10^2 cfu/ml	1.00-8.00	3.31
% Percentage Hydrocarbon Utilizers	0.01	0.01

Source: EnvAccord Wet Season Field Survey, October 2014

4.4.4.5 Seasonal Variation of Soil Sample Results

No significant variations were noted in the results of soil samples from the study area during the wet and dry seasons. The soil of the area is generally slightly acidic with low level of nutrients. No heavy metals accumulations were recorded in the soil during the wet and dry seasons.

4.4.5 Hydrology, Water Use and Groundwater Quality

4.4.5.1 Hydrology

The hydrological survey of the Project site and its surrounding environment revealed that the Project area is generally lacking in natural surface water bodies or seasonal river beds. Periodic rainfall is expected to occur in the area (especially in the month of April to October) resulting in storm water. The run-off is largely expected to readily penetrate the surface soil locally or drain along the surface terrain through the central depression in the Project site in the south westward direction. The tendency for flooding in the project area is very limited. The Project area generally experiences low annual rainfall compared to the Southern part of Nigeria.

4.4.5.2 Water Use in the Project Area

Water plays an important role in human's daily activities. In order to gain a better understanding of the water use in the study area, interviews were held with some residents in the Project's host communities. A walk-around tour of the communities was also undertaken.

The major sources of water in the Project area are hand dug wells, boreholes, excavated pits (for water retention) and Kanki Dam. The nearest shallow hand dug well to the Project site is approximately 330 m north in Fanga Village, one of the villages/wards that constitute Kafin Dangi community. The depth of the well as at the time of site visit in March 2014 was approximately 70 m. Another shallow well close to the Project site is approximately 1 km southwest in Kauyan Dawa community with a depth of approximately 30 m. The hand dugs wells are mostly recharged during the rainfall period. No existing borehole is present within the Project site. Water for the proposed Project activities will be sourced from boreholes which will be dug onsite.

Some of the boreholes in the communities, where available, are provided by the Kankia LGA as part of its rural development programme.

The Kankia Dam is situated approximately 200 m southwest of the Project site. The dam was constructed about 12 years ago by the Kastina State Government (Ministry of Water Resources) to serve as a source of water for irrigation and domestic use in Kankia. At the time of site visit in March 2014, the dam was found to be non-operational and under repair. Information from officials of Kankia LGA revealed that the dam had been non-functional for about two (2) years. This was attributed to an incomplete maintenance work carried out on the dam. It was also gathered that the Federal Government, through the Sokoto-Rima River Basin Development Authority is planning to revamp the dam. The capacity of the dam could not be ascertained at the time of this study. No electricity (power) is generated from the dam.

Water is mostly used in the Project area for domestic purposes, irrigation and livestock rearing as indicated in Plate 4.3.

Plate 4.3: Water use activities in the Project Area

4.4.5.3 Groundwater Quality

Groundwater samples were collected from existing boreholes and hand dug wells in the study area, specifically from the neighbouring communities. A total of four (4) groundwater resources were sampled, inclusive of control point. The sampling locations are indicated in Figure 4.13.

At each sampling station, groundwater samples were collected into 2-litre polyethylene bottles for general physico-chemical analysis, while samples for oil & grease / hydrocarbon determination were collected in 1-litre glass bottles and preserved with concentrated sulphuric acid. Samples for heavy metals were collected separately in plastic containers and fixed with concentrated nitric acid. Pre-sterilized 50 ml McCartney bottles were used for samples meant for microbial analysis.

In-situ measurement was conducted in the groundwater samples for the following parameters (with short holding time):

- pH,
- Electrical conductivity,
- Total dissolved solids (TDS),
- Dissolved oxygen,
- Ambient water temperature

Measurement was carried out with the use of a pre-calibrated Extech Oyster Water. Plate 4.4 below shows sample photographs of groundwater sampling activities in the study area.

Plate 4.4: Groundwater sampling activities in the Study Area

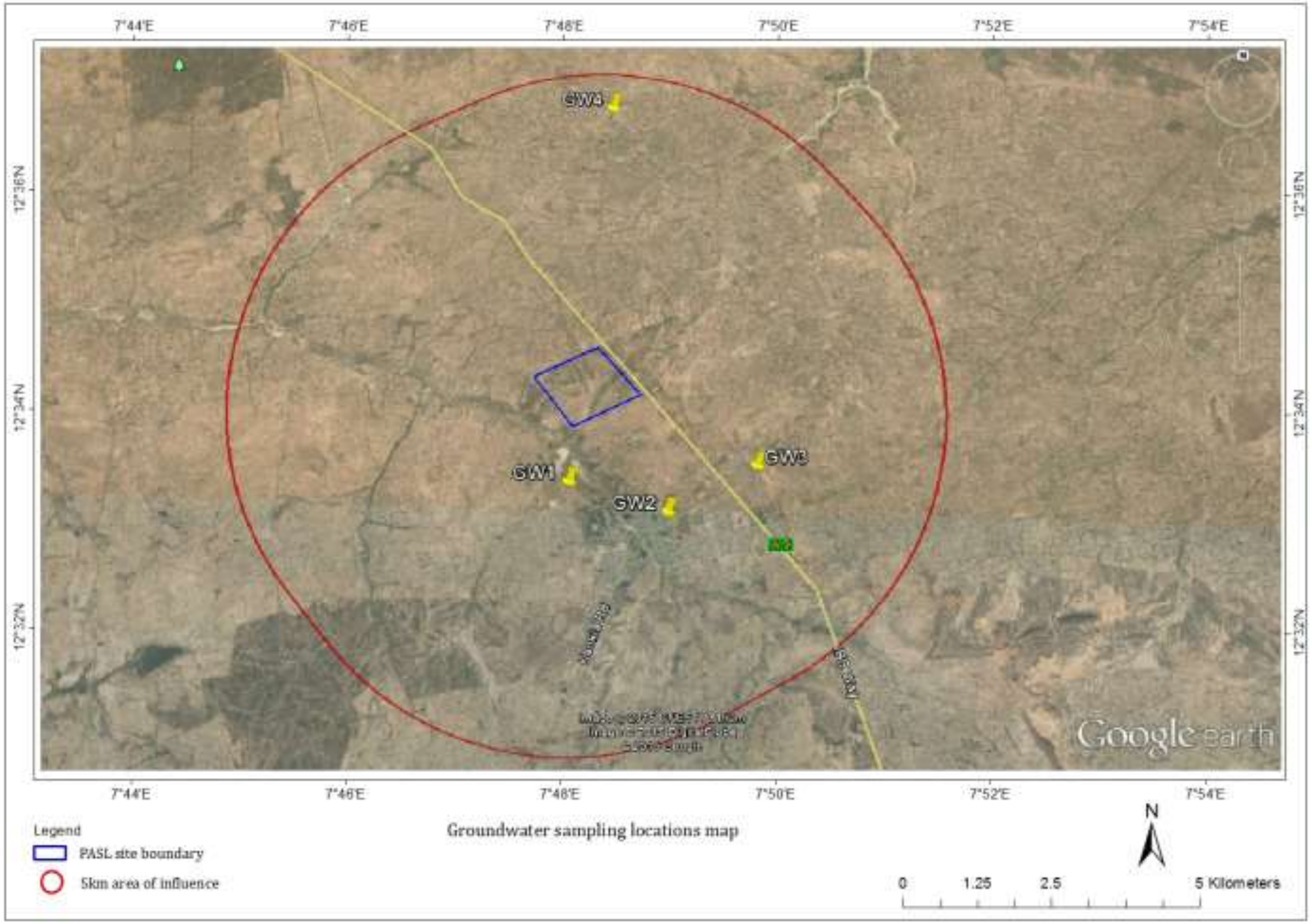

Figure 4.13: Groundwater sampling locations in the study area

The results of the physico-chemical analysis of groundwater samples collected from the study area are summarized in Table 4.12 below. The full results are provided in Appendix 6.

Table 4.12: Descriptive summary of physico-chemical results of groundwater samples from the study area

PARAMETER	*Wet Season		**Dry Season (data obtained from report of previous study conducted in 2013 in the project area)		WHO Limit		FMEnv. Limits
	Range	Mean	Range	Mean	Highest Desirable Level	Max. Permissible Level	
pH	6.66 - 7.68	6.99	7.1-7.91	7.44	7.0-8.5	6.5-9.2	6.5-8.5
Conductivity, µS/cm	183.70 - 530.00	389.42	28.00 - 110.50	75.17	NS	1000	-
Turbidity (mg/l)	0.68 - 1.64	1.01	Trace		NS	NS	1
Hardness, mg/l	86.74 - 110.65	101.11	-	-	100	500	200
Temperature, 0C	29.20 - 32.20	30.53	26.50 - 34.60	29.2	NS	NS	<40
Total Dissolved Solids, mg/l	93.70 - 264.00	193.93	48.00 - 99.00	66.67	200	500	500
Salinity, ppt	0.07 - 0.31	0.18	0.00 - 0.03	0.02	NS	NS	NS
DO, mg/l	4.50 - 4.97	4.77	2.10 - 2.90	2.61	NS	NS	7.5
COD, mg/l	64.00 - 128.00	96	9.13-12.22	12.22	NS	NS	NS
BOD, mg/l	1.34 - 2.02	1.73	9.13-10.9	2.69	NS	NS	0
Total Suspended Solids, mg/l	0.68 - 2.12	1.45	1.20 - 5.63		NS	NS	<10.0
Nitrate, mg/l	2.00 - 3.00	2.50	1.2-13.2	13.2	NS	NS	10
Sulphate, mg/l	15.00 - 30.00	21.5	-	-	200	400	500
Phosphate, mg/l	3.00 - 7.00	4.5	0.7-2.54	1.31	NS	NS	5
Potassium, mg/l	3.60 - 4.70	4.05	-	-	NS	NS	NS
Oil and Grease, mg/l	<0.001	ND	ND	-	NS	NS	0.05
Lead, mg/l	ND	ND	ND	-	NS	NS	0.05
Copper, mg/l	0.01-0.11	0.0625	-		0.05	1.5	1
Cadmium (mg/l)	-	-	-	-	-	-	<1
Chromium (mg/l)	-	-	1.2-13.2	-	-	-	<1

Source: *EnvAccord Wet Season Field Survey, October 2014; **EIA of 20 MW Photovoltaic Solar Power Project at Kankia NS= Not Specified ND= Not Detected

In the wet season, the pH of the groundwater samples ranged from 6.66 to 7.68 (very slightly acidic to slightly alkaline). The pH falls within the WHO and FMEnv limits of 6.5 - 9.2 and 6.5 - 8.5 respectively for drinking water. Ambient groundwater temperature values ranged between 29.2 ^{0}C and 30.9 ^{0}C, which fall within the FMEnv recommended limit of <40 ^{0}C for potable water. The Electrical conductivity of the groundwater samples ranged from 183.70 to 530.00µS/cm, below the WHO limit of 1000 µS/cm. The Total Dissolved Solids in the groundwater samples ranged between 93.7 mg/l and 264.00 mg/l which fall below the WHO and FMEnv limits of 500ppm for potable water. Salinity of the groundwater samples was very low indicating freshwater environment. The values ranged from 0.07 ppt to 0.13 ppt.

The Biological Oxygen Demand (BOD) in the groundwater samples ranged from 1.34 mg/l to 2.02 mg/l while the Chemical Oxygen Demand (COD) ranged from 64.00 to 128.00 mg/l. The BOD values are slightly above the FMEnv limit of 0.0 mg/l for BOD in drinking water. This may be attributed to human and animal waste contamination. Dissolved Oxygen content of the groundwater samples ranged between 4.50 mg/l and 4.97 mg/l, below the FMEnv limit of 7.5mg/l for potable water.

Heavy metals in the groundwater samples were either recorded in low concentrations or below the detection limits of Atomic Absorption Spectrophotometer (AAS) used for analysis. The concentrations of Oil & Grease in the groundwater samples were less than 0.001 mg/l.

For the microbial properties, the population of total heterotrophic bacteria (THB) count recorded in the groundwater samples ranged from 1.380 x 10^2 cfu/ml to 2.270 x 10^2 cfu/ml while total heterotrophic fungi population occurred between 3.0 x 10 cfu/ml and 11.0 x 10 cfu/ml. The micro-organisms in the ground water were probably introduced from the soil within the area since microorganisms are important components of soil. The results of microbial analysis of the groundwater samples are summarized in Table 4.13 below. Detailed results are presented in Appendix 6.

Table 4.13: Descriptive summary of the Microbiological Content of water Samples across the study area

Parameter/Unit	Wet season	
	Range	Mean
Total Heterotrophic Bacteria x 10^2 cfu/ml	1.38 - 2.27	1.80
Total Heterotrophic Fungi x 10 cfu/ml	3.00 - 11.00	6.25
Total Coliforms	0.00 - 1.40	0.35
Total Hydrocarbon Utilizing Bacteria cfu/ml	ND	ND
Total Hydrocarbon Utilizing Fungi cfu/ml	ND	ND

Source: EnvAccord Wet Season Field Survey, October 2014 ND= Not Detected

In the dry season, the pH values reported in groundwater samples from the Project area ranged from 7.1 to 7.91 (neutral to slightly alkaline). The pH values were within the permissible limit recommended by FMEnv and WHO for potable water. Electrical conductivity ranged from 28.0 to 110.5µS/cm, below the WHO limit of 1000 µS/cm. TDS ranged from 48.0 to 99.0 mg/l, below the FMEnv limit of 500 mg/l for drinking water. No heavy metal or hydrocarbon contaminations were reported in the groundwater samples.

4.4.6 Habitat and Terrestrial Flora

4.4.6.1 Introduction

This section presents the terrestrial flora characteristics of the Project site and the surrounding environment. Plants contribute greatly to human welfare, and environmental sustainability. In addition they also provide other benefits such as, holding valuable information about a site's environmental conditions. The occurrence, relative abundance, physiology, and tolerance of certain plants show the prevailing environmental conditions of an area.

A vegetation survey was undertaken to be able to describe and document the baseline vegetation characteristics of the study area. The vegetation assessment was carried out at nine (9) sampling locations within and around the Project site using belt transect method (Figure 4.14). Interviews were also held with officials of the Department of Agriculture, Kankia LGA as part of the assessment.

Flora specimens were identified in the field (*in situ)* and in the herbarium (*ex situ*) using appropriate manuals and monographs. Photographs were taken at the sampling points and adjoining areas to record relevant plant and animal species, habitat characteristics and other features.

In addition, the ecological status of the species encountered was evaluated and classified appropriately according to the following threat categories (IUCN, November 2014.3) as may be applicable: a) Extinct, b) Extinct in the Wild, c) Critically Endangered, d) Endangered, e) Vulnerable, f) Near Threatened, g) Least Concern, h) Data Deficient, i) Not Evaluated.

The results of the vegetation assessment are presented as follows:

- Habitat characterization
- Plant Species Distribution
- Physiognomy, Floristic composition, and Biodiversity assessment
- Inventory of economic plants
- Protected Areas

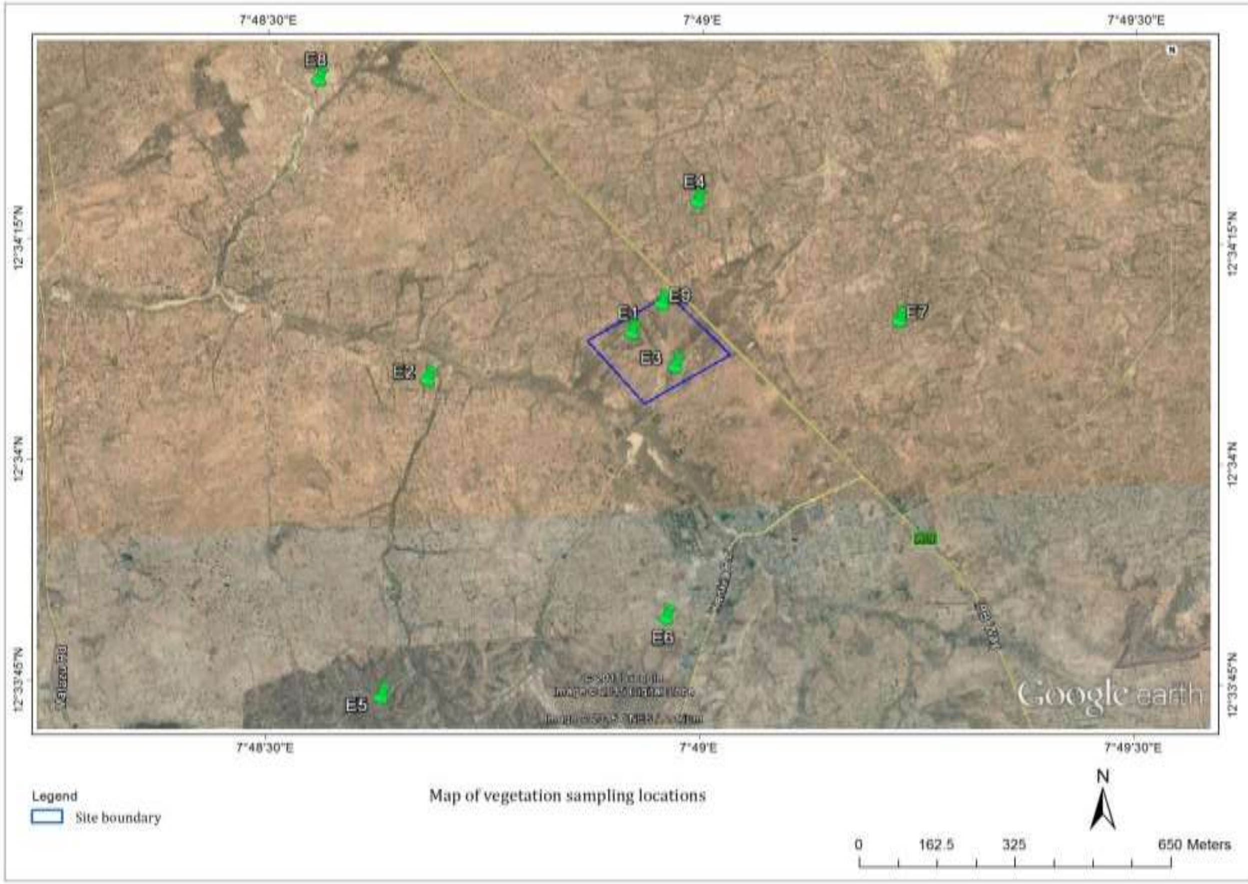

Figure 4.14: Vegetation sampling locations within and around the Project Site

4.4.6.2 Habitat Characterization

The study area lies within the Sudan Savannah vegetation belt of Nigeria in West Africa. By virtue of this, it falls within the tropical continental vegetation belt of Africa which is known to have a distinct ecological landscape consisting of semi-arid areas with scattered trees, shrubs and grass vegetation.

The primary ecosystem within the project site was found to be characterized by open savannah vegetation with shrubs, grasses and herbs which appear green in the wet season and pale brown and withered in the dry season. Only scattered trees (less than 10 in number) are present within the Project site. The height of the trees ranged from approximately 4 to 9 m. The vegetation of the Project site is mainly regarded as shrub-grazing land. No farmlands or wetland are present on site. The vegetation of the project site was noted to have been largely altered by human interference.

The wider study area can be generally characterized as a modified habitat in line with the IFC Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources- which defines modified habitats as "areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands".

The habitat types identified in the wider study area (Figure 4.15) include the following:

- Grazing Land
- Cultivated areas (farmland)
- Wetland

These are further described below:

Grazing Land

The vegetation in the grazing land areas is dominated by herbaceous species. The diversity of herbaceous species is higher during the wet season, while diversity and abundance were greatly reduced during the dry season. The plant species that dominate the grazing areas are *Combretum micrathum and Cassia obtusifolia.* Plates 4.5 and 4.6 show the photographs of the dominant vegetation type found within the Project site and the grazing activities in the area.

As noted during the baseline field survey, the livestock grazing is mostly free ranging although some pastoral farmers from the neighbouring communities such as Kauyan Maina and Kanfin Dagi situated over 2km from the Project site occasionally lead livestock, mostly cattle, to the site for grazing.

Plate 4.5: Dominant vegetation type found within the Project Site

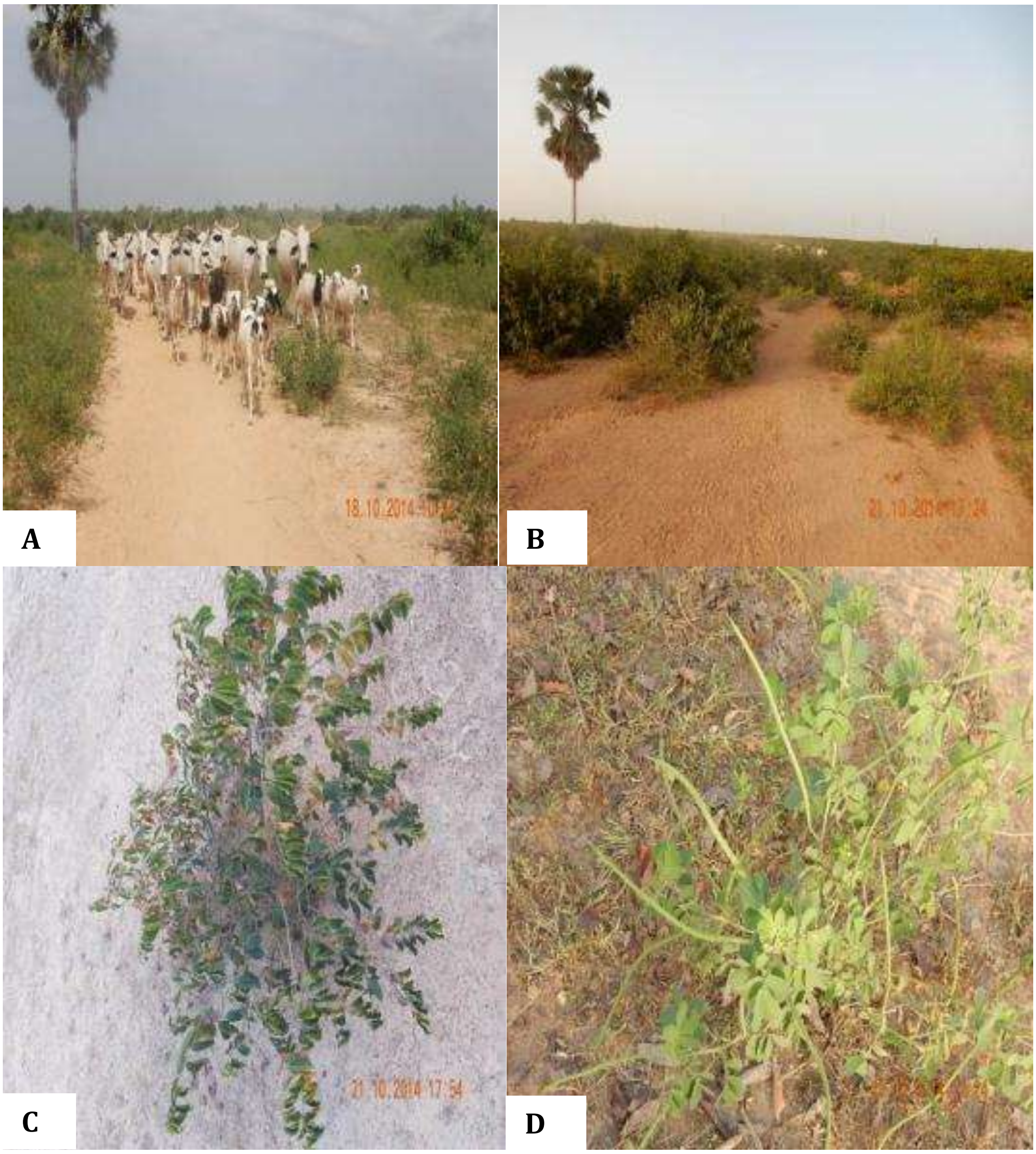

Plate 4.6: A; Grazing activities observed within the study area B; Grazing land dominated by *Combretum micrathum* (c) *and Cassia obtusifolia* (D)

Cultivated Areas (Farmland)

Areas that have been used for agriculture are found within the study area but outside the Project site. These areas are largely devoid of natural trees and shrubs due to clearing of the land, and planting with agricultural crops. Crops usually planted in the area include sorghum, millet, rice, and maize. As at the time of the additional site visit conducted in March 2015, there were no farmlands on the Project site as well as its immediate surrounding up to about 200 m radius from the site boundary.

A photograph of one of the farmlands noted in the wider study area is shown in Plate 4.7 below.

Plate 4.7: Photograph of a farmland in the study area (about 800 m from the Project site)

Wetland

Wetlands ecosystems encountered in the wider study area were mostly observed to be as a result of human activities such as clay excavation. Plate 4.8 shows the wetland species noted in the area.

Plate 4.8: Wetland Species; A) *Paspalum virginatum*, B) *Nypheae lotus*

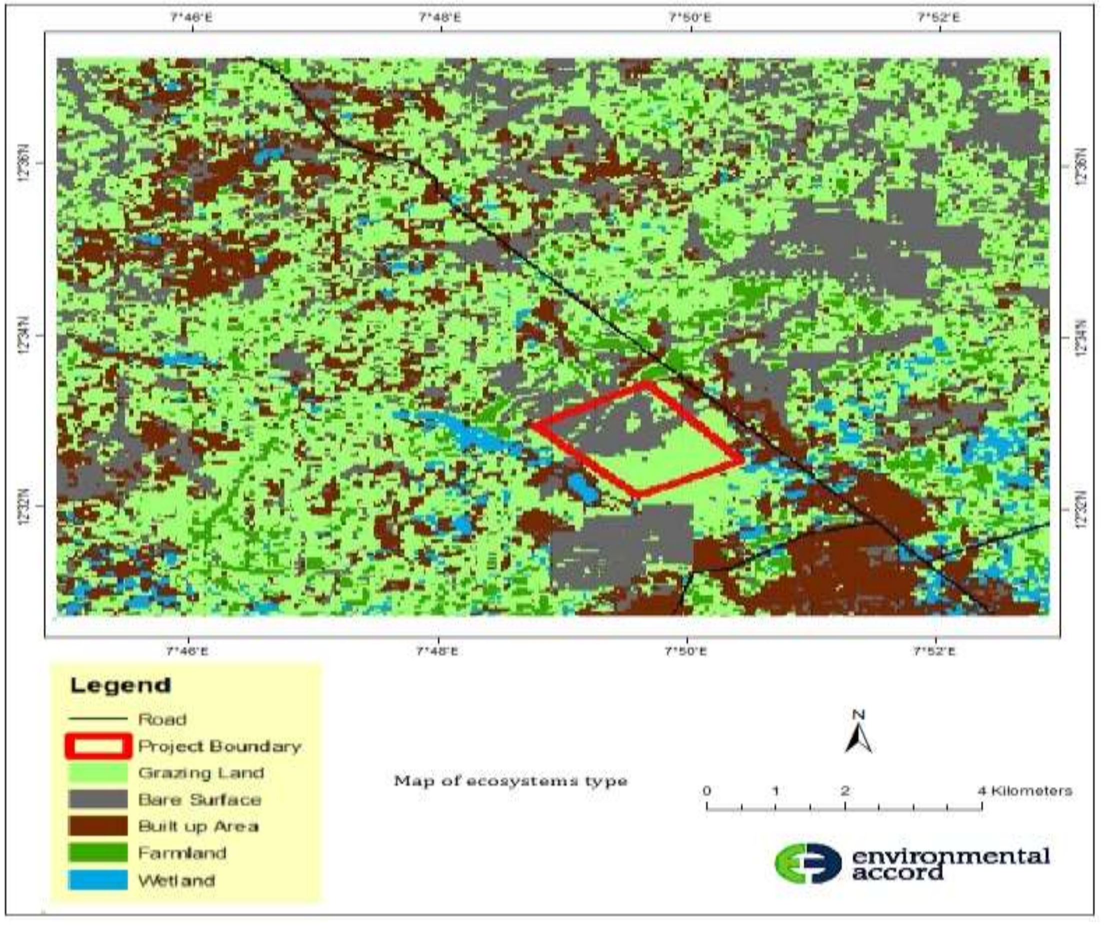

Figure 4.15: Map of habitat types noted in the study area

Table 4.14 summarizes the habitat description noted at each of the locations sampled as well as the common plant species recorded.

Table 4.14: Floristic Composition and Habitat Description

Sample Locations	GPS Co-ordinates	Remarks
*PASL E1	7.818269, 12.559389	Grazing land dominated by *Cassia occidentalis, Pennisetum glaucum* and *Acacia niloticaand Acacia nilotica*
PASL E2	7.807894, 12.56594	Farmland dominated with plantations of *Lycopersicon esculentum , Glycine max , Phaseolus vulgaris , Pennisetum glaucum and Capsicum sp.*
*PASL E3	7.816454, 12.564671	Grazing land dominated by *Cassia sieberiana and Combretum micrathum*
PASL E4	7.841816, 12.587825	Grazing land dominated by *combretum micrathum, Cassia occidentalis and Balanites aegyptiaca*
PASL E5	7.787525, 12.527971	Abandoned farmland dominated by *Acacia nilotica, Sorghum bicolor and Cassia occidentalis*
PASL E6	7.807477, 12.555423	Grazing land dominated by *Cassia occidentalis and Acacia nilotica*
PASL E7	7.823006, 12.574519	Grazing land dominated by *Cassia sieberiana and combretum micrathum, Cassia occidentalis*
PASL E8	7.781431, 12.605118	Farmland dominated by *Sorghum bicolor , Cassia occidentalis, Azadiracta indica and piliostigma reticulatum*
*PASL E9	7.821423, 12.562912	Grazing land dominated by *Acacia nilotica combretum micrathum, Cassia occidentalis*

Source: EnvAccord Wet Season Field Survey, October 2014 *Within the project site

4.4.6.3 <u>Plant Species Distribution</u>

The study area recorded a variety of plant species. Abundant species noted to be widely distributed within and around the study area include; *Calopogonum mucunoides, Sida acuta, Moringa oleifera Cassia occidentalis, Pennisetum glaucum, Acacia nilotica, Combretum micrathum, Cassia sieberiana and Azadiracta indica*.

Tree species observed outside the project site belong mostly to the families of Fabaceae, Poaceae, Euphorbiaceae and Combretaceae.

Table 4.15 shows the distribution of plant species encountered in the study area.

Table 4.15: Distribution of Plant Species across the Sampling Locations

Plant species encountered	Family names	*E1	E2	*E3	E4	E5	E6	E7	E8	*E9
Acacia nilotica	Fabaceae	+	+	-	+	+	-	+	+	+
Acrosticum aureum	Pteridaceae	+	-	-	+	-	-	-	-	-
Aleo buettneri	Liliaceae	-	-	-	+	-	-	-	-	-
Amaranthus viridis	Amaranthaceae	+	-	-	-	-	-	-	-	-
Anacardium occidentale	Anacardaceae	-	-	-	-	+	-	-	-	-
Anogeissus leiocarpa	Combretaceae	-	+	-	+	-	-	-	-	-
Arachis hypogaea	Fabaceae	-	+	-	-	-	-	-	-	-
Azadiracta indica	Meliaceae	+	+	-	+	+	-	+	+	+
Balanites aegyptiaca	Zygophyllaceae	-	+	-	+	-	-	+	+	+
Borassus aethiopum	Arecaceae	-	+	-	-	-	-	-	+	-
Bridella farruginea	Euphorbiaceae	-	-	-	-	+	-	-	-	-
Calopogonium mucunoides	Fabaceae	+	+	-	+	+	-	+	+	+
Calotropis procera	Asclepiadaceae	-	-	-	-	-	-	-	+	-
Capsicum sp.	Solanaceae	-	+	-	-	-	-	-	-	-
Cassia obtusifo lia	Fabaceae	+	+	-	+	+	-	+	-	+
Cassia occidentalis	Fabaceae	+	+	-	+	+	-	+	-	+
Cassia sieberiana	Fabaceae	+	-	+	-	-	-	+	-	+
Ceiba petantra	Bombacaceae	-	-	-	-	-	+	-	-	-
Celosia argentea	Amaranthaceae	+	-	-	-	-	-	-	-	-
Combretum micrathum	Combretaceae	-	-	+	+	-	+	+	-	+
Commiphora africana	Burseraceae	-	-	-	-	+	-	-	-	-
Corchorous Olitoriu	Tiliaceae	+	-	-	-	-	-	-	-	-
Delonix regia	Fabaceae	-	-	-	-	-	-	+	-+	-
Dichrostachys cinerea	Fabaceae	+	+	-	+	-	-	-	-	-
Eucalyptus camaldulensis	Myrtaceae	+	+	-	-	-	+	-	+	-
Euphobia hirta	Euphorbiaceae	-	+	-	-	-	-	-	-	-
Faidherbia albida	Fabaceae	-	+	-	-	-	-	-	-	-
Glycine max	Fabaceae	+	+	-	-	+	-	-	-	-
Gmelina arborea	Verbenaceae	-	-	-	-	-	-	+	-	+
Guiera sensgalensis	Combretaceae	-	-	+	+	-	-	-	-	+

Plant species encountered	Family names	*E1	E2	*E3	E4	E5	E6	E7	E8	*E9
Hyphaene thebaica	Arecaceae	-	+	-	-	-	-	-	-	-
Ipomoea batatas	Convolvulaceae	-	+	-	-	-	-	-	-	-
Jatropha curcas	Euphorbiaceae	+	-	-	+	-	-	-	-	-
Lawsonia inermis	Lythraceae	+	-	-	-	-	-	-	-	-
	Onagraceae	-	-	-	+	-	-	-	-	-
Lycopersicon esculentum	Solanaceae	-	+	-	-	-	-	-	-	-
Mangifera indica	Anacardiaceae	-	+	-	-	+	-	-	+	-
Mimosa pudica	Fabaceae	+	-	-	-	-	-	-	-	-
Monochoria vaginalis		-	-	-	+	-	-	-	-	-
Moringa oleifera	Moringaceae	+	-	+	+	-	-	+	-	+
Nypheae lotus	Nymphaeaceae	-	-	-	+	-	-	-	-	-
Olea europaea	Oleaceae	-	-	-	-	-	-	+	-	+
Oryza sativa	Poaceae	+	-	-	-	-	-	-	-	-
Parkia biglobosa	Fabaceae	+	+	-	-	+	+	-	+	-
Paspalum virginatum	Poaceae	-	-	-	+	-	-	-	-	-
Pennisetum glaucum	Poaceae	+	-	-	-	-	+	-	-	-
Phaseolus vulgaris	Fabaceae	+	-	-	-	-	-	-	+	-
Piliostigma reticulatum	Fabaceae	+	-	-	+	-	-	-	+	-
Psidium guajava	Myrtaceae	+	-	-	-	-	-	-	-	-
Sesamum Indicum	Pedaliaceae	-	+	-	-	-	-	-	+	-
Sida acuta	Malvaceae	-	+	-	+	-	+	+	+	+
Sorghum bicolor	Poaceae	+	+	-	+	+	-	-	+	-
Spigelia anthelmia	Loganiaceae	-	+	-	-	-	-	-	-	-
Vitellaria paradoxa	Sapotaceae	-	+	-	-	-	-	-	-	-
Zea mays	Poaceae	+	-	-	-	-	-	-	-	-
Ziziphus mauritiana	Rhamnaceae	-	-	-	+	+	-	-	-	-

KEY; Absent (-), Presence (+) ***Within the Project Site**
Source: EnvAccord Wet Season Field Survey, October 2014

Photographs of some of the flora species recorded in the study area are shown in Plates 4.9 and 4.10.

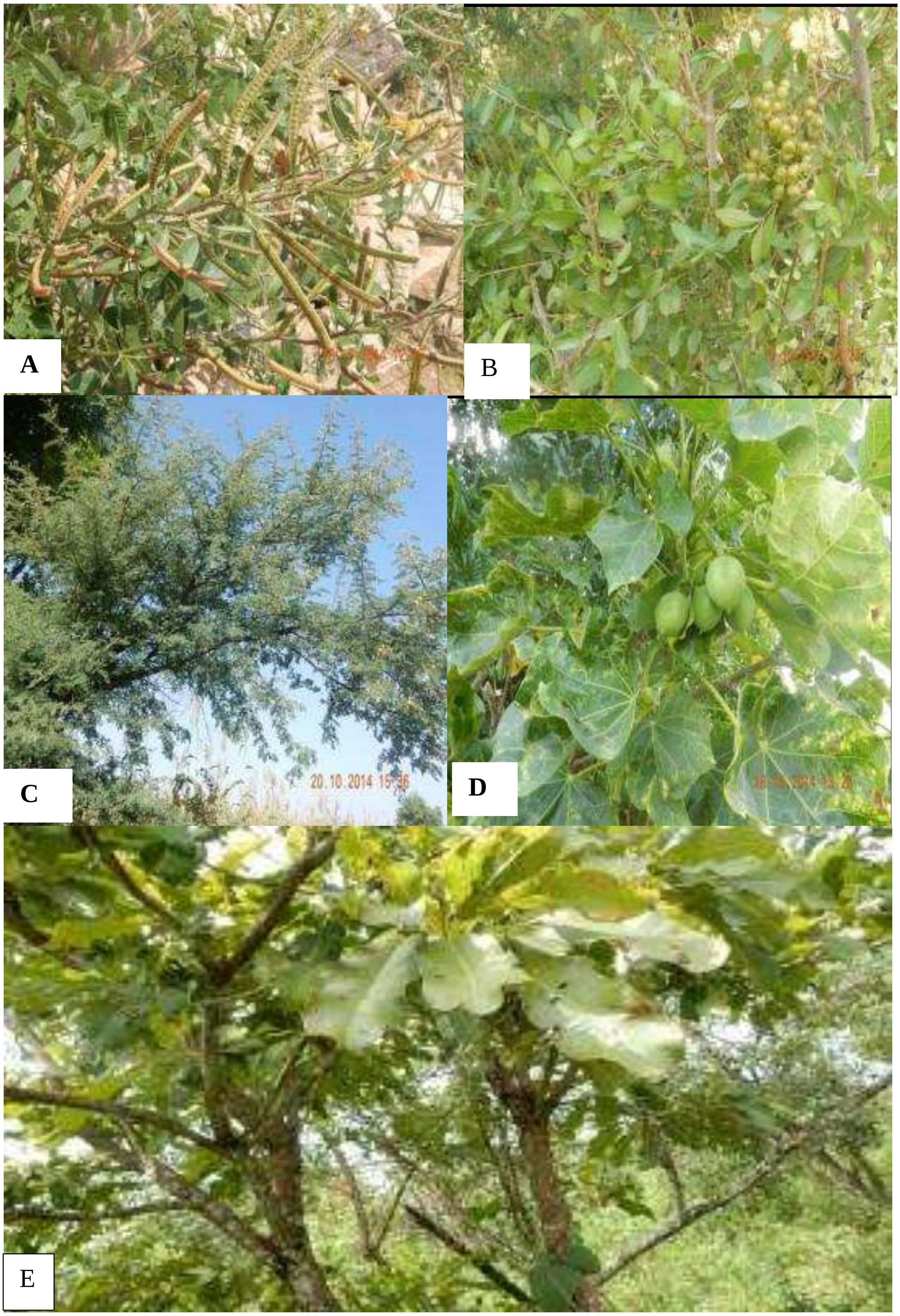

Plate 4.9: ***A; Cassia occidentalis, B; Lawsonia inermis, C; Acacia nilotica, D; Jatropha curcas E; Vitellaria paradoxa***

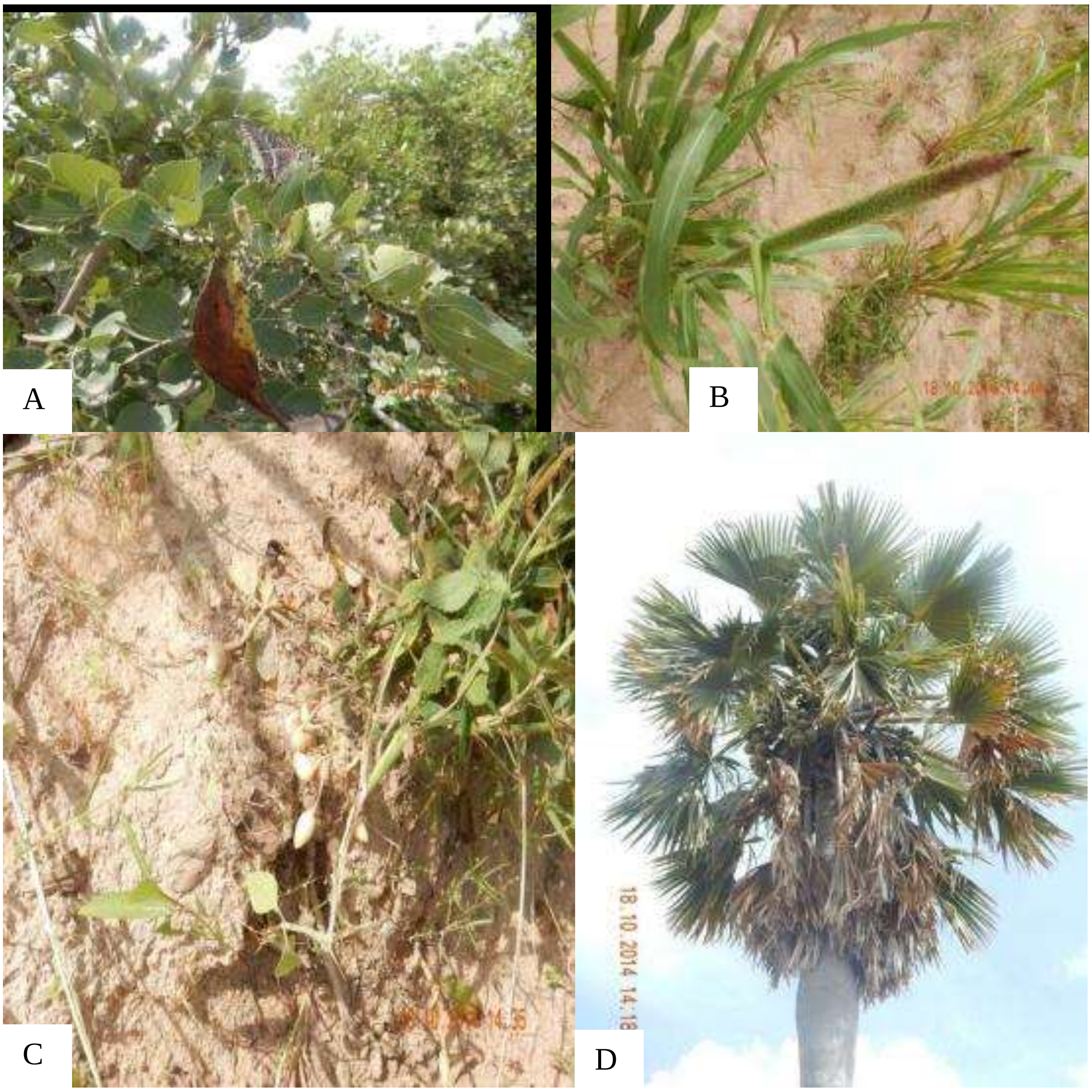

Plate 4.10: A; *Piliostigma reticulatum, B;* Pennisetum glaucum, C; *Glycine max, D; Borassus aethiopum*

4.4.6.4 <u>Physiognomy, Floristic Composition and Biodiversity Assessment</u>

Ecosystems in Nigeria are naturally endowed with arrays of floristic composition of different plant forms including trees, shrubs, herbs, ferns, climbers and other non-wood forest resources (Olajide, 2003).

Species composition, distribution and structure of the vegetation of the study area as well as the physiognomic view show few trees shrub, herb and grasses. From the study, 56 plants were identified, belonging to 22 families, 54 genera. Plant species in the entire study area of 5km radius from the Project site boundary were observed to occur as herbs, grasses, shrubs, trees, ferns and climbers with a percentage distribution of 32.8%, 8.6%, 10.3%, 39.7% and 1.72% respectively.

It is however important to note that the Project site is specifically dominated by shrubs and herbs. Only scanty trees are present. The tree species noted within the site is mainly *Borassus aethiopum.*

The full list of plant species recorded in the study area is provided in Appendix 6.

In terms of biodiversity assessment, the IUCN (International Union of Conservation of Nature) Red List of Threatened Species ((IUCN, November 2014.3) was employed. The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable).

The IUCN Red List also includes information on plants, fungi and animals that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e., are Data Deficient); and on plants, fungi and animals that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (i.e., are Near Threatened).

The plant species encountered in the study area fall under the categories of Vulnerable, Data Deficient, Least Concern and Not Evaluated with a percentage of 2%, 2%, 7% and 89% respectively as shown in Table 4.16. *Vitellaria paradoxa* which falls under IUCN vulnerable category, was encountered only in 1 out of 9 locations sampled (E2). There are no IUCN critically endangered or endangered plant species in the study area. In addition, there are no known protected species within the Project site under the Nigerian legislation.

Table 4.16: IUCN Categorization

S/N	IUCN Category	No of Plant Species	Percentage (%)
1.	Vulnerable	1	2
2.	Data Deficient	1	2
3.	Least Concern	4	7
4.	Not Evaluated	50	89

Source: EnvAccord Wet Season Field Survey, October 2014

The IUCN status of the plant species encountered in the study area is highlighted in Table 4.17 below.

Table 4.17: Species Biodiversity Status across the Study Area

Plant species	Common /local names	Family names	Habits	IUCN status
Acacia nilotica	Gum Arabic Tree	Fabaceae	Tree	NE
Acrosticum aureum	Leather Fern	Pteridaceae	Fern	NE
Aleo buettneri	Aloe	Liliaceae	Herb	NE
Amaranthus viridis	Green Amaranth	Amaranthaceae	Herb	NE
Anacardium occidentale	Cashew	Anacardaceae	Tree	NE
Anogeissus leiocarpa	African Birch	Combretaceae	Tree	NE
Arachis hypogaea	Groundnut	Fabaceae	Herb	NE
Azadiracta indica	Neem Tree	Meliaceae	Tree	NE
Balanites aegyptiaca	Desert Date	Zygophyllaceae	Tree	NE
Borassus aethiopum	African Fan Palm	Arecaceae	tree	NE
Bridella farruginea	Kizni (HL)	Euphorbiaceae	Tree	NE
Calopogonium mucunoides	Wild Ground Nut	Fabaceae	Climber	NE
Calotropis procera	Sodom Apple	Asclepiadaceae	Shrub	NE
Capsicum sp.	Pepper	Solanaceae	Herb	NE
Cassia obtusifolia	Tafassa(HL)	Fabaceae	Herb	NE
Cassia occidentalis	Tafassa(HL)	Fabaceae	Herb	NE
cassia sieberiana	African Laburnum	Fabaceae	Tree	NE
Ceiba petantra	Silk-Cotton	Bombacaceae	Tree	NE
Celosia argentea	Plumed Cockscomb	Amaranthaceae	Herb	NE
Combretum micrathum	Geza (HL)	Combretaceae	Shrub	NE
Commiphora africana	African Myrrh	Burseraceae	Tree	NE
Corchorous Olitorius	Jew's Mallow	Tiliaceae	Herb	NE
Delonix regia	Flamboyant Tree	Fabaceae	Tree	LC
Dichrotachya cinerea	Sickle Bush	Fabaceae	Tree	NE
Eucalyptus camaldulensis	River Red Gum	Myrtaceae	Tree	NE
Euphobia hirta	Asthma Plant	Euphorbiaceae	Herb	NE
Faidherbia albida	Apple-Ring Acacia	Fabaceae	Tree	NE
Glycine max	Soy-Bean	Fabaceae	Climber	NE
Gmelina arborea	Gmelina	Verbenaceae	Tree	NE
Guiera sensgalensis	Moshi Medicine	Combretaceae	Herb	NE
Hyphaene thebaica	Ipomoea Batatas	Arecaceae	shrub	NE
Ipomoea batatas	Sweet Potato	Convolvulaceae	Climber	NE
Jatropha curcas	Physic Nut	Euphorbiaceae	Shrub	NE
Lawsonia inermis	Henna Plant	Lythraceae	Shrub	NE
	Ludwigia	Onagraceae	Herb	NE
Lycopersicon esculentum	Tomatoes	Solanaceae	Herb	NE
Mangifera indica	Mango	Anacardiaceae	Tree	DD
Mimosa pudica	Sensitive Plant	Fabaceae	Herb	LC
Monochoria vaginalis	Oval-Leafed Pondweed		Herb	LC
Moringa oleifera	Moringa	Moringaceae	Tree	NE
Nypheae lotus	Water-Lily	Nymphaeaceae	Herb	NE
Olea europaea	Olive Tree	Oleaceae	tree	NE
Oryza sativa	Rice	Poaceae	Grass	NE
Parkia biglobosa	Locust Beans	Fabaceae	Tree	NE
Paspalum virginatum		Poaceae	Grass	NE
Pennisetum glaucum	Millet	Poaceae	Grass	NE
Phaseolus vulgaris	Beans	Fabaceae	Climber	NE
Piliostigma reticulatum	Kalga (HL)	Fabaceae	Tree	NE
Psidium guajava	Guava	Myrtaceae	Shrub	NE
Sesamum Indicum	Oriental Sesame	Pedaliaceae	Herb	NE
Sida acuta	Brown Weed	Malvaceae	Herb	NE

Plant species	Common /local names	Family names	Habits	IUCN status
Sorghum bicolor	Guinea Corn	Poaceae	Grass	LC
Spigelia anthelmia	Worm Weed	Loganiaceae	Herb	NE
Vitellaria paradoxa	Shea Tree	Sapotaceae	Tree	VU
Zea mays	Maize	Poaceae	Grass	NE
Ziziphus mauritiana	Indian Jujube	Rhamnaceae	Tree	NE

KEY: * HL- Hausa Language, *DD- Data Deficient, *NA- Not Evaluated, *LC- Least Concern

Source: EnvAccord Wet Season Field Survey, October 2014

4.4.6.5 Inventory of Economic Plants

Plants are gifts of nature, a variety of useful products are obtained from them, many of which are essentials for the wellbeing of mankind. There are several economic uses of plants and this can be classified under the following: food, vegetables, fruits, oilseed, sugar, spice and condiments, medicinal beverages, ornamental, etc.

The most common plant species found in the study area include *Acacia Spp., Euphorbia Spp., Hibiscus Spp., Ficus spp., Combretum spp.,* and *Ziziphus Spp*.

Table 4.18 presents the economic importance of plant species observed in the study area. The plant species within the Project site serve as forage for livestock. Information gathered from the local communities revealed that the Project site does not serve as a special ecosystem of importance to the residents of the area.

Table 4.18: Economic Importance of Flora Species Encountered

Plant species	Common names	Family names	Habits	Economic importance
Acacia nilotica	Gum Arabic Tree	Fabaceae	Tree	Forage, Gum.
Acrosticum aureum	Leather Fern	Pteridaceae	Fern	Medicine, Forage
Aleo buettneri	Aloe	Liliaceae	Herb	Medicine
Amaranthus viridis	Green Amaranth	Amaranthaceae	Herb	Vegetable
Anacardium occidentale	Cashew	Anacardaceae	Tree	Fruit
Anogeissus leiocarpa	African Birch	Combretaceae	Tree	Fuelwood
Arachis hypogaea	Groundnut	Fabaceae	Herb	Food
Azadiracta indica	Neem Tree	Meliaceae	Tree	Medicine
Balanites aegyptiaca	Desert Date	Zygophyllaceae	Tree	Food, medicine
Borassus aethiopum	African Fan Palm	Arecaceae	Tree	Food, Medicine
Bridella farruginea	Kizni (HL)	Euphorbiaceae	Tree	Medicine
Calopogonium mucunoides	Wild Ground Nut	Fabaceae	Climber	Forage
Calotropis procera	Sodom Apple	Asclepiadaceae	Shrub	Medicine
Capsicum sp.	Pepper	Solanaceae	Herb	Spice
Cassia obtusifolia	Tafassa(HL)	Fabaceae	Herb	Medicine
Cassia occidentalis	Tafassa(HL)	Fabaceae	Herb	Medicine
Cassia sieberiana	African Laburnum	Fabaceae	Tree	Timber
Ceiba petantra		Bombacaceae	Tree	Timber

Plant species	Common names	Family names	Habits	Economic importance
Celosia argentea	Plumed Cockscomb	Amaranthaceae	Herb	Vegetable
Combretum micrathum	Geza (HL)	Combretaceae	Shrub	Medicine
Commiphora africana	African Myrrh	Burseraceae	Tree	Medicine
Corchorous Olitorius	Jew's Mallow	Tiliaceae	Herb	Vegetable
Delonix regia	Flamboyant Tree	Fabaceae	Tree	Firewood, Medicine
Dichrotachya cinerea	Sickle Bush	Fabaceae	Tree	Firewood
Eucalyptus camaldulensis	River Red Gum	Myrtaceae	Tree	Firewood
Euphobia hirta	Asthma Plant	Euphorbiaceae	Herb	Medicine
Faidherbia albida	Apple-Ring Acacia	Fabaceae	Tree	Medicine
Glycine max	Soy-Bean	Fabaceae	Climber	Medicne, Food
Gmelina arborea	Gmelina	Verbenaceae	Tree	Medicine, Timber
Guiera sensgalensis	Moshi Medicine	Combretaceae	Herb	Medicine
Hyphaene thebaica	Ipomoea Batatas	Arecaceae	Shrub	Medicine
Ipomoea batatas	Sweet Potato	Convolvulaceae	Climber	Food
Jatropha curcas	Physic Nut	Euphorbiaceae	Shrub	Medicine, Biofuel
Lawsonia inermis	Henna Plant	Lythraceae	Shrub	Medicine
	Ludwigia	Onagraceae	Herb	Medicine
Lycopersicon esculentum	Tomatoes	Solanaceae	Herb	Spices
Mangifera indica	Mango	Anacardiaceae	Tree	Food, Medicine
Mimosa pudica	Sensitive Plant	Fabaceae	Herb	Medicine
Monochoria vaginalis	Oval-Leafed Pondweed		Herb	Medicine
Moringa oleifera	Moringa	Moringaceae	Tree	Medicine, Food
Nypheae lotus	Water-Lily	Nymphaeaceae	Herb	Medicine
Olea europaea	Olive Tree	Oleaceae	Tree	Medicine
Oryza sativa	Rice	Poaceae	Grass	Food
Parkia biglobosa	Locust Beans	Fabaceae	Tree	Spice
Paspalum virginatum		Poaceae	Grass	Medicine
Pennisetum glaucum	Millet	Poaceae	Grass	Medicine
Phaseolus vulgaris	Beans	Fabaceae	Climber	Food
Piliostigma reticulatum	Kalga (HL)	Fabaceae	Tree	Medicine
Psidium guajava	Guava	Myrtaceae	Shrub	Food
Sesamum Indicum	Oriental Sesame	Pedaliaceae	Herb	Medicine
Sida acuta	Brown Weed	Malvaceae	Herb	Medicine
Sorghum bicolor	Guinea Corn	Poaceae	Grass	Food
Spigelia anthelmia	Worm Weed	Loganiaceae	Herb	Medicine
Vitellaria paradoxa	Shea Tree	Sapotaceae	Tree	Medicine
Zea mays	Maize	Poaceae	Grass	Food, Fodder
Ziziphus mauritiana	Indian Jujube	Rhamnaceae	Tree	Medicine

Source: EnvAccord Wet Season Field Survey, October 2014

4.4.6.6 Protected Areas

IUCN defined protected areas as Areas of land and/or sea dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means (IUCN, 1994).

There are no protected areas within the entire 120 ha of the Project site. However, in the wider environment of the study area (within 5 km radius), some areas are designated as plantation by the Katsina State Government and Kankia LGA. Under the laws, the areas should not be encroached or tampered with without approvals from the relevant authority. The identified plantations noted in the wider study area of the proposed Project are provided in Table 4.19 and Figure 4.16.

Table 4.19: List of Plantations noted in the wider study area of the Project site

S/N	Plantation Areas	GPS Co-ordinates	Remarks	Dominant Species Encountered
1.	Nasarawa Plantation	7.8124, 12.50420	Occupies about 50-70 hectares of land. It is located along Kankia road, Kastina State. It is approximately 5 km from the Project site.	*Acacia nilotica Cassia occidentalis, Azadiracta indica, Balanites aegyptiaca, Parkia biglobosa, Borassus aethiopum, Calotropis procera, Eucalyptus camaldulensis, Phaseolus vulgaris*.
2.	Katsina Green Initiative Programme (Road Side tree plantings {afforestation program} for preventing desertification)	7.82256, 12.56906	It is 12 m by 250 m, located along IBB Way. It is approximately 500 m from the Project site.	*Gmelina arborea, Olea europaea Delonix regia.*
3.	Department of Forestry, Wood Fuel Plantation.	7.81764, 12.53189	Occupies about 10 hectares of land. It is located at Kukar, Kwaidae. It is approximately 3 km from the Project site.	*Cassia occidentalis, Azadiracta indica, Eucalyptus camaldulensis, Combretum micrathum, Piliostigma reticulatum.*

Source: EnvAccord Wet Season Field Survey, October 2014

In addition, there are no culturally significant sites or heritage assets within the Project site and the immediate surrounding environment based on the information gathered from the local communities and Katsina State Ministry of Culture and Tourism, chance find survey, and desktop review of existing reports related to the project area.

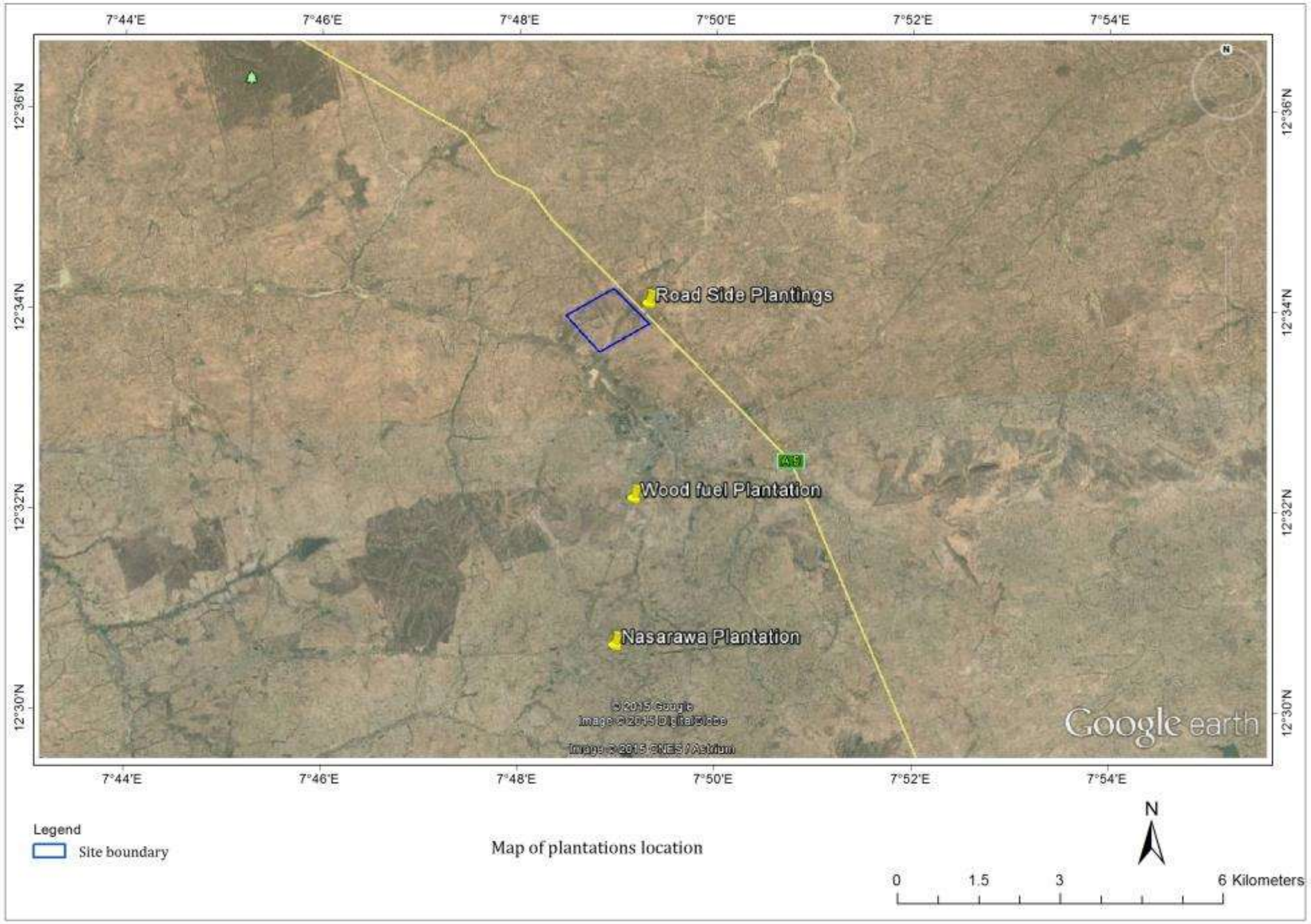

Figure 4.16: Map of existing plantations noted in the study area

4.4.7 Terrestrial Fauna

4.4.7.1 Methodology

A combination of sampling techniques were used for the fauna assessment of the study area and included identifying major ecosystem types to identify associated fauna, collecting and preserving representative fauna specimens (e.g. insects), analysis of tracks, faecal samples, nest type, feeding site, bird noise, shell types, interviews with local communities and review of relevant literature.

4.4.7.2 Findings

The findings of the fauna assessment are presented as follows:

- The Project Site

The proposed project site is situated on a 120ha land area characterised by open savannah vegetation consisting of shrubs, grasses and a few trees. The fauna species found within the project site at the time of survey include invertebrates such as annelids (earthworms), arthropods (ants, termites, and beetles) and vertebrates such as reptiles (lizards, skink), birds (sparrow, pigeons and waxbill) and mammals such as (cattle, sheep, goat and camel). No spawning area for frogs or other aquatic organisms was encountered within the Project site. Plates 4.11 and 4.12 below show some fauna species encountered at the project site during the survey.

It is important to note that the mammals such as sheep, goat and camel noted on the site move freely from one location to another. They do not permanently reside on the site. They are occasionally moved to the site due to the presence of shrubs and herbs for grazing.

Plate 4.11: (A). Black Ants colony (B). Termite's mound belonging to colony of *Microteres species*

Plate 4.12: Livestock grazing within the proposed project site (A). Goat *Capra species* (B) Cattle *Bos bos*

- <u>The Transmission Corridor</u>

Results of fauna assessment carried out along the proposed transmission corridor indicate low fauna diversity. This could be attributed to the residential nature of the area (the proposed transmission route would pass through a land area belonging to two communities; Gachi and Daourawa). The dominant fauna species of the area include domestic animals (cattle, sheep, goats, camel, and dogs). Other animal species noted in the area include insects, lizard and birds. The transmission line route is mostly dominated by shrubs and grasses with scanty trees.

Plate 4.13: Fauna species found along the proposed transmission line (A). Camel *camelus species* (B) Goat *Capra species*

- <u>Immediate Surroundings of the Project Site</u>

The fauna species identified in the immediate surroundings of the project site (1km, buffer area) include; invertebrates such as (insects, arachnids and myriapods) and vertebrae such as (amphibian, reptiles and mammals). The Kankia dam which is situated close to the proposed project site (approximately 200 m) used to provide habitat for aquatic vertebrates such as frog and small fishes, before it was abandoned for repair. The aquatic vertebrates around the dam include fish species such as (Alestes *Alestes nurse*, and Tilapia *Tilapia spp*) and Amphibians such as (Toads *Bufo spp* and Frogs *Rana spp*.).

Plates 4.14 to 4.15 show some fauna species encountered in the immediate surrounding (1 km buffer area) of the project site.

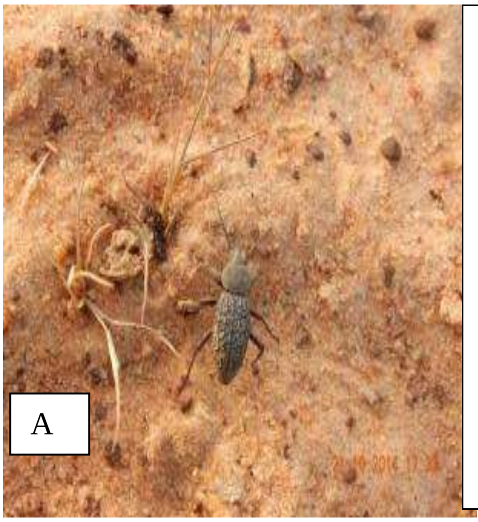

Plate 4.14: (A). Beetle (*Stephanocrates spp*) (B). Butterfly species of family Lycaenidae


Plate 4.15: (A).Waxbill *(Estrelidae spp)* **(B) Rock Pigeon (***Columba livia***)**

- <u>Wider Area of Project Influence</u>

The fauna in the wider environment of the Project's area of influence is characterised by numerous species among which are arthropods (e.g. insects and arachnids), amphibians, reptiles, birds and mammal that are suited to the seasonal weather and the hot-dry conditions. The fauna species identified include:

Invertebrate fauna: Insects, arachnids and myriapods as well as other species such as earthworms *Eudrilus euginae*, and snails *Archachatina marginata* which were found around wet areas during survey. Some insect species of this area are of economic importance, serving as food sources, crop pests and disease vectors of man and animals. These include aphids, grasshoppers, and honey bees.

Vertebrate fauna: Aquatic vertebrae (fish and amphibians) species inhabit the temporary water pools found in the wider area of project influence. Amphibians of this area include the frog *Rana species, Xenopus species* and toads *Bufo regularis.*

The reptilian fauna includes lizard (*Agama agama)*, Geko (*H*emidactylus species) chameleon (*Chamaeleo dilepis*) and snakes (*Natrix anoscopis)*.

The common bird types include the Francolin *Francolinus spp,* African swiff *Apus affinis*, Eagles *Haliaetus vocifer*, Egrets B*ublcus spp,* and many others i.e. Kites, Sparrows and Wood-pickers. Kankia was found to have high avian abundance and diversity and this could be attributed to the abundance of seed bearing grasses, fruits and insects in the open vegetation of the area.

Plates 4.16 and 4.17 below shows some fauna species encountered in wider area of project influence during the field study.

Plate 4.16: (A). Toad *Bufo species* found in a pond during survey (B). flap-necked chameleon *Chamaeleo dilepis*

Plate 4.17: (A).Waxbill *(Estrelidae spp)* **(B). Duck (***Anser anser***)**

The mammalian fauna reported in the wider environment of the Project's area of influence include ground squirrel *Xerus erythropus*, rodents *Thryonomis swiderianus* and antelopes *Cepholpus monticola*.

4.4.7.3 Fauna Utilization in Kankia area of Katsina State

Bush meat consumption and trade is a common practice in the study area. Other uses of animal species include hide and skin, plume, and feathers. Livestock farming is common in the study area. The commonly raised animals are: cattle, sheep, goats and domestic fowl. Others include dogs, cats, horses, monkeys and camels.

4.4.7.4 Conservation Status and Threats to Wildlife in the Study Area

Fauna species in the study area are exposed to human induced threats such as increased development activities, agriculture, and hunting.

None of the fauna species recorded in the Project site and the surrounding environment belongs to the IUCN threatened category as indicated in Table 4.20.

Table 4.20: Inventory of fauna species within the Study area and their IUCN Status

Phylum	Class	Order	Family	Common name	Local name	Scientific Name	IUCN Status
ANNELIDA	Oligocheata	Lumbriculida		Earthworms	Tanya	*Eudrilus eugeniae*	NE
ARTHROPODA	Arachnida	Araneida	Salticidae	Spider	Koda	*Alfenus chrysophaeus hiratoscirtus torquatus*	NE
	Insecta	coleoptera		Beetles	Serikinkaye	*Stephanocrates spp*	NE
		Diptera	Muscidae	Housefly	Soro	*Musca domestica*	NE
		Hymenoptera	Apedae	Honey Bees	Zuma	*Aphis melifera*	NE
			Formicidae	Ants' mound	Rina/Dila		NE
				Tailor Ants	Tura	*Oecophylla spp*	NE
				Soldier ants	Tura	*Dorylus spp*	NE
				Wasps	Rina	*Paracyphononyx spp*	NE
		Orthoptera	Pyrgomorphidae	Grasshoppers	Kaya	*Zonocerus Variegatus*	NE
			Gryllidae	African field Cricket		*Gryllus bimaculatus*	NE
		Mantodea	Mantidae	Praying Mantis		*Sphodromantis viridis*	NE
		Lepidoptera		Butterflies	Filofilo	*Aslauga camerunica*	NE
				Moth	Filofilo		NE
		Odonata		Dragonfly	Filofilo	*Crocothemis Palpopleura lucia*	NE
	Myripoda	Diplopoda		Milipedes	Susa	*Tibiomus species Peridontopyge spp Spirostreptus assiniensis*	NE
		Chilopoda		Centipedes	Bsariba	*Scolopendra spp*	NE
MOLLUSCA				African giant snail		*Archachatina marginata*	NE
				freshwater clam	Dodo		NE

Phylum	Class	Order	Family	Common name	Local name	Scientific Name	IUCN Status
CHORDATA	Pisces			Catfish	Tarabada	*Clarias gariepinus*	
			Cichlidae	Tilapia	Buku	*Tilappia spp*	NE
	Amphibian	Anura		Toad	Quado	*Bufo regularis B.ufo maculates*	LC
				Frogs		*Rana galamensis*	LC
		Squamata	Agamidae	Agama Lizards	Sari	*Agama agama*	LC
			Chamaeleonidae	Chameleon	Demo	*Chamaeleo gracilis*	LC
			Scincidae	Skinks	Damu		LC
				Geko	Adangade		LC
		Ophida	Culubridae	Green snake	Sawannachyi	*Philothalmnus heterodermus*	LC
			Elapidae	Black Necked Spitting Cobra	Gamsega	*Naja nigricolis*	LC
				Green Mamba	Sawanmahyi	*Dendroaspis jamesoni*	LC
			Viperidae	Gaboon viper	Kasa	*Bitis gabonica*	LC
	Aves	Ciconiiformes	Ardeidae	Heron / Bittern		*Ardea spp, Botarus Stellaris*	LC
				Egret		*Bulbucus spp*	LC
		Anseriformes	Anatidae	Duck	Agwagwa	*Anas spp*	LC
		Falconiformes	Accipitridae	Eagles/Hawk/ Kites	Atu	*Aviceda cuculoides, Accipiter toussenelii, Circaetus cinereus*	LC
			Sagittariidae	Buzzard	Sayia	*Buteo spp*	LC
				Kestrel	Hasbiya	*Falco spp*	LC

Phylum	Class	Order	Family	Common name	Local name	Scientific Name	IUCN Status
		Galliformes	Phasianidae	Quail/Francolin/chicken/turkey		*Coturnix adansonii, Francolinus spp Gallus gallus, Meleagris spp*	LC
			Turniciformes	Turnix		*Turnix spp*	LC
		Gruiformes	Rallidae	Fluftails	Hundu	*Sarothrura spp*	LC
				Crake		*Crex spp, Porzana spp Aenigmatolimnas marginalis*	LC
		Charadriiformes	Rostratulidae			*Rostratula benghalensis*	LC
		Columbiformes	Columbidae	Pigeon/Dove	Hasbiya	*Columba spp, Streptopelia spp,Turtur spp, Treron spp*	LC
				Coucal		*Centropus spp*	LC
		Apodiformes	Apodidae	Swifts		*Telacanthura spp, Apus spp*	LC
			Phoeniculidae	wood hopper	Hundu	*Phoeniculus spp*	LC
		Piciformes	Picidae	Woodpeckers	Hundu	*Campethera spp Dendropicos spp*	LC
		Passeriformes	Alaudidae	Lark	Hundu		LC
			Hirundinidae	Swallow	Hundu	*Hirundo spp*	LC
			Crovidae	Crows		*Crovus*	LC
			Ploceidae	Weaver birds	Hundu		LC
			Passeridae	Sparrow	Hundu	*passer spp*	LC
	Mammalia	Artiodactyla	Bovidae	Cattle	Nama	*Bos*	LC
				Sheep	Rago	*ovis aries*	LC
				Goat	Akuya	*Capra*	LC

Phylum	Class	Order	Family	Common name	Local name	Scientific Name	IUCN Status
				Antelope/duiker		*Cepholpus monticola,*	LC
			Canidae	Dogs	Kare	*Canis Familarae*	LC
		Chiroptera		Bats	Zonzoro		LC
		Rodentia	Anomaluridae	Squirrel	Kurege	*Idiurus sp Xerus erythropus,*	LC
			Thryonomyidae	Grass cutter	Busi	*Thryonomis swiderianus*	LC

NE- Not evaluated LC-Least concerned

Source: The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Retrieved on 24 December 2014

4.4.8 Landscape and Visual Baseline

This section describes the current landscape and visual characteristics of the project area. A visual assessment was conducted during the baseline survey to characterise the prevailing landscape, and assess the site visibility from various viewpoints around the proposed project site.

The proposed power plant will be sited off the Katsina-Kano Expressway approximately 120 m away in the southern direction. The landscape of the Project site and its immediate environment can generally be described as open with several patches of bare surface and sparse vegetation consisting mostly of grasses, shrubs and few trees. The terrain of the area has a mixed gradient which can be described to vary from flat to gentle slope for most areas with few ridges, trenches, rocky outcrops (none was found within the project site) and manmade excavation sites observed across the terrain.

The project site will be visible from the following areas:

Katsina-Kano Expressway: The project site is particularly visible to commuters along the Katsina-Kano expressway.

Settlements: A section of the residents in the following communities Gandi, Kauyen Dawa, and Fonga will have a slight view of the project site.

Existing Infrastructure and Amenities: Infrastructural facilities and amenities found to be within the view of the proposed project site are:

- Gandi Primary School which is located approximately 50m from the project site in the western direction.
- Government Girls Junior Secondary School (GGJSS) located approximately 650 m east from the project site.
- The Katsina State Metal Works building ‘Gidan Kuza’, which is situated along Katsina-Kano expressway about 150 m from the proposed project site in the northern direction. This factory is currently not operational.
- Other facilities include the Katsina State Water Board building located about 80 m west of the project site. A beekeeping and fish rearing buildings located less than 150 m south of the project site and a tree nursery growing yard located close to the Kankia dam. These facilities are currently not operational.

In general the project site and surrounding is not considered to be of particular scenic aesthetic or recreational significance.

4.4.9 Baseline Characteristics of the Transmission Line Corridor

This section provides the general baseline environmental characteristics along the proposed project transmission corridor. This corridor is a 30 m wide strip of land with a length of approximately 4.1 km. This corridor is planned for the construction of a dedicated power line to convey the power generated at the proposed 80 MW power plant to the existing Kankia substation. The selected corridor follows the existing Kano-Katsina transmission line of approximately 30 m width. The transmission corridor is occupied by bare soil, grasses, shrubs, a few subsistence farmlands. A cemetery was noted close to the transmission line connection point to the Kankia substation (approximately 100m from the substation fence line). The proposed transmission corridor route was selected to ensure no physical structures or settlements lay within the proposed power line. A cross-section of the transmission line corridor showing the existing Katsina-Kano 132 kV power line is indicated in Plate 4.18.

Plate 4.18: A cross section of the proposed transmission line route

4.4.10 Land Type/Land Cover

This section discusses the existing land use type/land cover in the study area. A 5-km radius from the proposed Project site was selected for the land type survey. The land-type map was produced from a combination of satellite imagery (Landsat ETM+) and topographical maps covering the study area. The result of the land type survey is presented under the following sub-headings:

- Existing Land Type within the Project Site
- Existing Land Type within the Proposed Transmission corridor
- Existing Land Type in the Wider Study Area (outside the Project site)

  - <u>Existing Land Type within the Project Site</u>

The land use composition of the Project site was observed to be of two primary classes namely: Bare soil and Vegetation.

Bare soil: This covers approximately 60 per cent of the total site and includes the drying bed (flood plain), footpaths and unpaved road. The soil varies from fine sandy to clay and lateritic.

Vegetation: This is a general name used for the dense and sparsely spaced shrubs available within the project site. This accounts for approximately 40 % of the Project site.

Other forms of land type such as water body and built up area/settlements were not found within the project site. The existing land type/land cover of the Project site is indicated below in Figure 4.17.

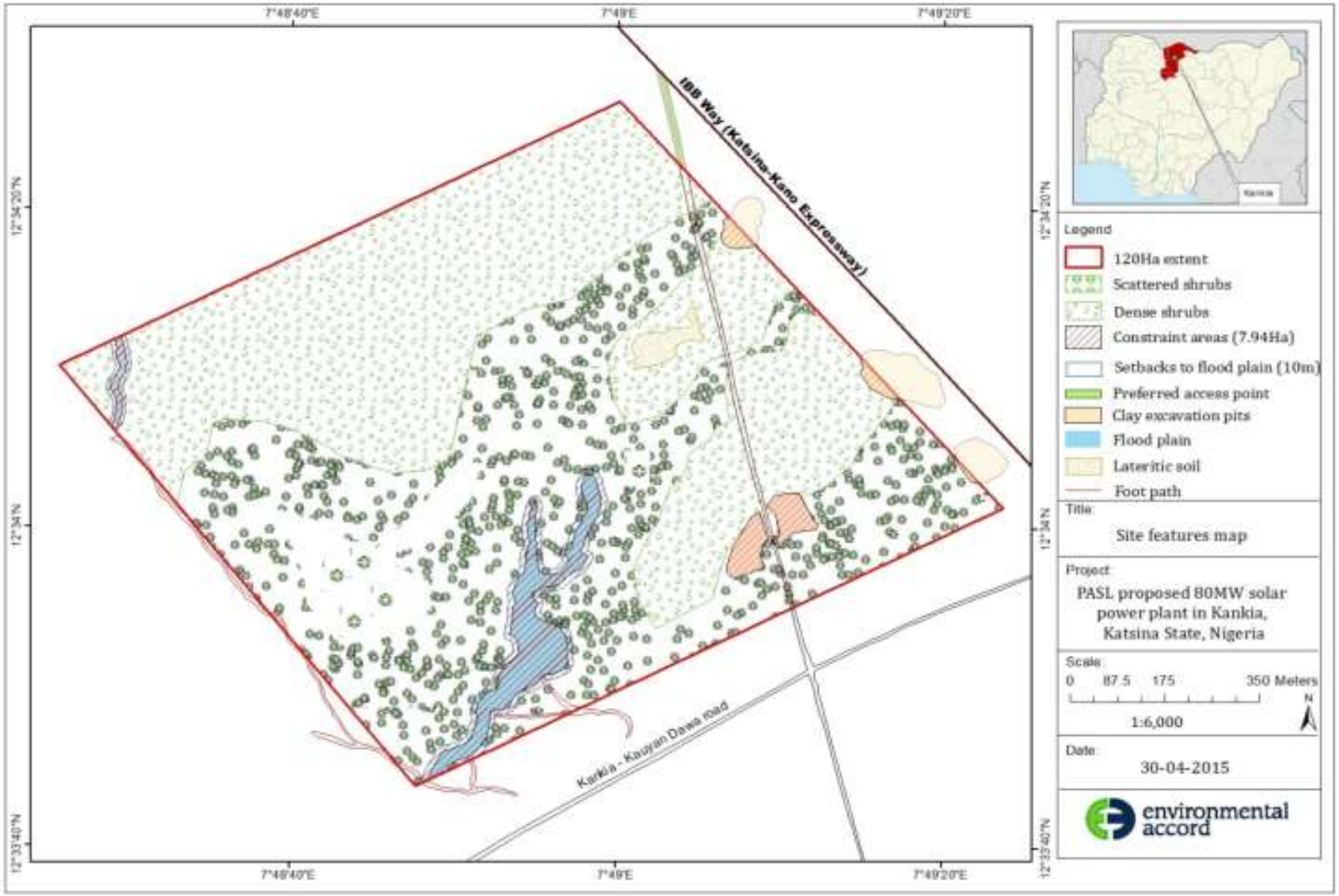

Figure 4.17: Land type map of the Project site

- Existing Land Type within the Proposed Transmission corridor

The proposed transmission line is planned to occupy a 30 m wide corridor covering a distance of approximately 4 km to the existing Kankia substation. The proposed transmission line will parallel to the existing 132 kV Kano-Katsina power line. The current land type along the proposed corridor is primarily bare soil, grasses, shrubs, a few subsistence farmlands. A cemetery was noted close to the transmission line connection point to the Kankia substation (approximately 100m from the substation fence line).

- Existing Land Type in the Wider Study Area (Outside the Project Site)

The land type characteristic of the wider study area (outside the Project site) is considered to be divided into the following categories (bare soil, vegetation, built up area/settlement, water body) (Figure 4.18). The estimated area covered by each of the land types is presented in Table 4.21 below.

Table 4.21: Existing Land Type/Land cover in the wider Study Area

S/N	Land use/ Land cover	Area (Ha)	Percentage (%)
1	Bare Soil	5931.09	85
2	Vegetation	598.77	8.6
3	Built up Area	442.17	6.3
4	Water body	4.14	0.06
	Total	6976.17	100

Source: EnvAccord Field Survey 2014

- **Built up Area**

There are no built up areas within the project site. Communities that fall within 5 km radius of the Project site are Gachi, Galadima, Kauyan Maina, Kafin Dangi and Kankia in Kankia LGA of Katsina State. However, Galadima, Kafin Dangi and Kankia communities have wards/villages that fall within 1km radius of the Project site (considered as the nearest villages to the site). The total area covered by the communities is 442.17 ha which represents 6.3 % of the wider study area. The socio-economic characteristics of the identified communities are further discussed in detail in Section 4.5 of this chapter.

- **Vegetation**

From the land-type analysis, vegetation was observed to cover about 598.77 ha and accounted for approximately 8.60 % of the wider study area. This includes shrubs, trees, and grasses.

- **Bare Soil**

Based on the land-type analysis, the dominant land-cover in the wider study area is bare soil, covering about 5931.09 ha. It accounts for approximately 85 % of the total area under study (5 km radius). This land class is used as agricultural fields, playing ground, roads and foot paths. The bare soils identified within the project site are the roads, foot paths, space within the sparse shrubs and the dry flooded area.

- **Water Body**

As stated above, there are no water bodies within the project site. The wider study area has water bodies like dam and temporary pools. The total land mass covered by the water bodies is approximately 4.14 ha. This accounts for about 0.06 %.

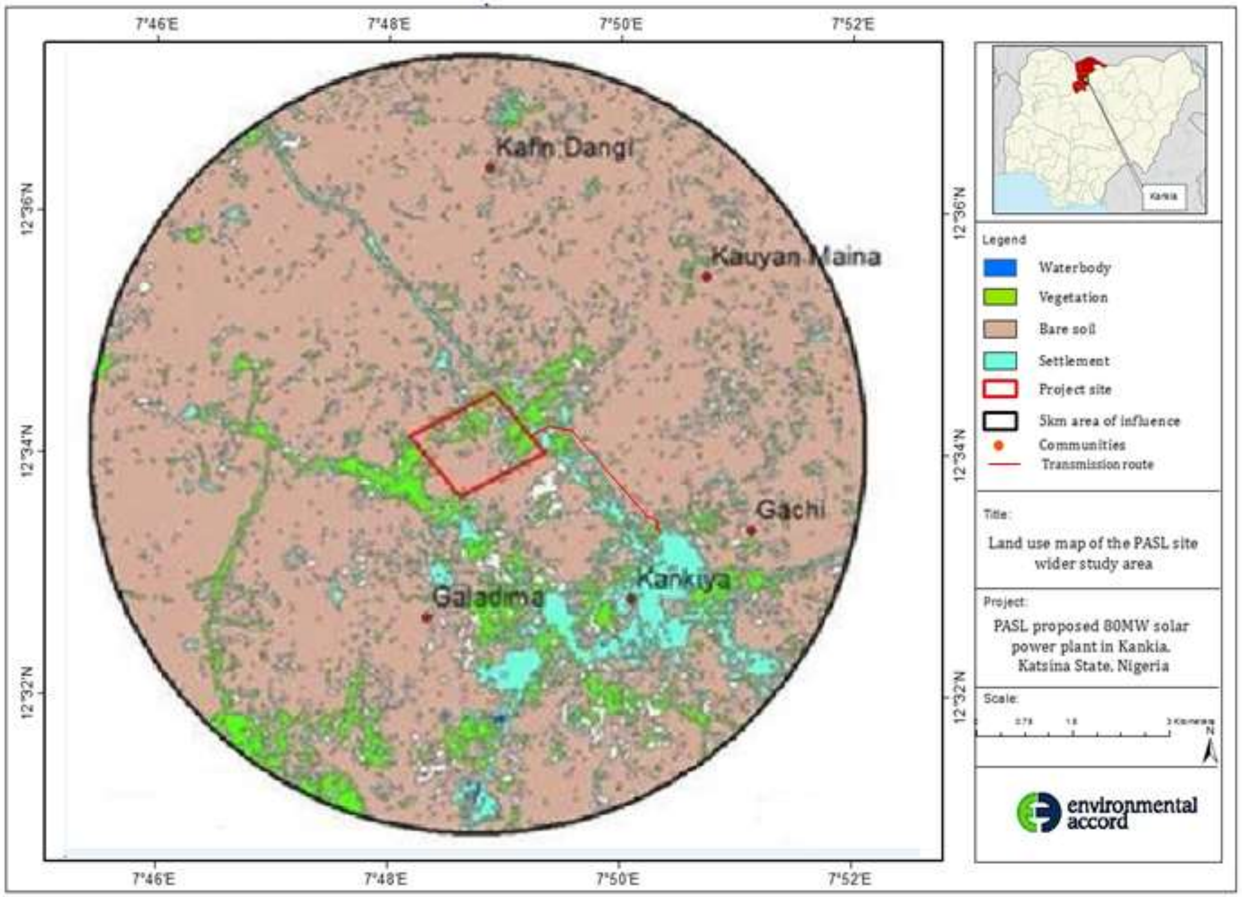

Figure 4.18: Land type/land cover of the wider study area

4.5 Socio-economic and Health Conditions of the Study Area

4.5.1 Introduction

This section provides information on the socio-economic (including health) conditions of the identified communities in the Project's area of influence.

Five (5) communities were identified within the Project's area of influence namely; Gachi, Galadima, Kauyan Maina, Kafin Dangi and Kankia. The distance and orientation of each of these communities to the Project site is as follows:

- Kafin Dangi (3.74 km north east),
- Kauyan Maina (2.98 km east),
- Galadima (1 km south west),
- Gachi (2.32 km south east), and
- Kankia (2.46 km south).

4.5.2 Methodology

The methodologies employed for the socio-economic survey of the Project area include:

❖ Questionnaire Survey

The household socio-economic survey covered the five (5) communities. However, the sample size per community was based on the estimated population size of each community. In deciding the sample size for this study, the following steps were taken:

- First, we determined the size of the population with which we are dealing.
- Determination of the desired precision of results. This is the closeness with which the sample predicts where the true values in the population lie. The difference between the sample and the real population is called the sampling error. For this study, the sampling error was put at ±10%.
- Determination of the Confidence Level which is expressed as a percentage and represents how often the true percentage of the population who would pick an answer lies within the confidence interval. A 90% confidence level was used.
- Estimation of the Degree of Variability. This is the degree to which the attributes or concepts being measured are distributed throughout the population. The higher the degree of variability of the distribution of a concept in the target audience, the larger the sample size must be to obtain the same level of precision. The target population for the survey is homogenous which makes it easier to measure variability, and was therefore put at about 10%.
- Estimation of the Response Rate. Direct contact/observation increases response, therefore the response rate was put at 90%.

- Based on this information, the equation for determining the sample size is represented as:

$$n = \frac{N\, z^2\, pq}{E^2\,(N-1) + z^2\, pq}$$

Where:
n = sample size required
N = number of people in the population
p = estimated variance in population, as a decimal: (0.10 for 10%)
q = 1-p
E = +- error (i.e. 0.1)
Z = based on confidence level: 1.645 for 90% confidence

A total of 250 questionnaires were randomly administered in the communities as follows: 80, 60, 50, 35 and 25 in Kankia, Galadima, Gachi, Kafin Dangi and Kauya Maina respectively. The sample aged groups were 18 years and above. A copy of the questionnaire used during the survey is provided in Appendix 8. Plate 4.19 below shows sample photographs of questionnaire survey in the study area. Amongst others, the questions asked covered age, sex, marital status, monthly income, occupation, housing pattern, health status of respondents, existing health facilities and respondent's perception of the Project. Responses to the questionnaire administration survey are detailed in Section 4.5.4.

Plate 4.19: Questionnaire administration during field survey

❖ <u>Key Informant Interview</u>

In-depth interviews with community leaders of the identified communities were also carried out to compliment the information obtained from the questionnaire survey and those obtained from existing records. Key informant interviews are qualitative in-depth interactions with persons/residents that have first-hand knowledge about the communities. These include traditional and religious leaders.

- Focus Group Discussions (FGDs)

Focus Group Discussions were conducted with groups of adult males, women, farmers, hunters and youths in the communities. The FGDs are further discussed in Section 4.5.5. Details of the community representatives that attended the FDGs are provided in Appendix 8.

- Direct/Field Observations

In addition to the questionnaires administration, the survey also involved observational methods wherein notes were taken on the activities noted in the communities. This method is useful for obtaining qualitative data and studying the existing status of the socio-economic environment of the study area.

- Literature Sources

Relevant published and unpublished materials relevant to the study area were also consulted. These include the internet, local books and materials specific to the project location.

4.5.3 Community Profile

4.5.3.1 Demography

The total population of Nigeria in 2010 was estimated to be 158.4 million, with a population growth rate of three per cent per year (World Bank, 2010). Approximately 51 per cent of the national population is male, against 49 per cent female. In 2009, Nigeria reported an average life expectancy of 51 years at birth, which was broken down into a life expectancy of 50 years for men and 52 years for women (World Bank, 2010).

Katsina State is approximately 24,971 km^2 in area. Based on the 2006 national population census, the state stood at a population of approximately 5.8 million people, of which approximately 51 per cent were male and 49 per cent female (Nigeria Bureau of Statistics (NBS), 2010). With a growth rate of 3 %, the estimated population of the state in 2015 is put at approximately 7 million people. The state is mainly populated by Hausa and Fulani people. The minority groups include the Yoruba and Igbo people who migrated from the southern Nigeria.

Kankia LGA of Katsina State is the host local government council for the proposed Project, it occupies an area of 824 km^2. Based on NBS data, for the year 2006, the population of Kankia L.G.A was 151,395 people which amount to 2.61% of the state's population. Out of this number 51 per cent were males and 49 per cent females (NBS, 2010).

The estimated population of Kankia LGA in 2015, based on 3 % growth rate, is approximately 192, 000 people. The population characteristic of the Kankia LGA, based on the national census conducted in 2006 is presented below in Figure 4.19.

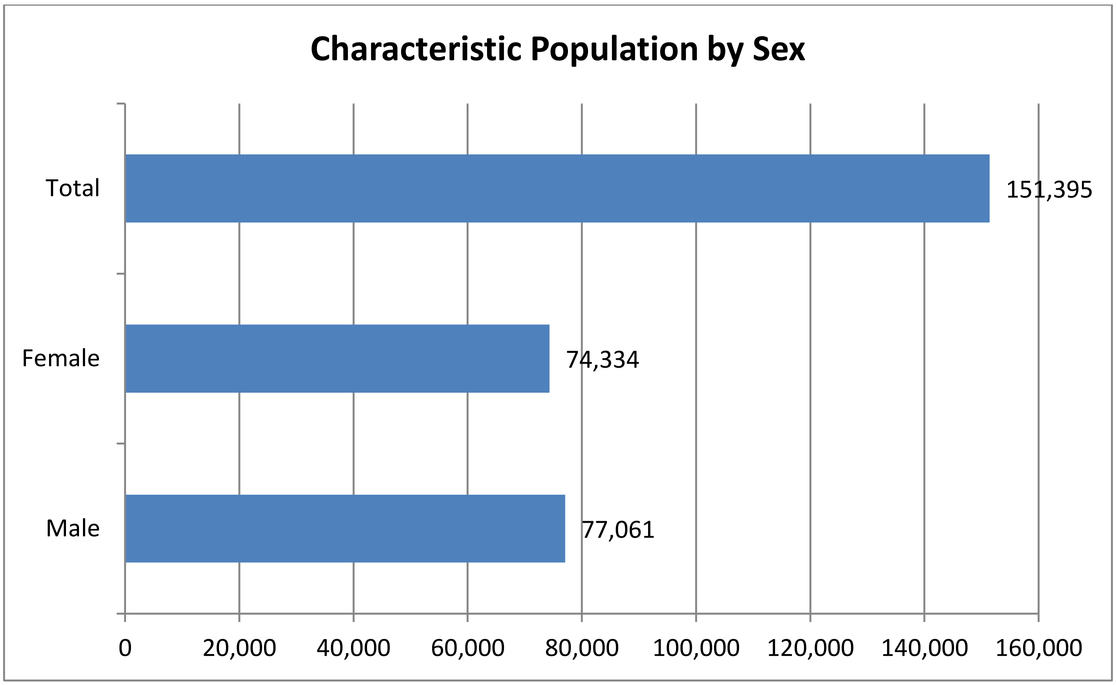

Figure 4.19: Population characteristics of Kankia LGA in 2006 based on sex
Source: National Bureau Statistics, 2010

The main language spoken in the study area is Hausa, which is largely the general language of the northern Nigeria. Although, the Fulani people in the LGA speaks both Fulani and Hausa languages.

The population of the sampled communities is predominantly made up of Hausas (95 per cent). The population is also dominated by Muslims. With the exception of Kankia and Galadima communities, the settlement pattern in the study area is largely rural in nature. The estimated population of the five (5) potentially affected communities, based on the information gathered field survey, is as follows:

- Kauyan Maina (5,000),
- Kafin Dangi (10,000),
- Gachi (12,000),
- Galdima (25,000)
- Kankia (28,000).

4.5.3.2 Historical Background and Social Structure

- **Culture and Ethnicity**

The people of Katsina State engage in various forms of festival. Some of the festivals in the state as a whole include:

Durbar: 'Durbar' is a local name for "Military Parade" where regiments would showcase their horsemanship in preparedness for war and their loyalty to the emirate, hundreds of years back. Today, the Durbar has become a festival celebrated in honour of visiting heads of state and at the culmination of the two Muslim festivals: 'Id-el Fitri' and 'Id-el Kabir'. Plates 4.20 and 4.21 show the pictures of Durbar and 'Sallah' festival activities.

Plate 4.20: Durbar Festival
Source: Kankia District Head

Plate 4.21: Sallah Festival in the Study Area
Source: Kankia District's Head

Jaci Festival: This is an annual fishing festival initiated by Muhammadu Dikko, a former emir of Katsina. During the annual gathering, fishermen converge at the emir's palace from different parts of the Katsina Province. The festival ceased temporarily until it was revived in 2000.

Kallon Kuwa: Kallon Kuwa is a post-harvest annual youth festival. Its name is derived from 'Kallon Kowa' in Hausa which means "viewing for all". The festival started around 1935. It is held to express happiness for the successful completion of the cropping season and to celebrate the coming of "Kaka" - a time of prosperity in terms of abundant food and increased economic and social activities. Traditional wrestling, boxing, singing and dancing take place during the festival.

- **Religion**

Islam is the most practiced religion in the sampled communities with a minute population of Christians and traditional worshippers. There are no reports of tension among religious groups in the study area as gathered from residents of the communities during field survey.

- **Administrative Institution**

All the communities have similar traditional systems of administration. Monarchies are a common form of government in Hausa land. The traditional head is usually referred to as the 'Magajin', and is supported by a number of village/ward heads.

The Kankia District head reports to the Emir of Katsina State while the heads of other communities in Kankia LGA report to the Kankia District head. Each community is divided into wards and each ward has a leader who reports to the community head.

The name of the 'Magajin' of Kankia is Alhaji Abdullah Hassan Sada. Other heads of the communities are: Alhaji Hassan Muhammad for Galadima, Alhaji Sada Bello for Kafin Dangi, Alhaji Ado Sulaiman Gachi for Gachi and Alhaji Surajo Kauyen Maina for Kauyen Maina.

The traditional leaders ensure that peace, unity, religious tolerance, inter-family interaction and security are maintained.

- **Security and Conflict Resolution**

The communities have functional internal arrangements to ensure security of lives and properties and to resolve internal conflicts among their people. Hunters and local 'vigilantés' oversee the security function in the communities. In addition, there are Nigerian Police Stations in Kankia and Galadima communities. The conflict resolution mechanism in the communities is organized around the Magajin and his chiefs. Minor disputes can also be adjudicated by village/ward head, while complex cases that cannot be handled through these mechanisms are referred to the Emir of Katsina State.

No inter communities conflict was reported during the field survey, suggesting a peaceful co-existence among the communities in the study area.

- **Community Migration Status and Patterns**

Historical migration into the area is considered to be seasonal. From the qualitative data gathered and census report, including responses from community stakeholders, it was gathered that majority of the residents are native of the study area. However, there is always occupational mobility of local youths to urban centres in other regions of the country during the wet season. The out-migration of the youths is attributed to the fact that agricultural work would have been completed prior to wet season.

4.5.3.3 Economic Activities

The communities in the study area are majorly into farming including arable and livestock farming. The crops usually planted include maize, millet, guinea corn, cowpea and groundnut, most of which are in subsistence and commercial scales.

Trading also dominates the local economy of the area as shown in Plate 4.22.

Plate 4.22: Activities within Kankia market at the time of field survey in October 2014

Residents of the communities also work in the public sector or engage in private businesses. Some are involved in semi-skilled professions such as tailoring, automobile mechanic, and transport service. The small scale industries are mainly private initiatives. These include bakery, sawmilling, metal fabrication and carpentry. Some residents combine economic activities in various forms to complement low production and income levels.

In Kankia community, which is the major community in the Project area, there are several retail and service-based businesses. These include telephone call centres, banks, salons, supermarkets, business centres, private schools and private medical centres, amongst others.

4.5.3.4 Infrastructure and Social Services

Electricity: Power transmission and distribution in the project area are controlled by Transmission Company of Nigeria (TCN) and distribution companies. As a result of the unsteady power supply, the system is supplemented by a large number of petrol and diesel generators owned by individual and commercial businesses. Four out of the five identified communities in the project area are connected to the national grid for power supply. Only Kauyan Maina community is yet to be connected to the national grid. The power supply serves as source of lightning for social and economic activities.

Water Supply: Sources of water in the study area are majorly hand-dug well and boreholes. Due to climatic condition, the study area is lacking adequate water in perennial rivers.

Roads Network: The major road in the study area is the Katsina-Kano Expressway, also called IBB way. There are also direct internal link roads within Galadima and Kankia communities. Most of the road networks that lead to the communities especially Kauyan Maina and Kafin Dangi are untarred. The major means of transport to the two communities are motorcycles while vehicles are mostly used in Kankia community.

Housing and Settlement Pattern: The settlement pattern of the project wider area is sparse to mid-dense populated settlements. Kankia community was originally an administrative and trading centre, a function it has retained. In metropolitan, most of the buildings in the area are bungalows and traditional in nature with hand-made mud, unplastered, thatched/iron roof and old age architectural design. The buildings in Kankia and Galadima are being improved with modern types using cement blocks, plastering, paints, aluminium roofing sheets and modern architectural design. Other communities in the area mostly have old type of buildings; majorly bungalow built with unplastered mud and thatch roofing system, though there are a few modern buildings.

Educational Facilities: The tertiary institutions in Katsina State generally include two federal universities (Umaru Musa Yar'adua University, Katsina and the Federal University, Dutsin-ma); a state university (Katsina Islamic University); a state polytechnic (Hassan Usman Katsina Polytechnic, Katsina); and two colleges of education (Isa Kaita College of Education, Dutsin-Ma and Yusuf Bala Usman College of Legal Studies, Daura). The state is also home to the College of

Administration in Funtua town; the School of Nursing and Midwifery in Katsina and the Health Auxiliary Training School, Funtua.

The only tertiary institution in the study area in Kankia is School of Health Technology. Each of the sampled communities has a primary school while there are secondary schools in Kankia and Galadima communities. The closest schools to the Project site boundary are Gandi Primary School and Government Girls Junior Secondary School (GGJSS) which are 50m and 660m away respectively. As such the proposed Project has the potential to contribute to academic activities in the institutions as part of its planned Corporate Social Responsibility.

Health Facilities: Health facilities in Katsina State are divided into primary, secondary and tertiary categories. Primary health care facilities include dispensaries and maternity homes which provide first line health care to the population. They are distributed throughout the whole state. Secondary health care includes general hospitals which cater for ailments beyond the competence of the primary health care facilities. Tertiary facilities are referral and research hospitals to cater for ailments beyond the competence of the secondary facilities and for research.

Health facilities are owned and managed by Local, State and Federal governments and the private sector. The Local Governments manage the primary health care facilities; the State Government manages the secondary health facilities while both the State and Federal manage the tertiary health facilities. The private sector generally has facilities that cut across the three categories with primary and secondary facilities being the most common.

The major healthcare facility in the project wider area is the General Hospital in Kankia, in addition to the Primary Health Care centres in other sampled communities.

Waste Disposal and Sanitation: Katsina State Environmental Protection Agency (KATSEPA) is the authority in charge of waste management in the study area. The Agency is responsible for collection, transportation and disposal of household wastes. The KATSEPA workers operate every Saturday of the week. On the whole, the rate of generation from households far exceeds the rate of collection of waste by KATSEPA. There is lack of private sector participation in waste management. The results are that there is the presence of heaps of indisposed refuse. In order to reduce the volume of wastes people usually engage in open burning of the wastes. Some of the wastes are however collected and taken to the farm and used as organic manure.

Tourism and Recreation: Katsina State as a whole is rich in indigenous heritage and important historic land marks. These include the Gobarau Minaret Katsina, National Museum, Katsina Kusugu Well, and Old Training College, Katsina. None of these ancient tourist centres is located within the study area in Kankia LGA.

4.5.4 Responses to Questionnaire Administration

This sub-section provides the analysis of the socio-demographic information of the respondents which cover areas such as age, gender, education, marital status, monthly income, occupation and social lifestyle.

- Age and Gender of Respondents

The distribution of the respondents according to predetermined age groups is presented in Figure 4.20. The dominant respondents fall between 18 and 30 years (52 per cent) while the least fall in the group of below 18 years and over 66 years. The respondents between 31 and 45 years account for 26 per cent. The gender of the respondents as illustrated in Figure 4.21 reveals that 97.1 per cent of sampled individuals are male while 2.9 percent (2 respondents) are female. The low number of female respondents could be due to religious belief in the area.

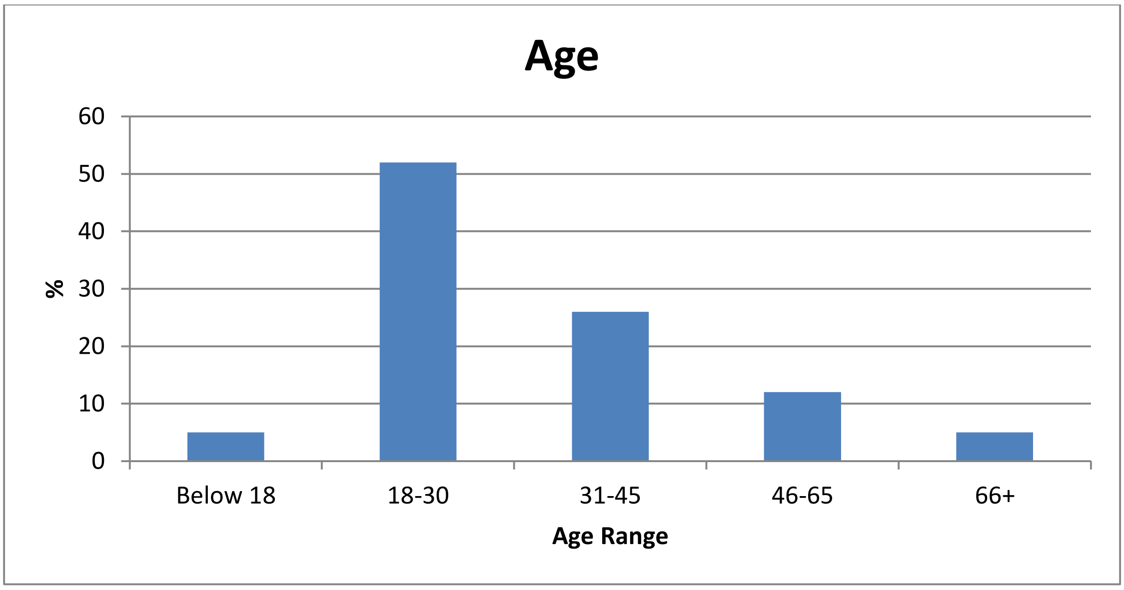

Figure 4.20: Age of Respondents
Source: EnvAccord Field Survey, 2014

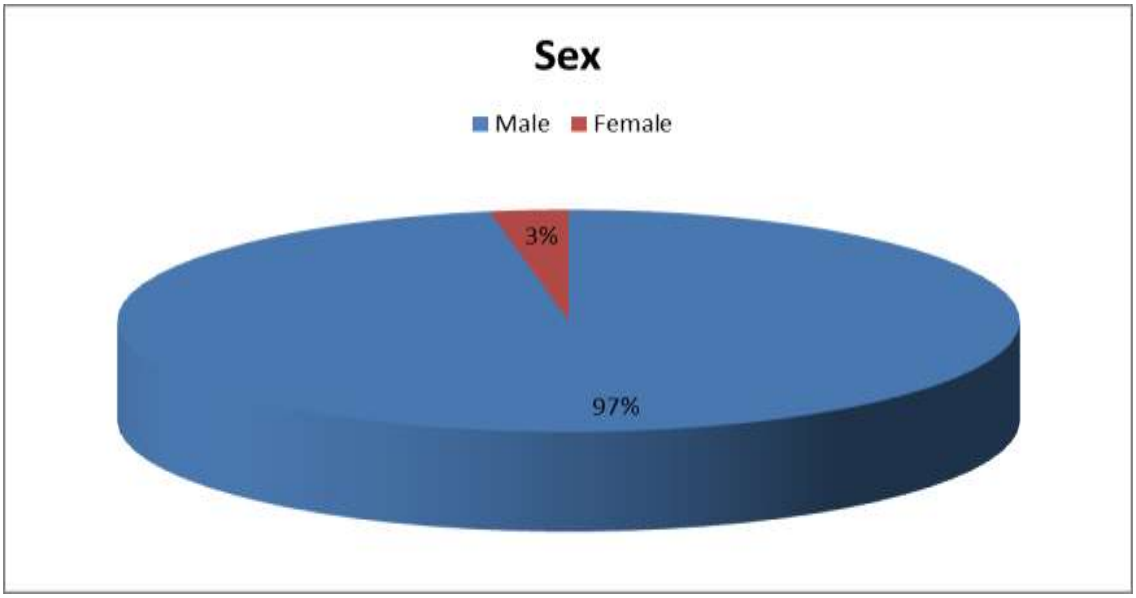

Figure 4.21: Sex of Respondents
Source: EnvAccord Field Survey, 2014

- Marital Status

Figure 4.22 shows the marital status of respondents at the time of the survey. Of all respondents, 34 per cent had never been married, 60 per cent were currently married while 6 per cent were divorced or separated. None of the respondents were widowed. Also, the families setting of the respondents are in the average of both monogamous and polygamous (Figure 4.23).

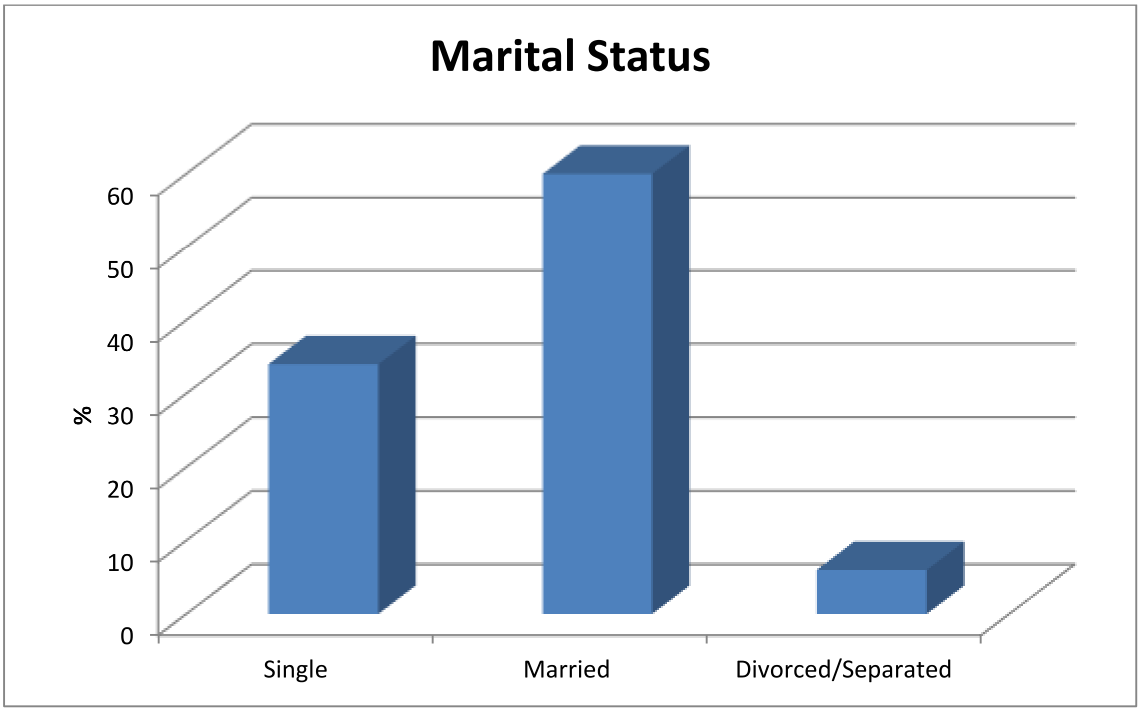

Figure 4.22: Marital Status of Respondents
Source: EnvAccord Field Survey, 2014

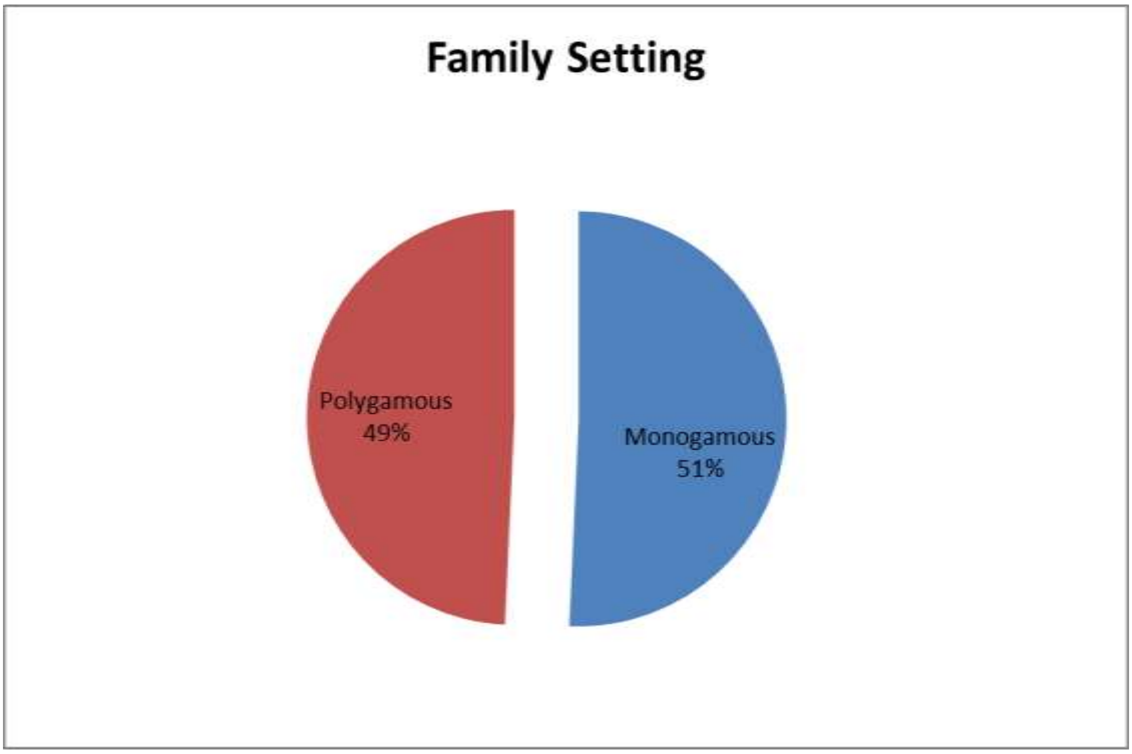

Figure 4.23: Respondents' Family Setting
Source: EnvAccord Field Survey, 2014

❖ Ethnicity and Religion

The ethnicity of the respondents is as follows: 95.6 per cent are Hausas, 2.9 per cent are Hausa-Fulani while 1.5 per cent belongs to the Igbo ethnic group (Figure 4.24). Their religion also was analysed, it was noticed that 100 per cent of the respondents were of the Islamic religion (Muslims), irrespective of their little variance in tribe and ethnic group.

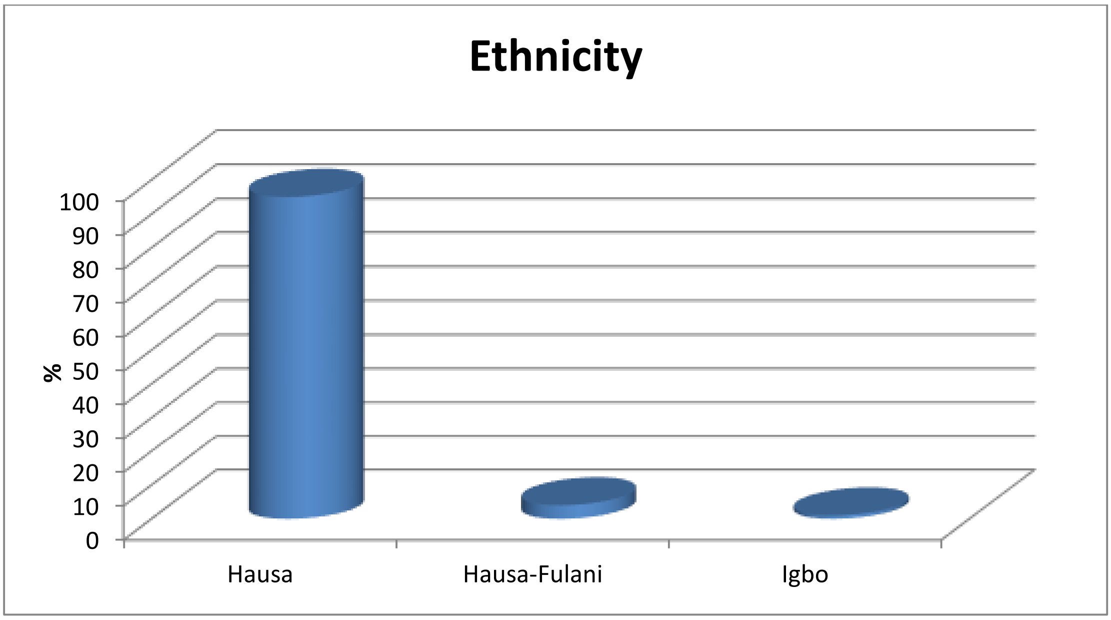

Figure 4.24: Ethnic Characteristics of the Respondents
Source: EnvAccord Field Survey, 2014

- Residential Status versus Length of Residence

The distribution of respondents by residential status is as follows: 85 per cent of the respondents reside all year round in the communities, 7 per cent were used to being a resident but absent for less than three months, 3 per cent were used to being residents but absent between three and six months, 2 per cent were visitors, while 3 per cent did not declare their residential status (Figure 4.25).

As regards the length of residence, the majority of the respondents with the estimated figure of 90 per cent of the total respondents have been living in their current residential building for over fifteen years (Figure 4.26).

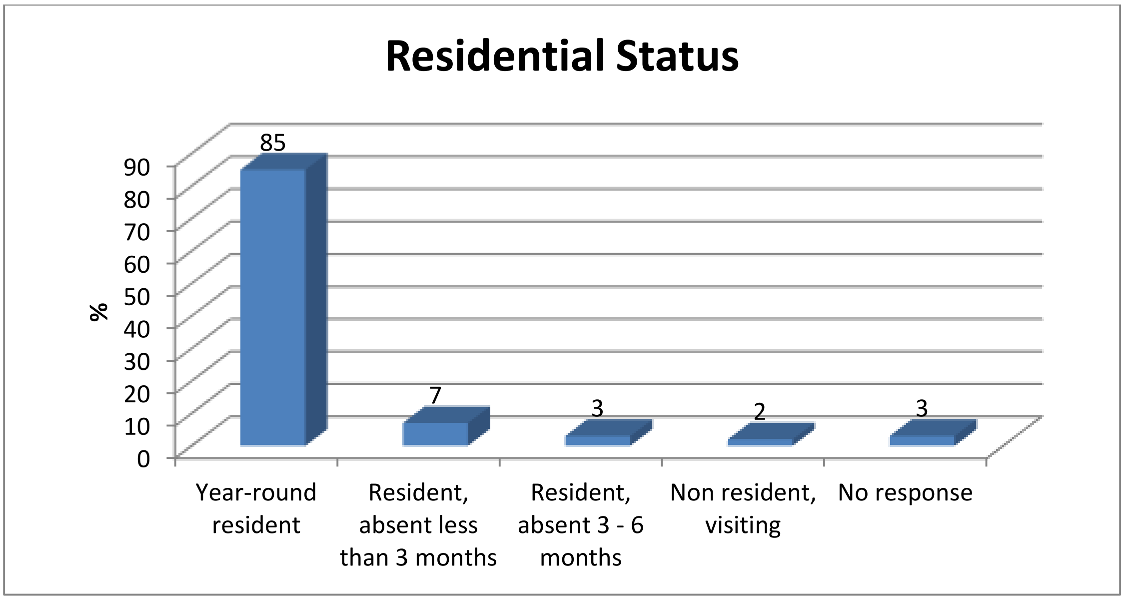

Figure 4.25: Residential Status of the Respondents
Source: EnvAccord Field Survey, 2014

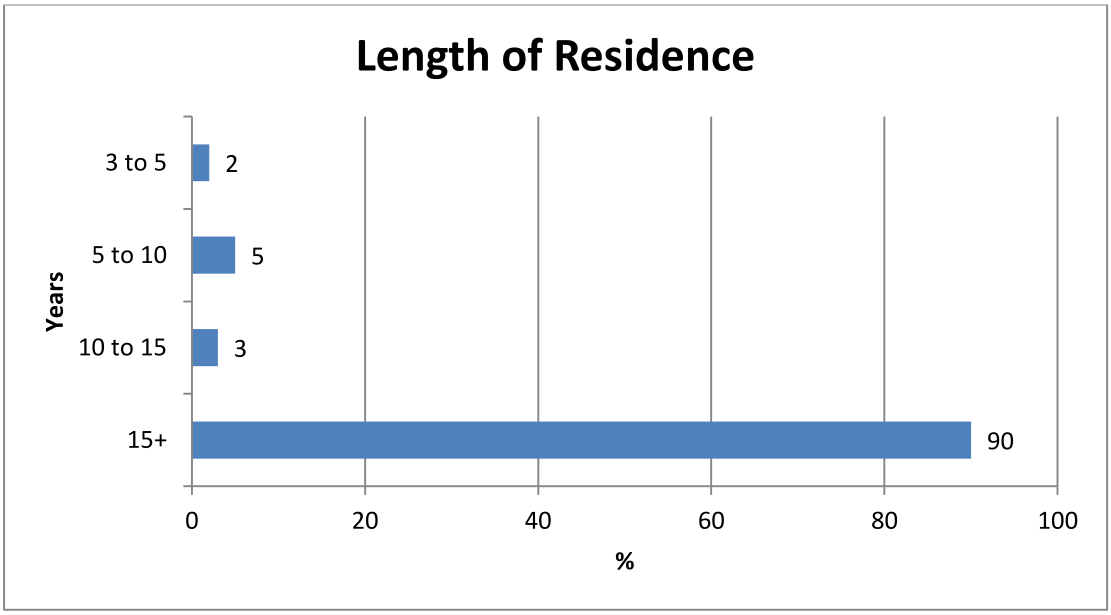

Figure 4.26: Length of Residence
Source: EnvAccord Field Survey, 2014

❖ Educational Status of Respondents

All respondents were asked if they had ever attended formal school. Respondents who had attended school were asked the highest level of school attended (primary, junior secondary, senior secondary, vocational/technical school or tertiary) and the highest class or year completed at that level.

As presented in Figure 4.27, 4.3 per cent of respondents reported no formal education; 13 per cent reported completing between one and six years of primary education; 39 per cent reported senior secondary school education, 7.2 per cent indicated to have completed vocational/technical school and 32 per cent had tertiary education. This indicates that majority of the residents are semi-literate.

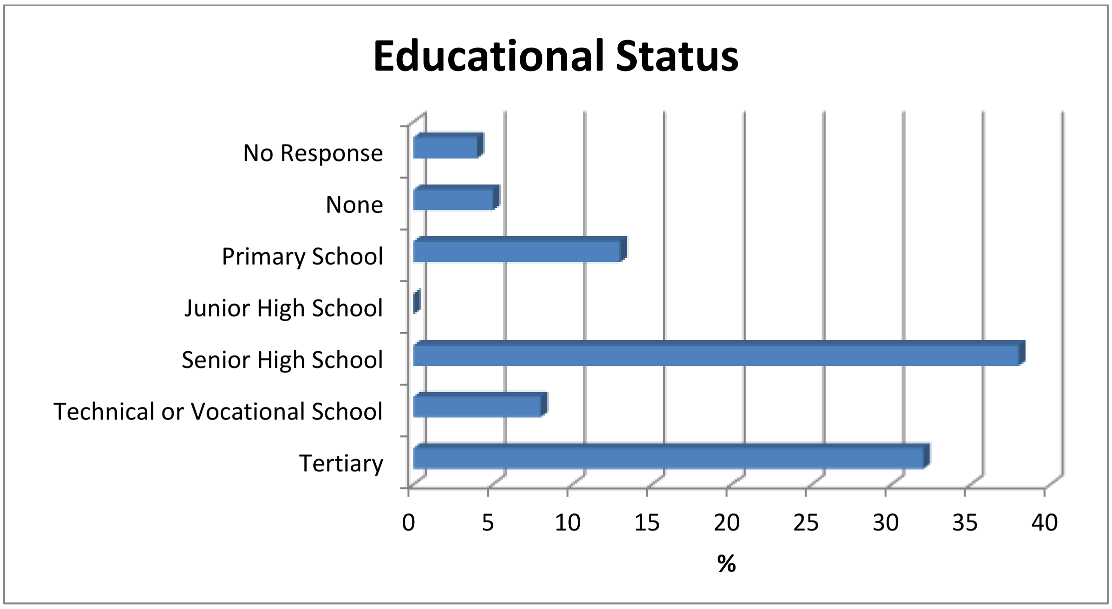

Figure 4.27: Educational Status of Respondents
Source: EnvAccord Field Survey, 2014

❖ Occupation of Respondents

As earlier indicated, the study area is predominantly rural to mid-urban with the population of each community less than 25,000 people. Kankia and Galadima are the most urbanized of the five (5) sampled communities. The occupation of the respondents is indicated in Figure 4.28. Farming (arable or pastoral) is the dominant activities in the area. Some of the respondents also indicated to be students. Other occupational activities of the respondents include petty trading, artisan, and civil service.

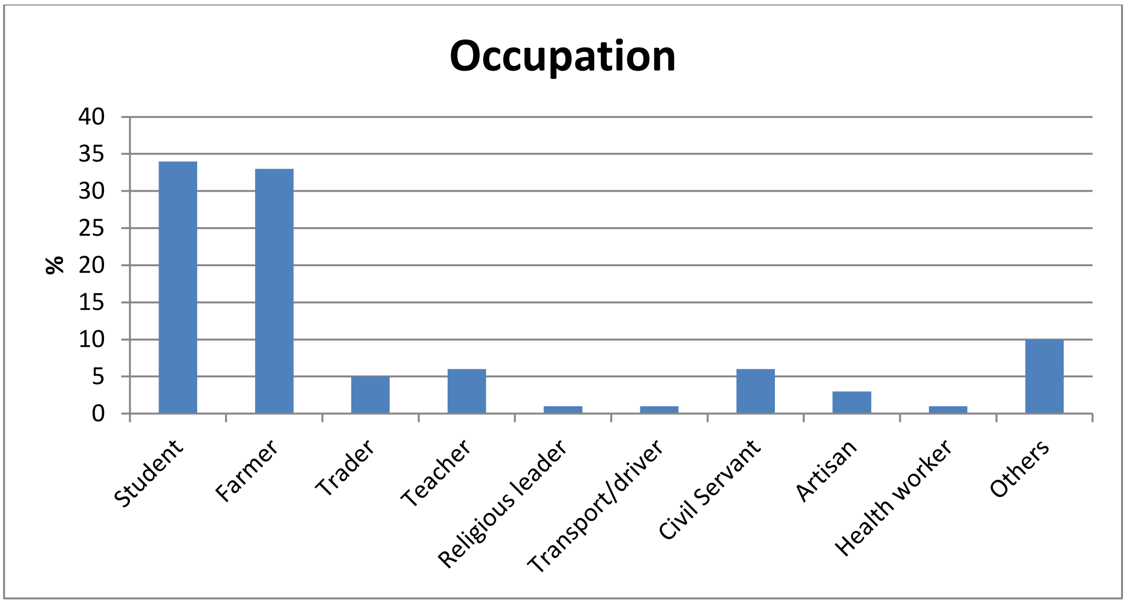

Figure 4.28: Occupation of Respondents
Source: EnvAccord Field Survey, 2014

The economy of the affected communities is basically agrarian with large scale production of maize, millet, guinea corn, wheat, groundnut and cowpea. Other crops like yam and cassava are produced in small quantities. 75 per cent to 85 per cent of the communities' labour force is in the agriculture sub-sector.

Cattle rearing are also practiced extensively in the area. Cattle are also used as a source of farm power for agricultural practices and for commercial meat production. As such farming is the dominant primary occupation for most residents of Kankia. Farming is practiced both at the subsistence and commercial level. However, no farmland currently exists on the proposed project site.

❖ Land Ownerships for Farming

The land ownership practice in the proposed project area varies. The environmental factors are favourable for agricultural production with the climatic conditions been predominantly semi-arid. However the project area is less suitable for fishing and aquaculture due to the absence of perennial rivers.

Guinea corn, millet, cowpea, maize and sugar cane are food crops that offer the best potentials while vegetables such as tomato and pepper thrive in the study area. Livestock grazing also flourishes in the area and this could be attributed to the abundance of perennial grass which provides forage material for livestock.

The assessment of land ownerships for the agricultural production is presented in Figure 4.29. 87 per cent of the farmers own the cultivated land while 13 per cent use the land rent free (family or community land).

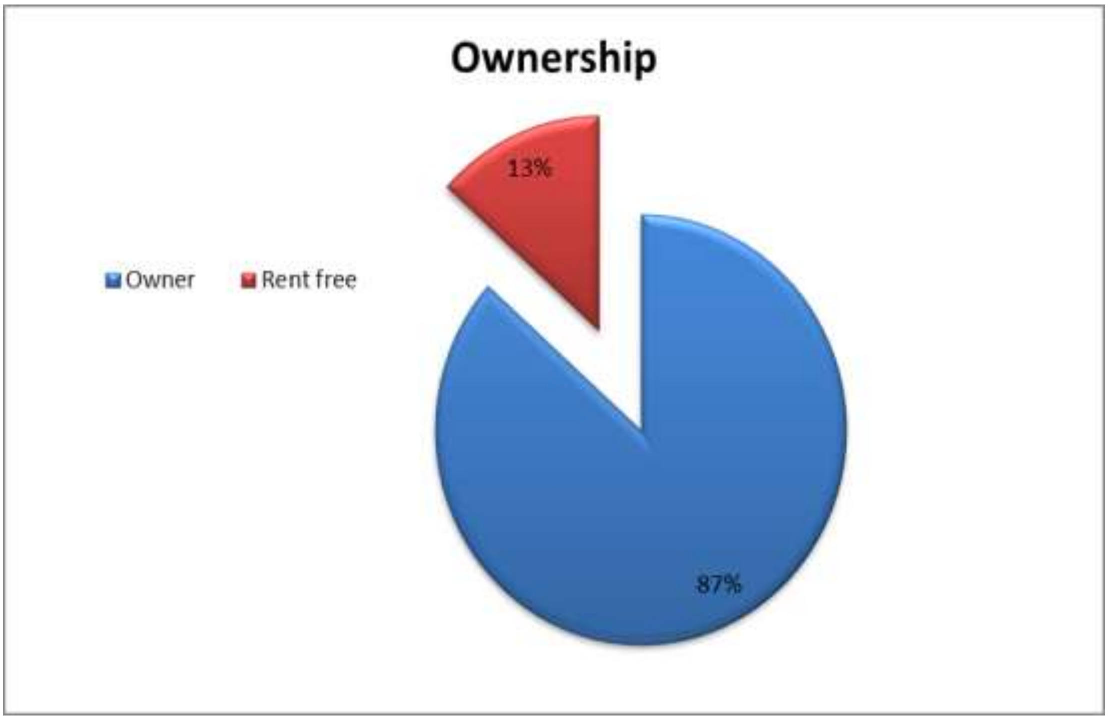

Figure 4.29: Land Ownership for Farming
Source: EnvAccord Field Survey, 2014

❖ <u>Household Annual Income</u>

Figure 4.30 illustrates the annual income of the respondents in the sampled communities. The annual income of majority of the respondents is above five hundred US dollars ($500).

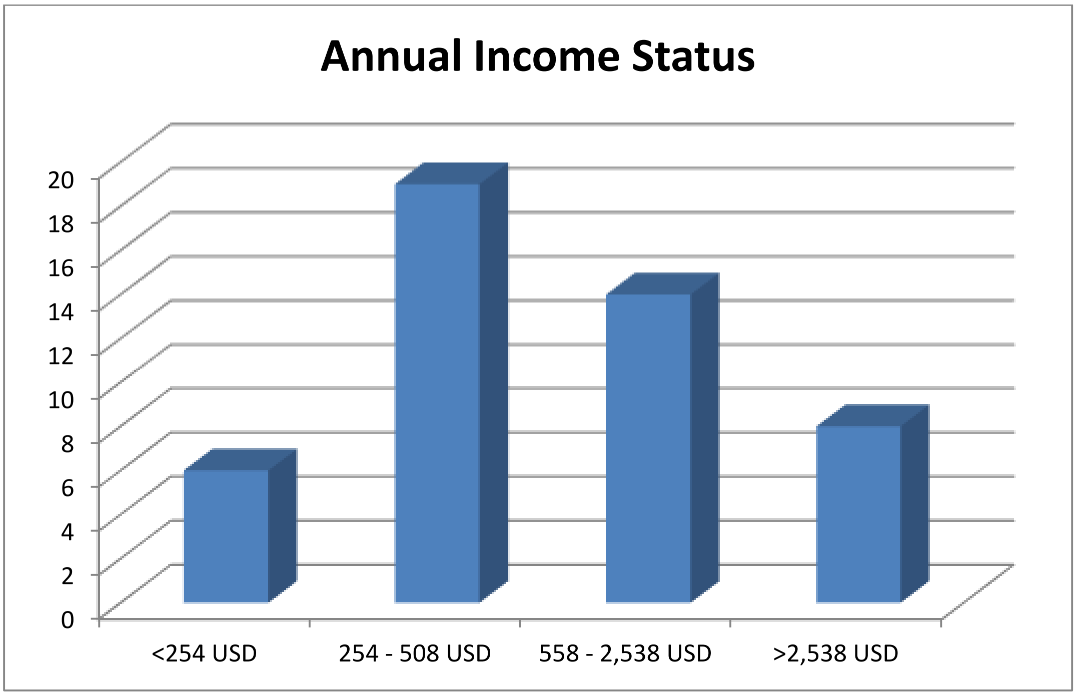

Figure 4.30: Annual Household Income in the study area in Naira
Source: EnvAccord Field Survey, 2014

❖ Household Monthly Income

The monthly income of the sampled households is presented in Figure 4.31. 19 per cent of the respondents had income of less than USD25. This is followed by the households in the group of USD25 to USD100 (40 per cent). 24 per cent of the respondents also receive USD100 to USD254. The respondents earning above USD508 and between USD254 to USD508 per monthly had 5 per cent and 12 per cent respectively.

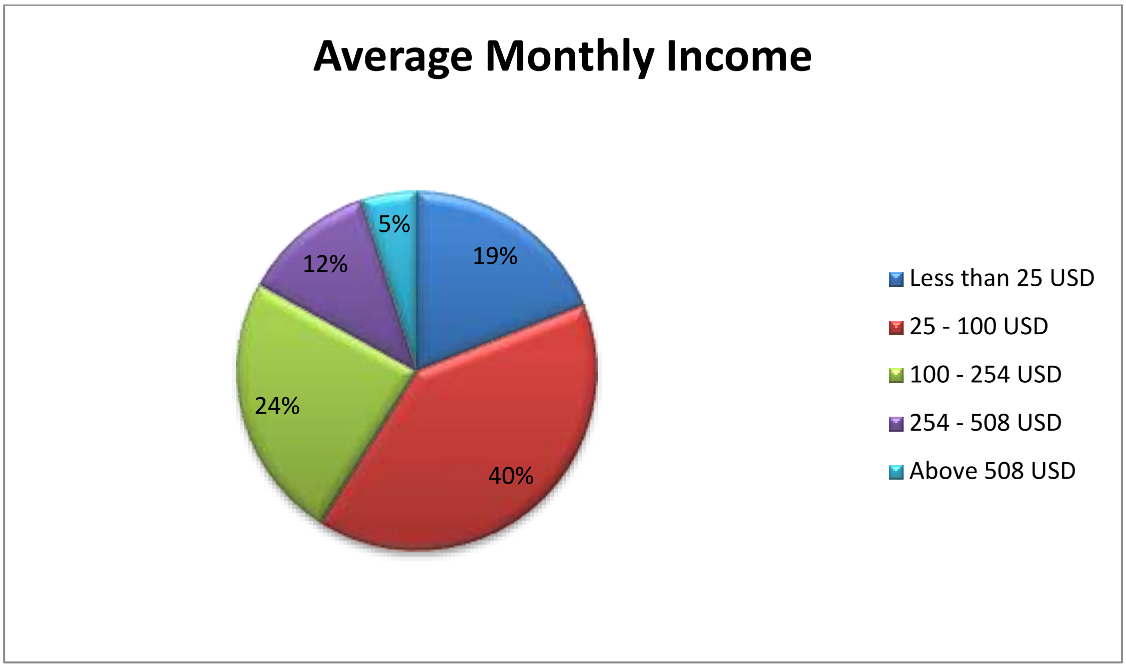

Figure 4.31: Average Monthly Income of In-scope Households
Source: EnvAccord Field Survey, 2014

❖ Housing Characteristics of Respondents

Table 4.22 summarizes the housing characteristics of the respondents in the study area. These include: construction materials for wall, roofing, and floor, toilet facility and tenure of housing. Mud plastered house had the highest percentage and pit latrine is the most commonly used toilet facilities among the respondents.

Table 4.22: Housing Characteristics of Respondents

Building Parts	Value Label	Percentage
Construction Material (Wall)	Plank Wall	5.8
	Mud (plastered)	40.6
	Mud (not plastered)	11.6
	Cement Block	31.9
	Others	10.1
	Total	*100*
Construction Material (Roofing)	Asbestos slates	4.3
	Corrugated aluminium zinc sheets	65.3
	Nigerite modern roof	13
	Thatched roof	2.9

Building Parts	Value Label	Percentage
	Others	14.5
	Total	*100*
Construction material (Floor)	Earthen	18.8
	Cement	60.9
	Tiles	7.3
	Others	13
	Total	*100*
Toilet Facility	Pit latrine	66.7
	Water borne system	14.5
	Toilet facility outside dwelling	4.3
	Others	14.5
	Total	*100*
Tenure of housing	Owner occupier	78.3
	Rent/Lease	2.9
	Occupied rent free	4.3
	Others	14.5
	Total	*100*

Source: EnvAccord Field Survey, 2014

❖ Accessibility of Educational Facilities to the Respondents

The communities have access to primary and secondary schools (Figure 4.32). All the sampled communities have primary schools while secondary schools are located in Kankia and Galadima communities.

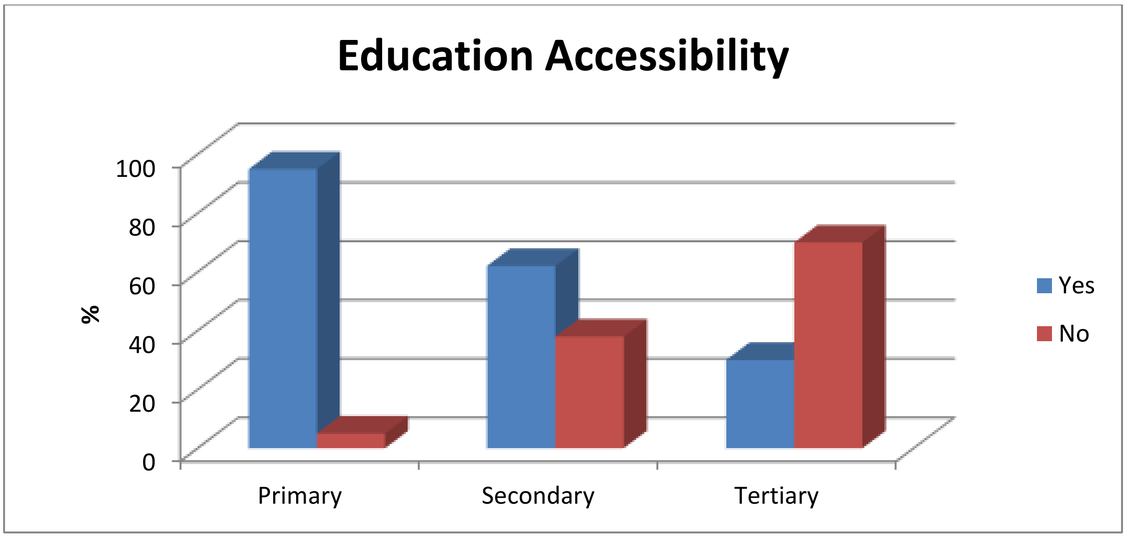

Figure 4.32: Access to Education by the Respondents
Source: EnvAccord Field Survey, 2014

Source of Power to the Respondents

Respondents were asked about sources of energy for household amenities, lighting and cooking. Torch and batteries (40 per cent) is a commonly used source of lighting in the communities in absence of electricity supply from the national grid. This is due to the fact that it is the most accessible and affordable power source by everybody. It was observed that there is availability of power source from the national grid in all the sampled communities except Kauyan Maina.

The respondents in Kauyan Maina indicated that the community has never been connected to the national grid. The power supply from the national grid to Kankia, Galadima, Gachi and Kafin Dangi is on the average of 12 hours per day. Other sources of power indicated by the respondents include generators, kerosene lamp and candle (Figure 4.33).

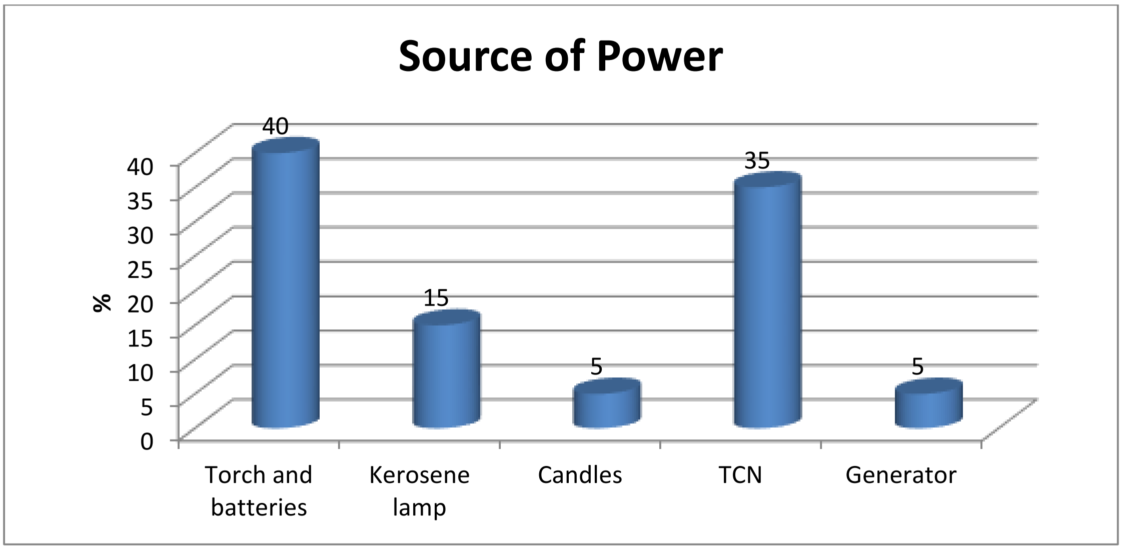

Figure 4.33: Source of Power used by the Respondents
Source: EnvAccord Field Survey, 2014

In terms of sources of cooking fuel, majority of the respondents indicated fire wood (61 per cent) as indicated in Figure 4.34.

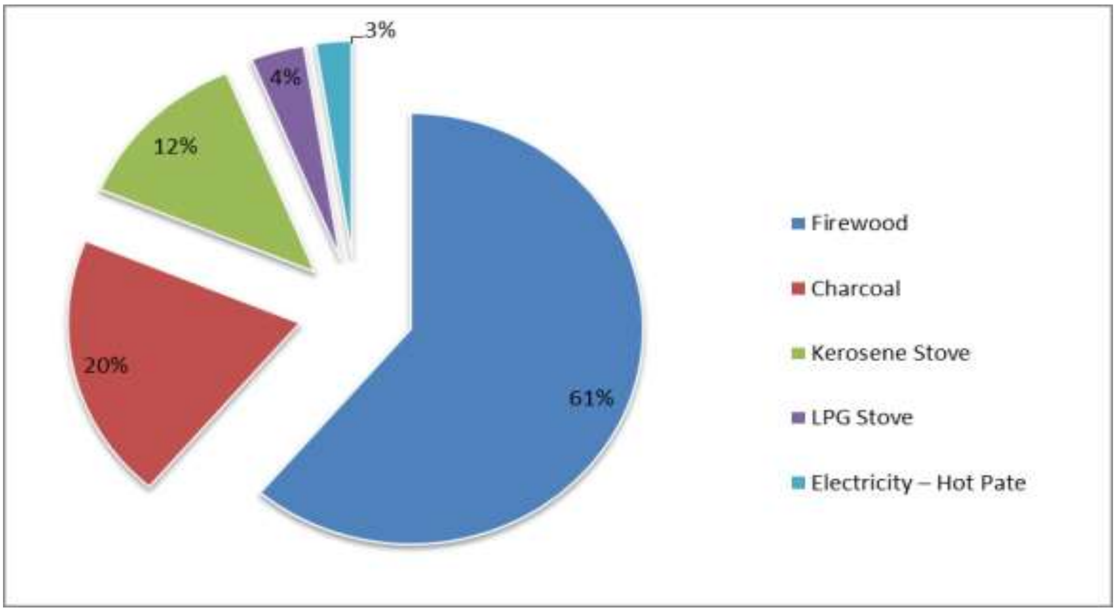

Figure 4.34: Source of Cooking Fuel used by the Respondents
Source: EnvAccord Field Survey, 2014

❖ Assessment of Changes in Standard of Living

The assessment of the opinion of the respondents on changes that have occurred over the last two years in terms of the standard of living is illustrated in Figure 4.35. 68 per cent of the respondents claimed to have a better standard of living on annual basis.

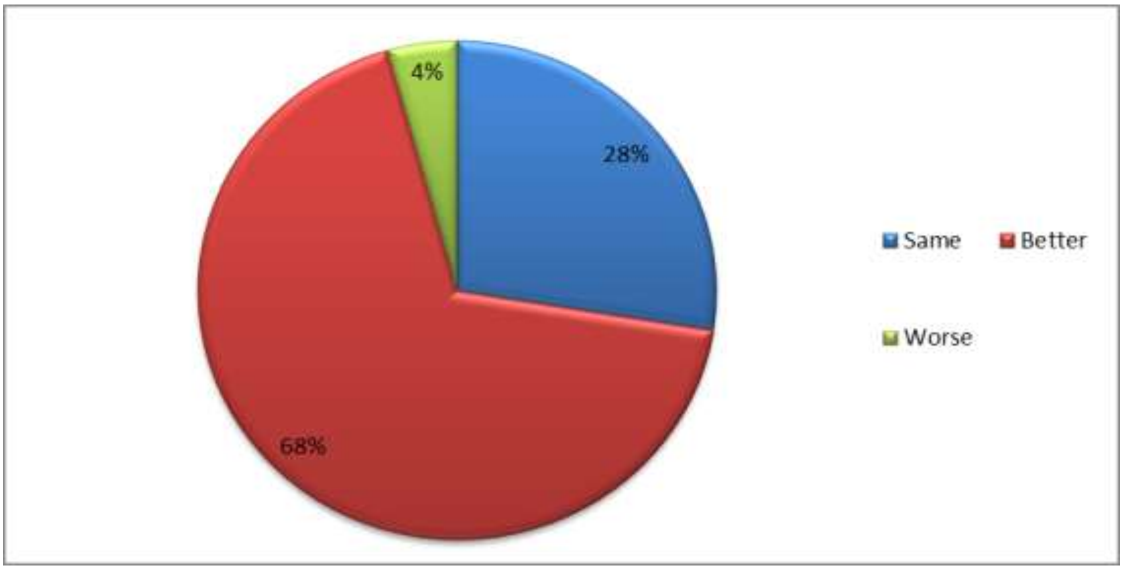

Figure 4.35: Responses to Standard of Living
Source: EnvAccord Field Survey, 2014

❖ Perception on the Proposed Project

As shown in Figure 4.36, a total of 74 per cent of the respondents claimed to be aware of the proposed Project while 26 per cent claimed not to be aware. 87 per cent of the respondents believed that the project would be highly beneficial to the communities as a whole in terms of job employment and improved socio-economic activities (Figure 4.37).

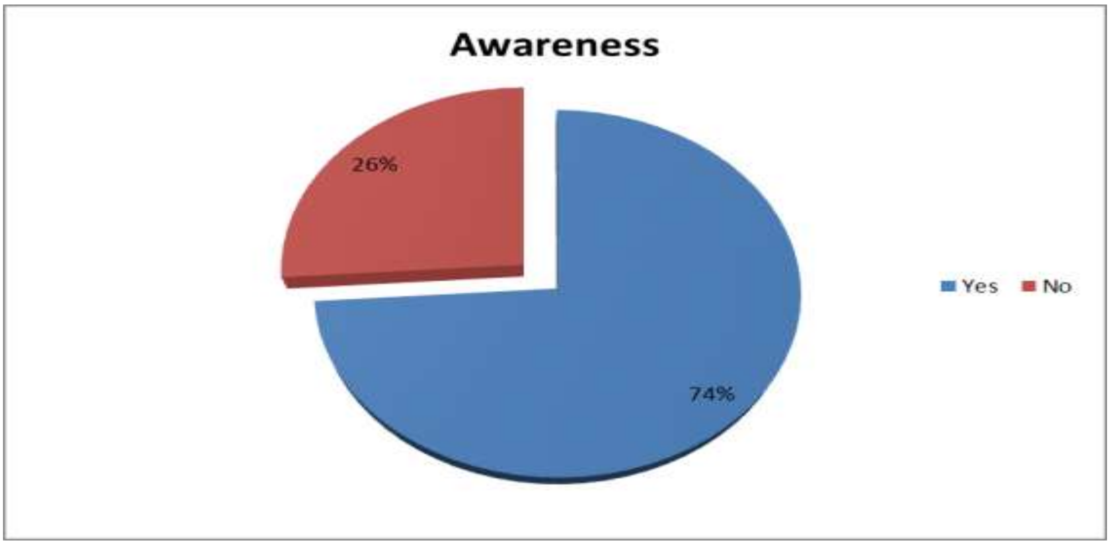

Figure 4.36: Respondents' Rate of Project Awareness
Source: EnvAccord Field Survey, 2014

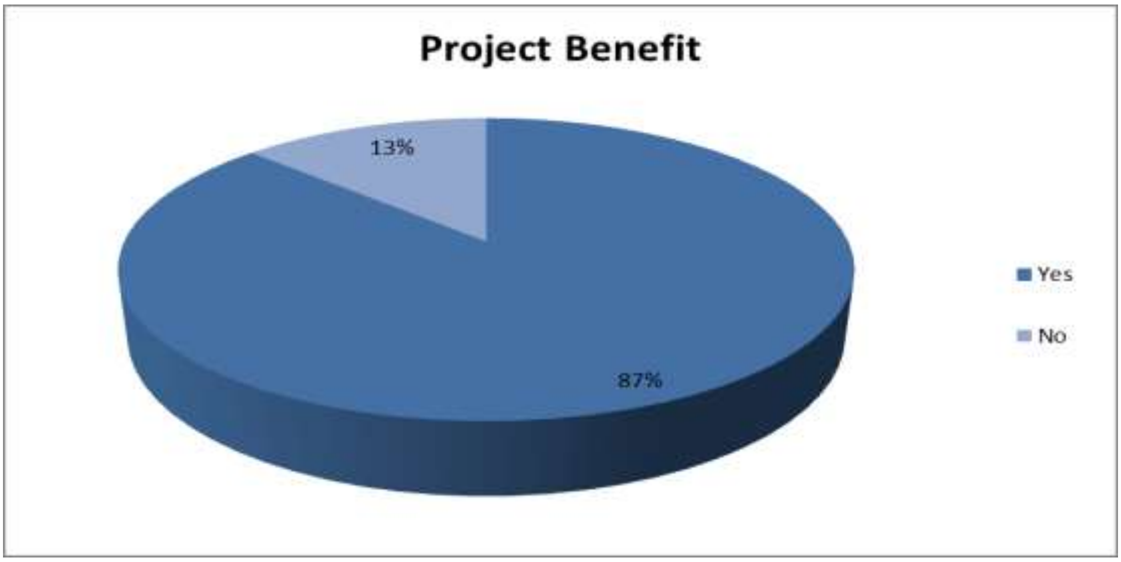

Figure 4.37: Respondents' View on Project Benefit
Source: EnvAccord Field Survey, 2014

❖ Concerns of Respondents on the proposed Project

In general, the respondents stated that the overall objectives of the proposed Project are good for the economic development of the area. However, some of the respondents raised some requests/concerns which include: youths from the communities should be considered for employment and given priority over other non-indigenes during project development; and provision of basic social amenities such as borehole for the communities.

❖ Prevalent Disease

The prevalent disease in the area as indicated by the respondents is malaria (Figure 4.38). This is however not peculiar to the study area alone.

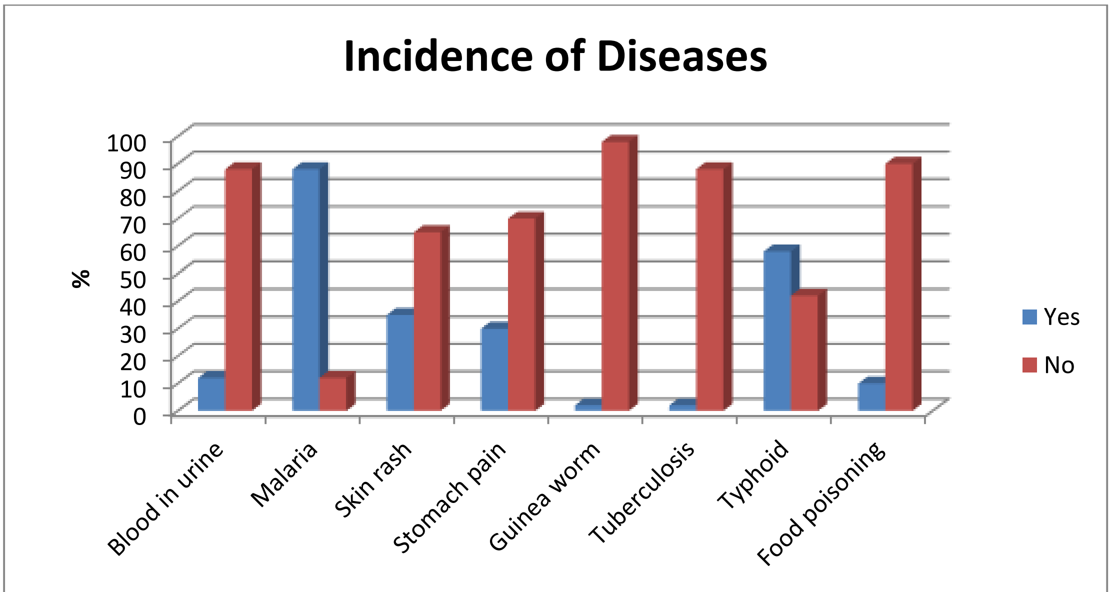

Figure 4.38: Disease incidence indicated by the Respondents
Source: EnvAccord Field Survey, 2014

- Health Status of Respondents

The respondents were asked to rate their households' health status. 80 per cent of the respondents claimed to have good health (Figure 4.39).

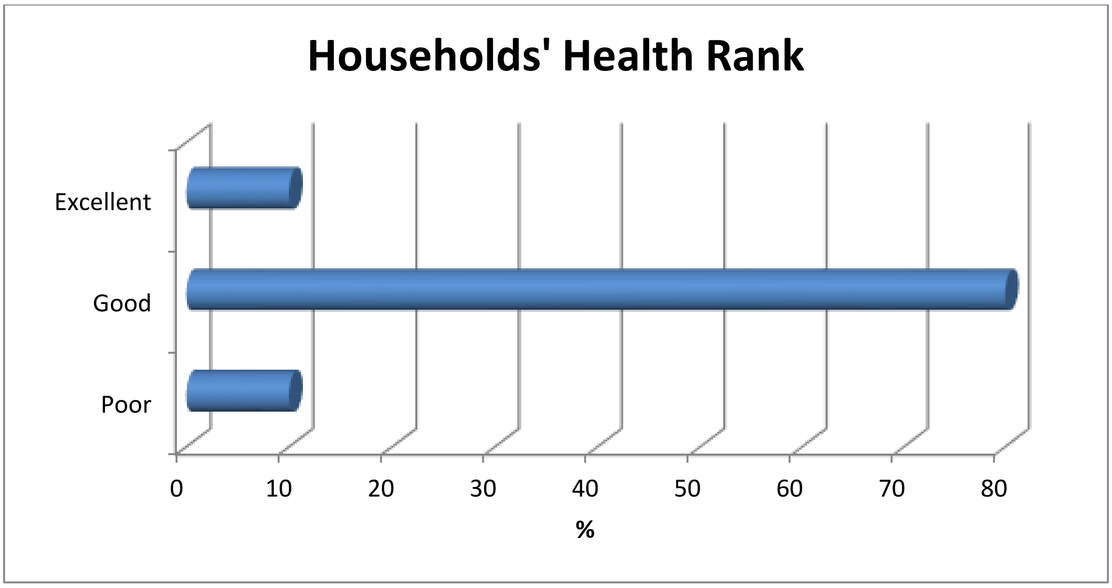

Figure 4.39: Respondents' Households' Health Ranking
Source: EnvAccord Field Survey, 2014

- Healthcare Facility used and Frequency of Visit

General hospital recorded the highest among the health facilities usually visited by the respondents (Figure 4.40). On the frequency of visit, 40 per cent of the respondents claimed not have visited any health facilities in the last few months while 5 per cent indicated to have done so more than 5 times (Figure 4.41).

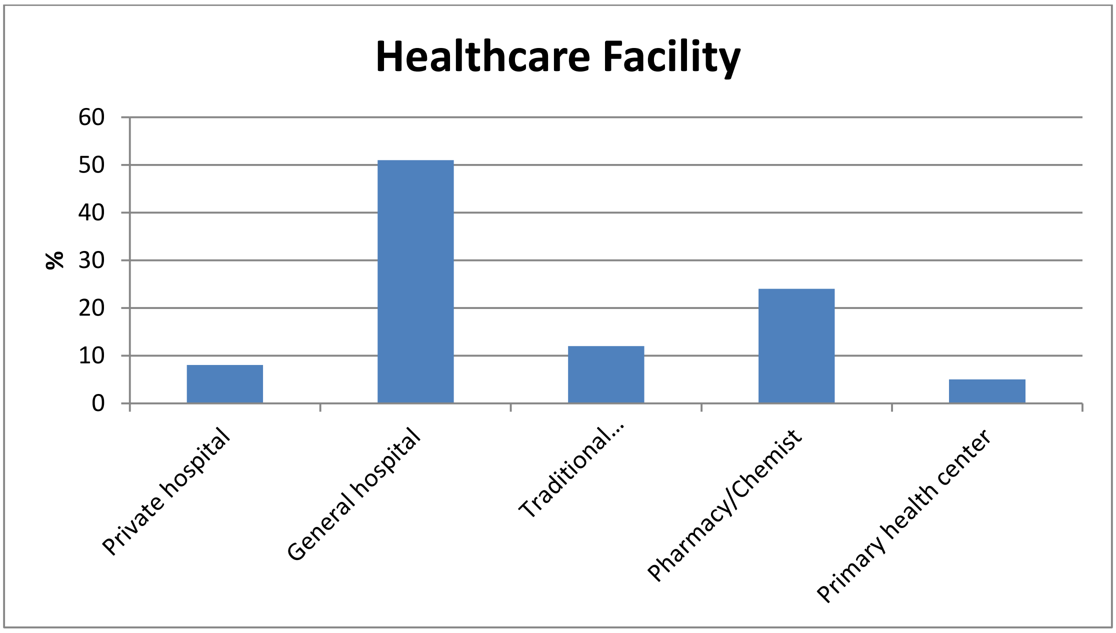

Figure 4.40: Type of Healthcare Facilities used by the Respondents
Source: EnvAccord Field Survey, 2014

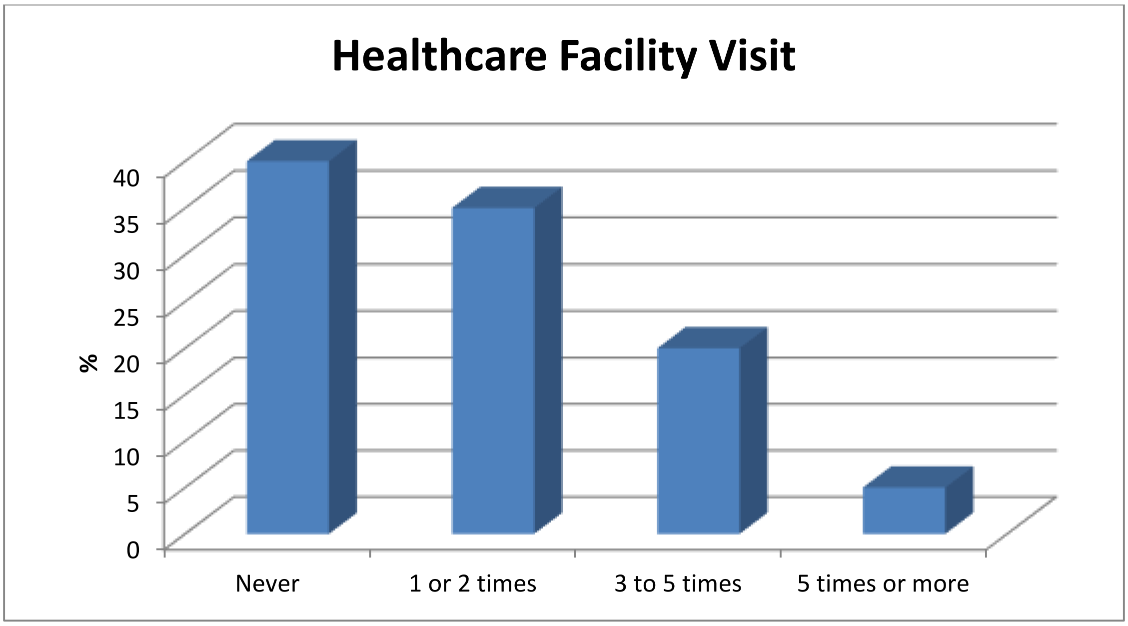

Figure 4.41: Frequency of Visit to Healthcare Facilities
Source: EnvAccord Field Survey, 2014

❖ Maternal Health

The respondents were asked questions regarding the maternal health of their households which include where they received ante-natal care. 71 per cent indicated Government hospital and 29 per cent mentioned traditional birth attendants (Figure 4.42).

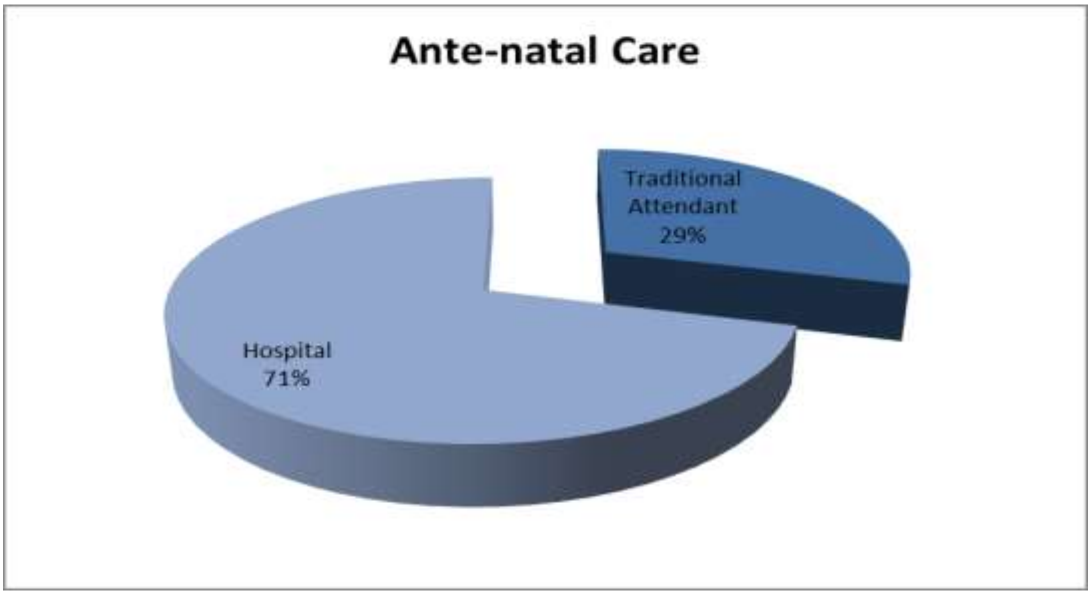

Figure 4.42: Ante-natal Care Visited by the Respondents
Source: EnvAccord Field Survey, 2014

4.5.5 Focus Group Discussions (FGDs)

The FGDs were held with different groups from the sampled communities in the Project's area of influence with the aim of informing the people about the proposed Project, its purpose, benefits, the project activities, likely impacts of the projects and proposed mitigation measures. In addition, the FGDs provided an avenue for the groups to give their opinion and concerns about the Project and their expectations.

The FGDs were held at the palace of Kankia District Head, Kankia on October 21, 2014 and included representatives of farmers, hunters, youths and women groups from each of the sampled communities (Plates 4.23 to 4.26). The discussion was held with the groups in English while an interpreter was available to convey the information to the groups in Hausa for better understanding.

The list of individuals that attended the FGDs is provided in Appendix 8. The groups however included women (15), youths (17), hunters and farmers (23). PASL will ensure that stakeholder engagement with different groups in the communities is sustained throughout the life cycle of the project. In addition, Corporate Social Responsibility (CSR) activities will be tailored to fit the need of the relevant groups in the affected communities.

The concerns raised by each group in relation to the Project during the FGDs are as follows: the adult women were more concerned about the provision of schools (both Islamic and Western), potable water, equipped health care facility and a vocational centre where they can learn different trades. They believe that they will benefit greatly from the proposed Project when put to use as it will boost their businesses, commercial, health and social life.

The adult men expressed their needs for accessible roads in all the five (5) communities with good drainage system. They emphasized that they hope for better living and income and they highly welcome the proposed Project. The hunters and farmers posed questions ranging from if there is plan available on receiving complaints on the project, involvement of the natives, provision of another land for pastoral farming and grazing, and if the panels have any effects on crops and farm productions. It was gathered during survey that the project site is not exclusively reserved for grazing; and there are other areas within the District that could provide good forage for grazing animals.

The youths were very comfortable with the proposed project and unanimously show their support for its implementation. They were concerned about job opportunity the proposed Project would offer. They also raised concern on the extent at which the solar powered electricity will be available.

Some grey areas were cleared during the discussions which included the provision of electricity to communities. It was mentioned that based on the applicable laws guiding power generation and transmission in Nigeria, the project developer can only generate power. Power distribution to local communities is handled by

Distribution Companies licensed by the Nigeria Government. In terms of employment, there is provision to hire the local people in a systematic manner during the Project development. In addition, it is the goal for the proposed Project to improve the conditions of the communities through implementation of corporate social responsibility (CSR) initiatives which will be strategically tailored to the needs of the communities.

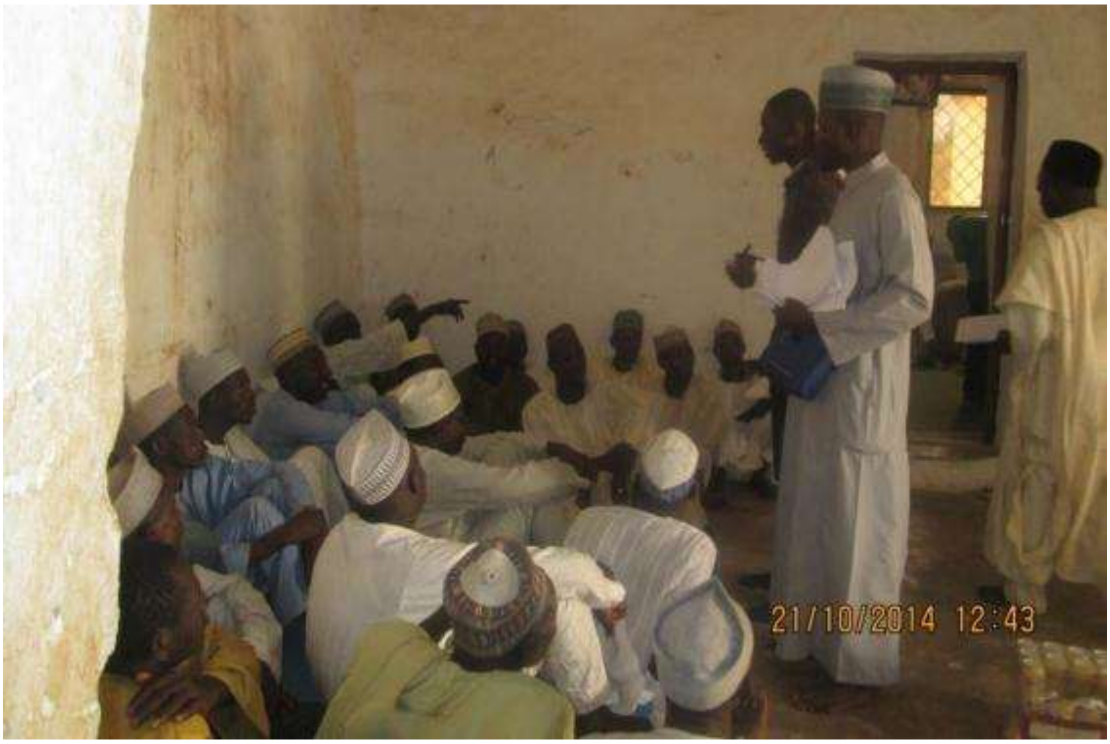

Plate 4.23: FGD with the farmers group from the five communities within the study area

Plate 4.24: FGD with the hunters group

Plate 4.25: FGD with the youth group

Plate 4.26: FGD with the adult women group from the five communities within the study area

4.6 Stakeholder Engagement

This section describes the activities that the Project has carried out to engage and consult with key stakeholders. It describes the process by which stakeholders were identified, the means by which they were consulted, and the outcomes of the consultations to date, some of which were already discussed in the previous sections. It further describes the actions that the Project took to disclose pertinent information to stakeholders.

4.6.1 Defining Stakeholder Engagement

Stakeholder engagement is an ongoing process of sharing project information, understanding stakeholder concerns, and building relationships based on collaboration. Stakeholder consultation is a key element of engagement and essential for effective project delivery. Disclosure of information is equally as vital.

In line with current guidance from the International Finance Corporation (IFC), consultation should ensure "free, prior and informed consultation of the affected communities". In other words, effective consultation requires the prior disclosure of relevant and adequate project information to enable stakeholders to understand the risks, impacts, and opportunities.

The Project's consultation program was intended to ensure that stakeholder concerns are considered, addressed and incorporated in the development process.

The stakeholder engagement documents for the scoping phase of the EIA are provided in Appendix 9.

4.6.2 Stakeholder Engagement Plan

To fulfil the overall objectives of stakeholder engagement for the proposed Project, a stakeholder engagement plan (SEP) has been developed which will be implemented throughout the Project life-cycle (Appendix 10). The plan lays out a process for consultation and disclosure. The four stages of the Stakeholder Engagement Plan are as follows:

- Scoping;
- EIA Study;
- EIA Disclosure; and
- Project Execution.

Table 4.23 is a summary of the process and stages of consultation for this EIA study.

Table 4.23: Summary of the process and stages of consultation for the EIA

Stages/Procedure	Goals	Objectives
Project Scoping and Design	• Registration with FMEnv. • Discuss project design • Ensure compliance with FMEnv regulations and guidelines	• Adequate consultation with authorities • Reduce conflict areas
Field Consultations	• Consult host communities on socio-economic aspects • Consult with public on health and EMF emission and risks of electrical hazards concerns • Consult on the general impact of the Transmission Line	• Ensure that the public, being the primary stakeholders, understand the project and its benefits • Ensure the Project developer understands the concerns and issues raised by the local communities so that appropriate mitigation measures can be taken.

Stages/Procedure	Goals	Objectives
Environmental reviews, analysis, reporting and public presentation	• Present results of field study • Discuss the potential impact/mitigation measures with proponent and regulators • Present the report for public review • Allow stakeholders determine whether their concerns are adequately addressed through the EIA report review process	• Seek approval of methodologies, results and Environmental Management Plan from State and Federal Regulators and the general public
Final Report	• Bridge the gaps observed at public review	• Implement mechanism to ensure continuous consultation
Production of Final Report	• Finalize mitigation and disclose to stakeholders	• Mechanisms in place to ensure ongoing consultation and compliance with agreements
Implement EMP	• Disclose result of monitoring • Implement public complaints/ grievance process	• Implement audit of proponent's project to assess social performance. • Ensure meaningful on-going consultation with stakeholders. • Evaluate lessons that could enhance proponent services to public
Final Evaluation	• Assess effectiveness of consultation process • Consult stakeholders for their assessment	• Lessons learnt might be transferred to other projects.
On-going consultation	• Assess effectiveness of SEP, grievance mechanism and overall project performance on and on-going basis throughout the operation of the project	• Build on the understanding developed from previous stakeholder engagement activities undertaken for the Project; • Ensure an ongoing consultation with stakeholders throughout the project life

The following sections describe the stakeholder engagement activities that have been carried out so far.

4.6.2.1 Scoping Activities

At the scoping stage, project stakeholders were identified in order to understand the individuals, groups, and organizations that may be affected by or may influence project development positively or negatively. Initially, a broad list of potentially affected and interested parties (AIPs) was considered, such as:

- National, regional and local government;
- Local businesses/cooperatives and associations;
- Local communities and individuals; and
- National and local environmental and social nongovernment organizations (NGOs)

A scoping workshop (Plate 4.27) was held in Katsina on October 16, 2014. The workshop was attended by representatives from Government Authorities, Non-Governmental Organizations (NGOs) and representatives of the host communities. The identified stakeholders were given the opportunity to participate and contribute to the EIA process. The list of stakeholder groups that attended the scoping workshop is highlighted in Table 4.24. The total number of attendees was 31. The summary of comments, suggestions and concerns that were raised during the scoping workshop and how they were addressed is provided in Table 4.25.

Plate 4.27: Sample photograph of regulatory authorities present at the scoping workshop

Table 4.24: Summary of Stakeholder Engagement Activities

Stakeholder Group and Interest in the proposed project	Stakeholder Name	Stakeholder Level			Connection to the Proposed Project	Means of Engagement	
		National	Regional	Local		Letter and BID	Scoping Workshop
Government Authorities	Federal Ministry of Environment (FMEnv)	✓			National government are of primary importance in terms of establishing policy, granting permits or other approvals for the Project, and monitoring and enforcing compliance with Nigerian law throughout all stages of the Project life-cycle.	√	√
	Nigerian Electricity Regulatory Commission (NERC)	✓				√	√
	Nigerian Bulk Electricity Trading (NBET) Plc.	✓				√	√
	Transmission Company of Nigeria (TCN), Kankia, Katsina.	✓				√	√
	Katsina State Ministry of Environment		✓			√	√
	Katsina State Ministry of Lands, Housing and Urban Development		✓			√	√
	Kankia Local Government Authority			✓	Katsina State and Kankia local authorities need be informed of progress and plans in their areas, to consider the proposed Project activities in their policy making, regulatory and other duties and activities.	√	√
Community	Magaji Gari, Kafin Dangi, Kyauyan Maina, Gachi and Galadima			✓	Households and communities that may be directly or indirectly	√	√

Stakeholder Group and Interest in the proposed project	Stakeholder Name	Stakeholder Level			Connection to the Proposed Project	Means of Engagement	
		National	Regional	Local		Letter and BID	Scoping Workshop
					affected by the proposed Project		
Non-Governmental Organizations (NGOs)	• International Centre for Energy, Environment and Development (ICEED)	✓			NGOs with direct interest in the proposed Project, and its social and environmental aspects that are able to influence the Project directly or through public opinion.	√	√

Table 4.25: Initial Scoping Consultation Findings

Stakeholder	Priority Issues	Quotes/Comments	Response during scoping workshop	Sections of EIA report that addressed comments
Federal Ministry of Environment	Permit application procedures, EIA process	The representative of the FMEnv at the scoping workshop lauded the project and asked the following questions: what will be the impact of the project based on the modification plan for expansion from 20MW to 80MW and increase in land acquisition? What is the technology proposed to be used for the project because this was not	The Commissioner of Resource Development, Katsina State expressed his appreciation to all stakeholders present. He mentioned that there was a Memorandum of Understanding (MoU) between Katsina State Government and Pan Africa Solar Limited; therefore, the project is in partnership with the PASL. He also mentioned some benefits which are	Chapter 3 (Project Description), Chapter 5 (Potential and Associated Impacts), Chapter 6 (Mitigation Measures) Chapter 7 (Environmental Management Plan) Aside the scoping workshop, a Stakeholders' consultation meeting (town hall meeting) was held on October 20, 2014 at the palace of "Kankia Magajin" (the district head of Kankia). The meeting was attended by the head of Kankia District and the heads of communities/wards that may be

Stakeholder	Priority Issues	Quotes/Comments	Response during scoping workshop	Sections of EIA report that addressed comments
		discussed by the Client? He also asked if there will be another stakeholder engagement as most of the people affected by the project were not around. He advised that the PASL should find out the major needs of the people per community and incorporate into their Corporate Social Responsibility (CSR) instead of imposing their ideas of CSR on the people.	- generation of more revenue, - availability of more power - creation of more jobs for the indigenes - attraction of investors He said the executive governor of Katsina state was making every effort to ensure the project success and thus encouraged all stakeholders to support the project. The Commissioner responded to some of the questions raised by the FMEnv representative. He said there will be no adverse impact relating to the displacement of people or settlements therefore there will not be need for compensation. The project site is within the Katsina Government reserved area and is not used for farming. There will be some negative impact during the construction stage like noise, air pollution due to emissions from large vehicles. However, necessary mitigation and compensation	potentially affected by the Project.

Stakeholder	Priority Issues	Quotes/Comments	Response during scoping workshop	Sections of EIA report that addressed comments
			measures will be recommended.	
Federal Ministry of Environment (Katsina State Office)	EIA process and stakeholder consultation	The representative of the FMEnv (Katsina State Office) at the scoping workshop asked the following questions: – Who are the developers of the project? – Is the project a joint one or solely owned by the Katsina State?	The project developers are Katsina State Government, Pan Africa Solar Limited and JCM Capital	Chapter 1 (Introduction)
National Electricity Regulatory Commission (NERC)	EIA process and stakeholder consultation	The representative of the (NERC) at the scoping workshop asked the following questions: – What measures are in place to prevent electrocution? – How will the technology transfer impact the people? – What plan is in place for the hearing effect of the people due to noise? – What is the plan against hazardous emission? He advised the Client to carry the communities along during the operational phase of the project.	Mr. Olumide Sanya of PASL that there are measures put in place to avoid electrocution as mentioned during both the technical and environmental presentations. Funmi mentioned that qualified skilled people of the land will be employed and trained thereby impacting them with knowledge. The Honourable Commissioner also mentioned by informing the house that there is an agreement between Katsina State Government and Pan Africa Solar Ltd to send Twenty (20) people from Kankia abroad for training to acquire skills that will be relevant for the operation of the facility. Funmi of EnvAccord explained that the Maximum permissible noise level is 90dBA and not 60dBA; however, during	Chapter 6 (Mitigation Measures) Stakeholder engagement plan has been developed as part of this EIA

Stakeholder	Priority Issues	Quotes/Comments	Response during scoping workshop	Sections of EIA report that addressed comments
			construction it is recommended as one of the mitigation measures that construction activities will be limited to day time and not extended to night hours so as to prevent disturbance during sleeping hours. It was clarified that there will be no hazardous emissions.	
Nigerian Bulk Electricity Trading Plc.	EIA process and stakeholder consultation	–	No comments received	-
Katsina State Ministry of Environment	EIA process and stakeholder consultation	The representative of the (Katsina State Ministry of Environment) at the scoping workshop asked the following questions: – The Client should specify the numbers of panels to be given to the houses as well as the number of houses that will be benefitted. – There should be serious consideration on CSR.	PASL will develop and maintain a robust Corporate Social Responsbility (CRS) which will be tailored to fit the need of the project area	Chapter 7 (Environmental Management Plant) – Additional management plan to be developed for the project.
Vice Chairman, Kankia Local Government Area	EIA process and stakeholder consultation	He expressed his happiness for the project and gratitude to the stakeholders. He was of the opinion that the project will not only be for the people of Kankia but for Katsina State as a whole.	He was appreciated	-

Stakeholder	Priority Issues	Quotes/Comments	Response during scoping workshop	Sections of EIA report that addressed comments
The Deputy Surveyor general of katsina state (Surveyor Mohammed Kabir)	Stakeholder consultation	He wanted to know who takes the responsibility of compensation for the land owners Since airplanes fly through the project site, what are the measures in place to avoid interference What measures are in place to guide against road congestion and accident along the ever-busy Kano-Katsina road?	The Hon. Commissioner of Resource Development said that the land belongs to the state government (Government reserved area) therefore there is no issue of compensation. He further stated that the people should not confuse the Pan African Solar Project with the New German Project because they are both Solar projects. Funmi of EnvAccord explained that the panels will be coated to prevent effect of lighting also the panels will be installed at a particular angular orientation that will not affect the airplanes. No there are no existing airports within the project's area of influence.	-
The District Head Kankia Community	Stakeholder consultation	The District Head expressed his delight at the project and gave his support for the project on behalf of people from Kankia. He mentioned that his people are in full support of projects that will bring advancement to the communities and Katsina as a whole.	-	-

4.6.2.2 EIA Study Activities

Engagement activities in the EIA study stage included consultations designed to introduce the Project to stakeholders that could potentially be affected by the Project. This was intended to refine the EIA scope by generating additional feedback on the EIA approach, key issues and key stakeholders to be consulted, as well as to inform the development of mitigation for the Project.

In the course of stakeholders' engagement activities, different interest groups were also consulted. Aside the scoping workshop, a Stakeholders' consultation meeting (town hall meeting) was held on October 20, 2014 at the palace of "Kankia Magajin" (the district head of Kankia). The meeting was attended by the head of Kankia District (Plate 4.28) and the heads of communities/wards that may be potentially affected by the Project (Plate 4.29). The total number of attendees was 25.

The communities were unanimous in declaring that their most important need was provision of constant electricity and job creation for their indigenes. Therefore, the prospects of the project are a major source of excitement for them. They were of the opinion that it would benefit the communities as a whole by stimulating development and employment opportunities. They also expressed the need for a well-staffed standard hospital that would have drugs and 24 hour services with the presence of a functional ambulance. Provision of pipe-borne water was also mentioned as one of the social amenities the communities would need.

Plate 4.28: Stakeholder Engagement Meeting with Kankia District Head and the village heads

Plate 4.29: EnvAccord Field team, Kankia District Head and Village Heads

CHAPTER FIVE:

ASSOCIATED AND POTENTIAL IMPACTS

CHAPTER FIVE

ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction

This chapter presents the potential environmental and socio-economic impacts associated with the proposed Photovoltaic (PV) Solar Power Plant Project in Kankia Local Government Area of Katsina State, Nigeria.

Additional mitigation measures required to complement those incorporated in the Project design for the identified impacts are highlighted in the next chapter.

5.2 Impact Assessment Overview

The potential for an environmental impact exists where an environmental aspect has been identified i.e. where a project activity has been determined to have the potential to interact with the bio-physical and socio-economic environment. The significance of each impact is then determined.

The methodology used for assessing the potential and associated impacts of the proposed Project consists of five (5) major steps:

Step 1: Identification of the proposed Project activities and their interaction (directly or indirectly) with the identified environmental receptors/resources in the Project area;

Step 2: Comprehensive preliminary identification of potential impacts as a result of cause and effect relationship;

Step 3: Comparative assessment of impact importance, identification of impacts that are likely to be significant through application of a basic set of impact significance criteria based on the preliminary information available about each impact;

Step 4: Detailed assessment of the identified focus area impacts characterization techniques, quantification of impacts to the extent possible and rigorous qualitative characterization of impacts that cannot be quantified; and

Step 5: Final assessment of the severity levels of impacts through application of the results of the quantitative and qualitative characterization of impacts developed in Step 4 to a set of objective impact severity criteria; identification of impacts warranting mitigation.

Figure 5.1 summarizes the process used for identifying and assessing potential impacts of the proposed Project.

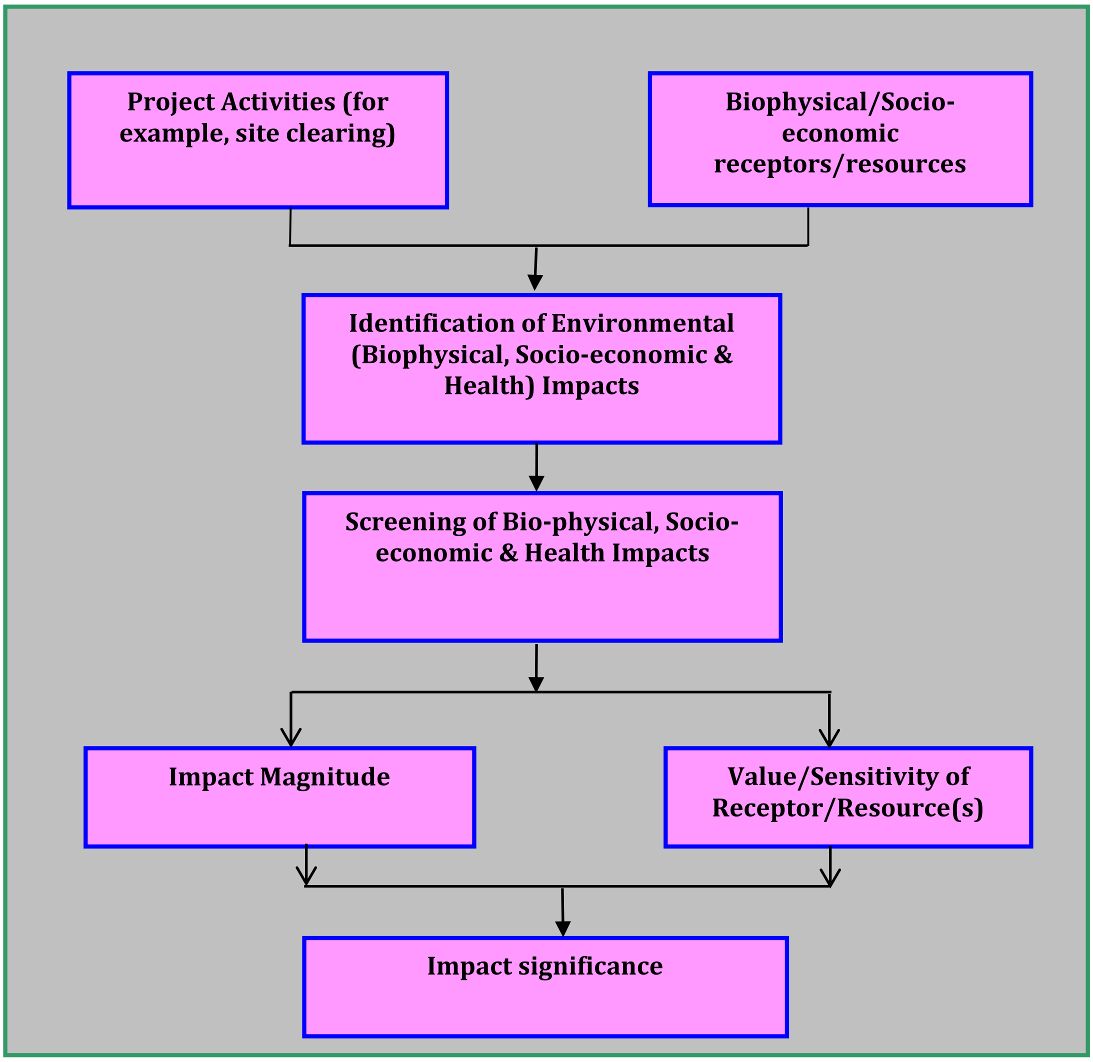

Figure 5.1: Overview of the Impact Assessment Process

The primary objectives of the impact assessment process are to:

- Establish the significance of identified potential impacts that may occur as a result of the proposed Project activities.
- Differentiate between those impacts that are insignificant (i.e. can be sustained by natural systems) and those that are significant (i.e. cannot be sustained by natural systems).

In determining the significance of impacts, the factors considered included: magnitude of impacts (which is a function of the combination of the following impact characteristics: extent, duration, scale and frequency); value/sensitivity/fragility and importance of relevant environmental and social receptors; legal/regulatory requirements; and public perceptions (based on stakeholders' consultation).

The assessment of impact significance is qualitative and quantitative.

Qualitatively, the impact significance is ranked on four (4) widely accepted levels namely:

- Major,
- Moderate,
- Minor, and
- Negligible**.**

These rankings are used for both bio-physical and socio-economic impacts. Potential cumulative impacts are also considered.

The impact assessment undertaken for the proposed Project covers the entire life cycle of the Project i.e.:

- Pre-construction;
- Construction/Installation;
- Operation;
- Decommissioning and Abandonment

5.3 Impact Prediction Methodology

Various impact prediction guidelines and methodologies have been developed and applied in various EIA activities. Internationally acceptable methods of impact prediction and evaluation include the following:

- Checklist (Canter, 1977)
- Interaction Matrix (Leopold *et al*., 1971)
- Overlays Mapping (McHarg, 1968);
- Networks; and
- Battelle Environmental Evaluation System (Dee *et al*., 1972)

The Interaction Matrix method, when compared to the other approaches, provides the same level of details requires comparable knowledge of the environment and relies on limited data unlike the other methods that rely on availability of large historical data bank. It also has a wide range of application. Thus, a modified Leopold Interaction Matrix was selected for the purpose of impact screening for this EIA.

5.4 Identification of Environmental and Socio-economic Aspects and Impacts

5.4.1 Environmental and Socio-economic Aspects

The International Organization for Standardization's Environmental Management Systems (EMS), ISO 14001, defines an environmental aspect as: *"An element of an organization's activities, products or services that can interact with the environment."*

To identify environmental aspects of the Project, the proposed Project activities were considered in terms of their direct or indirect potential to:

- Interact with the existing natural environment including its physical and biological elements;
- Interact with the existing socio-economic environment; and
- Breach relevant policy, legal and administrative frameworks including national legislation, relevant international legislation/conventions, standards and guidelines, and corporate environmental policy and management systems.

Activities assessed covered routine, non-routine and accidental events.

5.4.2 Definition of Impacts

ISO 14001 defines an environmental impact as: *"Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services."*

Table 5.1 illustrates the links between activity, aspect and impact.

Table 5.1: Example of a Link between Activities, Aspects and Impacts

Activity	Aspect	Potential Impact
Use of vehicles for transporting equipment to site	Exhaust emissions	Decrease in air quality
	Noise	Disturbance to surrounding environment
Site clearing and grading	Removal of the vegetation and fauna	Loss of biodiversity or natural habitat
Plant Installation	Excavation of soil	Soil erosion

5.4.3 Potential Impact Characteristics

The following characteristics were also used to define potential impacts that may be associated with the proposed Project:

i. *Negative:* An impact that is considered to represent an adverse change from the baseline or to introduce a new undesirable factor.
ii. *Positive:* An impact that is considered to represent an improvement to the baseline or to introduce a new desirable factor.
iii. *Direct*: Impacts that result from the direct interaction between a planned project activity and the receiving environment.
iv. *Indirect:* Impacts that result from other activities that are encouraged to happen as a consequence of the project.
v. *Temporary:* Temporary impacts are predicted to be of short duration, reversible and intermittent/occasional in nature.
vi. *Short-term:* Short term impacts are predicted to last only for a limited period but will cease on completion of the activity, or as a result of mitigation measures and natural recovery.
vii. *Long-term:* Impacts that will continue for the life of the project, but cease when the project stops operating.
viii. *Permanent:* Potential impacts that may occur during the development of the Project and cause a permanent change in the affected receptor or resource that endures substantially beyond the project lifetime.
ix. *On-site:* These are limited to the project site.
x. *Local:* Impacts that affect locally important environmental resources or are restricted to a single (local) administrative area or a single community.
xi. *Regional:* Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries.
xii. *National:* Impacts that affect nationally important environmental resources; affect an area that is nationally protected; or have macro-economic consequences.
xiii. *Reversible:* An impact that the environment can return to its natural state.
xiv. *Irreversible:* An impact that the environment cannot return to its original state, e.g. the extinction of an animal or plant species.
xv. *Cumulative*: Potential impacts that may result from incremental changes caused by other past, present or reasonably foreseeable actions together with the Project.
xvi. *Residual:* Both environmental and social impacts that will remain after the application of mitigation measures to project impacts during each of the project phases (preconstruction, construction, operation, decommissioning/post-decommissioning).

5.4.4 Screening and Scoping for Potential Impacts

A modified version of the Leopold Interaction-matrix technique was employed to screen and scope for the potential impacts of the proposed Project on the environment. The basis for the screening was derived from the following:

- Knowledge of the Project activities as summarized in Table 5.2.

- Detailed information on the environmental and socio-economic setting of the study area/project's area of influence
- Review of other EIA reports on similar projects/environments.
- Series of experts group discussions, meetings and experience on similar projects.

Table 5.2: Summary of the proposed Project Activities

S/N	Project Phase	Associated Project Activities
1.	Pre-construction	Site selection/land take
		Mobilization of personnel, equipment, materials to site
		Site clearing and preparation
2.	Construction/ Installation	Civil work activities including construction/improvement of internal access roads, excavation, trenching, cable laying, foundation piling, construction of buildings such as office
		Installation of power plant facilities and erection of high voltage power lines (pylon)
		Waste generation
3.	Operation	Measuring the performance of the PV power through the use of telemetric monitoring
		Regular onsite preventive and corrective maintenance
		Waste generation
4.	Decommissioning and Abandonment	Dismantling of PV modules and plant facilities including removal of underground cable runs
		Waste generation
		Rehabilitation of disturbed land

The Leopold Interaction Matrix developed for the proposed Project is presented in Tables 5.3 and 5.4. The Interaction Matrix was developed by placing the proposed Project activities in the rows and the identified existing environmental and socio-economic components in the columns. The interaction was then established.

Table 5.3: Activity-Receptor Interaction for Impact Screening

Summary of Project Activities at Various Phases	Receptors																
	Physical						Biological		Socio-economic						Others (Health and Safety)		
	Air Quality	Ambient Noise	Soil	Ground water and Aquifers	Hydrological system	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities	Infrastructure	Employment/ Income	Visual Prominence	Construction workers	Workplace health and safety	General Public
Pre-construction																	
Site/Land Take									X								
Mobilization of personnel, materials and equipment to site	X	X										X	x				
Site clearing and preparation	X	X	X	X	X	X	X	X									
Construction/Installation																	
Civil works activities including installation of PV modules and other components	X	X	X	X	X		X	X		X	X	X	X	X	X		X
Installation of transmission pylon (line)	X	X	X				X	X					X	X	X		X
Waste generation and disposal			X	X											X		X
Operation																	
Operation of Photovoltaic Modules and other components including routine maintenance		X			X		X	X			X		X	X		X	X
Evacuation of power to substation through 132 kV transmission line		X															X
Waste generation			X	X												X	
Decommissioning /Abandonment																	
Removal of PV modules and dismantling of other components	X	X	X		X					X		X	X		X		
Site remediation			X		X		X	X			X						
Waste generation and disposal			X	X													X

Table 5.4: Leopold's Activity-Receptor Interaction Matrix

Summary of Project Activities at Various Phases	Receptors																
	Physical						Biological		Socio-economic						Others (Health and Safety)		
	Air Quality	Ambient Noise	Soil	Groundwater and Aquifers	Hydrological system	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities	Infrastructure	Employment/ Income	Visual Prominence	Construction workers	Workplace health and safety	General Public
Pre-construction																	
Site/Land Take									1(2)								
Mobilization of personnel, materials and equipment to site	2(1)	2(1)										2(2)	+				
Site clearing and preparation	2(1)	2(1)	4(2)	1(1)	3(2)	3(2)	4(2)	3(1)									
Construction/Installation																	
Civil works activities including installation of PV modules and other components	3(1)	2(3)	4(1)	2(2)	2(2)		3(2)	3(2)		3(2)	1(2)	1(2)	++	2(2)	2(3)		
Installation of transmission pylon (line)	2(1)	2(1)	3(1)				2(1)	2(1)					+	2(2)	2(2)		2(2)
Waste generation and disposal			2(1)	2(2)											2(2)		2(2)
Operation																	
Operation of Photovoltaic Modules and other components including routine maintenance		2(2)			2(2)		2(1)	2(1)			2(2)		+	2(2)		3(2)	2(2)
Evacuation of power to substation through 132 kV transmission line		1(3)															1(3)
Waste generation			2(1)	2(2)												2(2)	
Decommissioning /Abandonment																	
Removal of PV modules and dismantling of other components	2(1)	2(1)	3(2)		3(2)					2(2)		2(2)			2(3)		
Site remediation			2(2)		2(2)		2(2)	2(2)			2(1)						
Waste generation and disposal			2(1)	2(2)													2(2)

x(y) = impact magnitude (sensitivity of receptor)

Table 5.5 presents the resources/receptors considered together with the changes that might indicate a Project-related impact.

Table 5.5: Resource/Receptors and Impacts Indicators Considered

Environmental Receptor	Comment	Potential Impact Indicators
Physical		
Soil	The soil environment of the Project site and its surroundings	Changes in physical, chemical and biological properties, loss of soil ecology and fertility, compaction, erosion etc.
Hydrology	Water flow pattern along the ground surface in the project area	Increased intensity and volume of storm water runoff; increased sediment load in the drainage channels as a result of erosion; and reduced water quality.
Groundwater/Aquifers	The groundwater resources and aquifers of area within the area of influence of the proposed project.	Groundwater level, changes in physical, chemical and biological properties, contamination, and availability of potable water as one (1) or two (2) boreholes is envisaged to be dug on the Project site.
Landscape/Topography	The geomorphological land forms and terrain of the project area	Alteration in drainage pattern, changes in landscape.
Ambient Noise	Ambient noise level in the Project site and its surrounding environment	Increased ambient noise level, night and day-time disturbance, hearing loss, communication impairment etc.
Air Quality	Air quality in and around the proposed Project site.	Increased concentrations of gaseous and particulate pollutants (such as NOx, SOx, CO, particulate in form of dust)
Biological		
Terrestrial Flora	Terrestrial plant species that occur within the Project site and its immediate surroundings	Loss of terrestrial flora, introduction of new species.
Terrestrial Fauna	Terrestrial fauna rely on the Project site as a habitat and/or food source.	Loss of terrestrial fauna; involuntary migration.
Socio-economic Environment		
Land Use	Existing land use of the Project site	Loss of land value for grazing
Population	Existing demography of the communities in the study area	Increased in local population due to influx of workers
Utilities	The utilities (e.g. power supply, water, sewerage	Changes in existing utilities, pressure on public utilities.

Environmental Receptor	Comment	Potential Impact Indicators
	services, etc.) of the Project area.	
Infrastructure	Infrastructure such as roads, waste handling facilities in the Project area.	Access to road, access to waste management facilities, access to emergency services
Employment	The employment situation in the project area and beyond.	Opportunities for local and national employment; changes in income level
Visual Prominence	The view of the Project site and its surroundings	Landscape alterations resulting in unpleasant changes in the visual character of the area
Other (Health and Safety)		
Construction workers	The health and safety of workers involved in the construction phase of the proposed Project.	Accidents, injury, fatality, exposure to nuisance (dust, noise), fire, spread of sexually transmitted diseases such as HIV (Human Immunodeficiency Virus)
Workplace Health and Safety	The health and safety of employees involved with the operations phase of the Project.	Accidents, injury, exposure to radiation (Electromagnetic Field), explosion, ergonomics.
General Public	The health and safety of general public including people residing or working in the Project's area of influence	Exposure to radiation (Electromagnetic Field), accident, fire, explosion, etc.

5.4.5 Determination of Impact Significance

Once all environmental aspects were identified, the levels of impacts that may result from the proposed Project activities were assessed. Three (3) stages were utilized to establish significance of impacts as follows:

- **Impact Magnitude** which is a function of the combination of the following impact characteristics: extent, duration, scale and frequency;
- **Value/Sensitivity/Fragility and importance of the identified receptor or resources**;
- **Identification of the impact significance,** which is the "product" of a combination of the above two key variables.

The magnitude of an effect is often quantifiable in terms of, for example, the extent of land take, or predicted change in noise levels while the sensitivity, importance or value of the affected resource or receptor is derived from:

- Legislative controls;

- Designated status within the land use planning system;
- The number of individual receptors, such as residents;
- An empirical assessment based on characteristics such as rarity or condition; and
- The ability of the resource or receptor to absorb change.

The determination of significance also includes consideration of performance against environmental quality standards or other relevant pollution control thresholds; and compatibility with environmental policies.

All through the impact prediction and evaluation process, expert discussions were constituted and employed extensive use of matrices and predefined criteria in predicting environmental impacts, determining their magnitude, and impact significance. To minimize subjectivity, independent scores were thereafter statistically analyzed and the results of the scores judged as follows:

- if variance, $s^2 < 5\%$ of the mean, subjectivity is minimal and the score is good; and
- if $s^2 > 5\%$ but $< 10\%$ of the mean, the score is fair and scorers were given the opportunity to review their scores.

5.4.5.1 Impact Magnitude

Magnitude is in practice a continuum, and evaluation along the spectrum requires the exercise of professional judgment and experience. Each impact is evaluated on a case-by-case basis, and the rationale for each determination is noted. The magnitude designations employed for potential negative impacts, are:

- Negligible,
- Low,
- Medium and
- High.

In the case of a positive impact, it is considered sufficient for the purpose of the impact assessment to indicate that the Project is expected to result in a positive impact, thus no magnitude designation has been assigned.

The magnitude of an impact takes into account the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum from negligible to high. These criteria are discussed further in the sub-sections below.

5.4.5.1.1 Determining Magnitude for Bio-physical Impacts

For bio-physical impacts, the quantitative definitions for the spatial and temporal dimension of the magnitude of impacts used in this assessment are provided in Table 5.6 and summarized in the following paragraphs:

A **High Magnitude Impact** affects an entire area, system (physical), aspect, population or species (biological) and at sufficient magnitude to cause a significant measureable numerical increase in measured concentrations or levels (to be compared with national or international limits and standards specific to the receptors) or a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent upon it, to its former level within several generations.

A high magnitude impact may also adversely affect the integrity of a site, habitat or ecosystem.

A **Medium Magnitude Impact** affects a portion of an area, system, aspect (physical), population or species (biological) and at sufficient magnitude to cause a measurable numerical increase in measured concentrations or levels (to be compared with national or international limits and standards specific to the receptors) and may bring about a change in abundance and/or distribution over one or more plant/animal generations, but does not threaten the integrity of that population or any population dependent on it.

A medium magnitude impact may also affect the ecological functioning of a site, habitat or ecosystem but without adversely affecting its overall integrity. The area affected may be local or regional.

A **Low Magnitude Impact** affects a specific area, system, aspect (physical), group of localized individuals within a population (biological) and at sufficient magnitude to result in a small increase in measured concentrations or levels (to be compared with national or international limits and standards specific to the receptors) over a short time period (one plant/animal generation or less, but does not affect other trophic levels or the population itself), and localized area.

A Very Low/Negligible Magnitude Impact: Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and are characterized as having a very low or negligible magnitude.

A number of considerations have been built into these Impact Magnitude Criteria including temporal, spatial, impact reversibility, direct and indirect impacts and relevant legal or policy constraints.

Table 5.6: Impact Magnitude Criteria for Bio-physical Impacts

Category	Ranking	Definition
High	**4**	• Regional to national scale impact resulting in: ○ Medium term change and/or damage to the natural environment and its ecological processes. ○ Reduction in regional habitat and species diversity. ○ Direct loss of habitat for endemic, rare and endangered species of fauna and/or flora and for species' continued persistence and viability nationally and regionally (for species unable to disperse). • Breach of environmental regulations and company policy and/or 100%-200% exceedance of international, national, industry and/or operator standard for an emission parameter.
Medium	**3**	• Local to regional scale impact resulting in: ○ Short term change and/or damage to the natural environment and its ecological processes. ○ Direct loss of habitat crucial for species' (including listed species) continued persistence and viability in the project area (for species unable to disperse). ○ Introduction of exotic species of fauna in invasive floral species replacing resident 'natural communities' within the project area. ○ Environmental stress lowering reproductive rates of species within the project area. • Potential breach of environmental regulations and company policy and/or 50%-100% exceedance of international, national, industry and/or operator standard for an emission parameter. • Complaints from the public, authorities and possible local media attention.
Low	**2**	• Local scale impact resulting in: ○ Short term change and/or damage to the local natural environment and its ecological processes. ○ Short-term decrease in species diversity in selected biotopes/areas within the project area. ○ Increased mortality of fauna species due to direct impact from project activities. • 10%-50% exceedance of international, national, industry and/or operator standard for an emission parameter. • Public perception/concern.
Negligible	**1**	• Impact largely not discernible on a local scale being absorbed by the natural environment; areas adjacent to disturbed areas absorb exodus of species able to disperse. • Up to 10% exceedance of international, national, industry and/or operator standard for an emission parameter. • Public perception/concern.
Beneficial	**+**	• Activity has net positive and beneficial effect resulting in environmental improvement for example: • Positive feedback from stakeholders. • Potential financial gains.

5.4.5.1.2 Determining Magnitude for Socio-economic Impacts

For socio-economic impacts, the magnitude considers the perspective of those affected by taking into account the likely perceived importance of the impact, the ability of people to manage and adapt to change and the extent to which a human receptor gains or loses access to, or control over socio-economic resources resulting in a positive or negative effect on their well-being. The quantitative elements are included into the assessment through the designation and consideration of scale and extent of the impact. Table 5.7 presents the impact magnitude criteria for socio-economic impacts.

Table 5.7: Impact Magnitude Criteria for Socio-economic Environmental Impacts

Category	Ranking	Definition
High	**4**	• Major impacts on human health (e.g. serious injury). • Significant impact on the livelihoods of individuals (i.e. access to income source restricted over lengthy period of time). • Serious impact on access to community facilities and utilities. • Breach of economy social policy and/or regulation.
Medium	**3**	• Modest impact on human health and well-being (e.g. noise, light, odor, dust, injuries to individuals). • Medium impact on access to community facilities and utilities (e.g. access to utilities restricted for long periods (weeks) of time). • Moderate impact on the wider economy, at a local, regional and/or national scale (e.g. only moderate levels of employment and supplies sources within Nigeria). • Potential breach of company social policy and/or legislation.
Low	**2**	• Limited impact on human health and well-being (e.g. occasional dust, odors, traffic noise). • Some impact on access to community facilities and utilities (e.g. access to cultural centers restricted to a limited extent, i.e. (days).
Negligible	**1**	• Possible nuisance to human health and well-being (e.g. occasional unpleasant odors) • Inconvenience experienced in accessing community facilities and utilities (e.g. electricity supply disruption for short (hours) period of time). • No impact on livelihood, community facilities and human health.
Positive	**+**	• Beneficial improvement to human health. • Benefits to individual livelihoods (e.g. additional employment opportunities). • Improvements to community facilities/utilities. • Incre ased economy (e.g. local procurement, sourcing of supplies).

5.4.5.2 Determining Receptor Sensitivity

In addition to characterizing the magnitude of impact, the other principal variable necessary to assign significance for a given impact is the value, and sensitivity/fragility of the receptor. This refers to economic, social, and/or environmental/ecological importance of the receptor, including reliance on the receptor by people for sustenance, livelihood, or economic activity, and to the importance of direct impacts to persons associated with the resource.

Impacts that directly affect people or vital natural resources are deemed to be more important than impacts that indirectly affect people or vital resources. The sensitivity of the receptor criterion also refers to potential impacts to Environmentally Sensitive Areas (ESAs) and impacts to species, including loss of endangered species, effects of introduction of invasive species, and similar environmental/ecological impacts.

There are a range of factors to be taken into account when defining the sensitivity of the receptor, which may be physical, biological, cultural or human. Where the receptor is physical (for example, soil environment) its current quality, sensitivity to change, and importance (on a local, national and international scale) are considered. Where the receptor is biological (for example, the aquatic environment), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

The receptors-sensitivity designations employed in this impact assessment process are **low**, **medium** and **high** which are universally acceptable.

The sensitivity/fragility/value criteria for physical, biological and socio-economic receptors are defined in Table 5.8.

Table 5.8: Physical, Biological and Socio-economic Receptor-Sensitivity/Fragility/Value Criteria

Category	Ranking	Definition
Physical (for example, air quality)		
High	**3**	All ambient conditions/concentrations exceed guideline limits and are indicative of the resource being impacted or polluted. There is no (or very little) assimilation capacity for increased concentrations/ change in conditions.
Medium	**2**	Some ambient conditions/concentrations exceed guideline limits while others fall within the limits. There is some small assimilation capacity for increased concentrations/ change in conditions. Resource use does affect other users
Low	**1**	All ambient conditions/concentrations are significantly lower than guideline limits and there is capacity for assimilation for

Category	Ranking	Definition
		additional concentrations/ change in conditions. Resource use does not significantly affect other users.
Biological (for example, terrestrial ecology)		
High	**3**	Specifically protected under Nigerian legislation and/or international conventions; listed as rare, threatened or endangered e.g. IUCN
Medium	**2**	Not protected or listed but may be a species common globally but rare in Nigeria with little resilience to ecosystem changes, important to ecosystem functions, or one under threat or population decline.
Low	**1**	Not protected or listed as common / abundant; or not critical to other ecosystem functions.
Socio-economic and health		
High	**3**	Those affected will not be able to adapt to changes and continue to maintain pre-impact status.
Medium	**2**	Able to adapt with some difficulty and maintain pre-impact status but only with a degree of support.
Low	**1**	Those affected are able to adapt with relative ease and maintain pre-impact status.

5.4.5.3 Significance

The significance of the impact is determined by calculating the "product" of impact magnitude and severity/fragility of the relevant receptor(s). Figure 5.2 below illustrates the process for combining the impact magnitude with the receptor sensitivity.

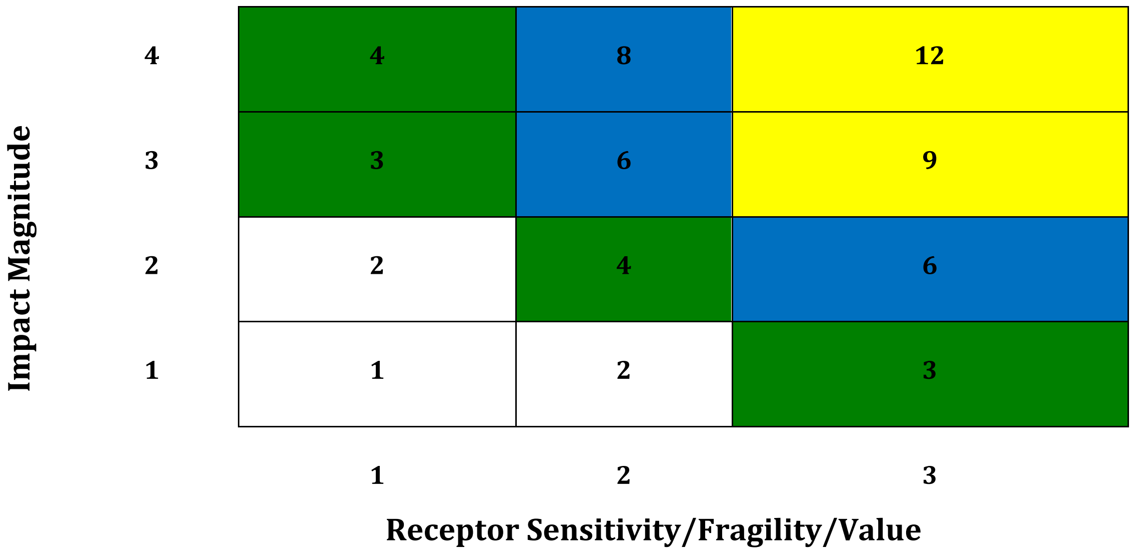

Figure 5.2: Impact Magnitude-Receptor Sensitivity Product Results

Based on its impact magnitude-receptor sensitivity/fragility/value score, each impact was again ranked into four (4) categories or orders of significance as illustrated in Table 5.9.

Table 5.9: Environmental impact significance rankings

Ranking (Impact Magnitude x Sensitivity of Receptor)	Significance
9-12	Major
6-8	Moderate
3 – 5	Minor
1-2	Negligible

Negligible impacts are where a resource or receptor (including people) will not be affected in any way by a particular activity or the predicted effect is deemed to be 'negligible' or 'imperceptible' or is indistinguishable from natural background variations.

An impact of minor significance is one where an effect will be experienced, but the impact severity is sufficiently low (with or without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value.

An impact of moderate significance is one within accepted limits and standards. Moderate impacts may cover a broad range, from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is ALARP (As Low As Reasonably Practicable).

An impact of major significant is one where an accepted limit or standards may be exceeded, or high magnitude impact occurs to highly valued/sensitive receptors/resources.

5.5 Impacts Discussion

The impacts discussion presented in this section is organized as follows:

- Potential impact of the proposed 80 MWp PV Solar Power Plant
- Potential impact of the proposed 132 kV transmission line to be installed as part of the Project
- Potential cumulative impacts

5.5.1 Potential Impact of the proposed PV Solar Power Plant

5.5.1.1 Pre-Construction Phase

The pre-construction phase of the proposed Project includes the following activities:

- Site selection/land take
- Mobilization of equipment, materials and personnel to site
- Establishment of laydown areas and construction workers camp
- Site clearing and preparation

❖ ***Site Selection/Land take***

As earlier documented in the previous chapters, the proposed Project site occupies an approximately 120 ha of land located in Kankia, Kankia LGA of Katsina State. The site is situated in a Government Reserved Area (GRA) along Katsina-Kano Road (IBB Way), in Kankia LGA. There are no residential buildings, structures and farmlands on the site.

Pre-construction surveys of the site have been undertaken and the findings of the surveys have been taken into consideration to ensure that the design of the facility responds to the identified existing environmental constraints. From the specialist investigations undertaken for the proposed energy facility development site, there were no absolute "no go" areas identified within the site.

The site is characterized by shrubs, grasses and herbs which serve as forage for livestock such as sheep, cattle, camel and goats. As noted during the baseline field survey, the livestock grazing is mostly free ranging although some pastoral farmers from the neighbouring communities such as Kauyan Maina and Kafin Dagi situated over 1 km from the Project site occasionally lead livestock, mostly cattle, to the site for grazing. It is important to note that the site is note exclusively reserved as a grazing land. The site is not known to fall within any gazeted grazing reserves or grazing routes. With the construction of the proposed PV Power Plant, the pastoral farmers will be precluded from using the Project site for further grazing. The impact magnitude is considered negligible and localized since there are abundant shrubs and grasses in the immediate surroundings of the Project site which can serve as alternative grazing land for the livestock. Also, the importance of the site for livestock grazing is considered low; no special string is attached to the use of the site for grazing as gathered from the local communities. Based on interview with residents of local communities in the study area, the Project site does not provide ecosystem services of special interest to the communities. In view of this, the significance of impacts of site acquisition for the proposed Project is considered negligible.

❖ ***Mobilization of Personnel, Equipment and Materials to Site***

Heavy-duty and other pieces of equipment will be moved to the Project site at the beginning of construction activities for civil work activities and equipment installation. All photovoltaic (PV) modules, electrical and structural equipment are planned to be shipped through Lagos port in Lagos State, and then trucked in "containers" to the Project site in Kankia, Katsina State by road. It is envisaged that about 500 truckloads transporting 300-400 x 40-foot containers would be required for construction phase.

The potential impact of mobilization activities discussed herein is limited to the Project site and its surrounding environment up to approximately 5 km radius.

The potential biophysical impacts associated with the mobilization activities include decrease in ambient air quality of the project area as a result of emissions from vehicles (such as trucks) that will convey materials and equipment to the site, as well as dust generation along the untarred road that leads to the Project site via the Katsina-Kano Expressway. The impacts could be more pronounced if the mobilization activities are carried out in the dry season due to the associated high prevailing wind usually recorded in the study area during the period. High noise levels from vehicular movement may also be generated during mobilization activities leading to annoyance.

However, considering that the mobilization activities will be intermittent and trucks that will transport construction equipment and PV materials to the site will not move to the project area at the same time, the impact magnitude is considered to be low. The impact is short term, localized, and reversible. The sensitivity of the current ambient air environment of the Project area is considered low judging by the values of air pollutants such as Carbon monoxide, Sulphur dioxide, Nitrogen dioxide and Total Suspended Particulates recorded in the Project site during the field data gathering. The air pollutants concentrations within the project site are generally below the Nigerian ambient air quality standards and the World Health Organization (WHO) Ambient Air Quality Guidelines. It was noted that there is high capacity for assimilation of vehicular emissions and dust associated with the mobilization activities due to low level of industrial activities in the area. The potential impacts significance of mobilization activities on the ambient air of the Project area is thus regarded as negligible.

For socio-economic environment, the mobilization of personnel, materials and equipment during pre-construction phase of the proposed Project could increase the traffic volume in the Project area as a result of movement of vehicles in and out of the Project site. The potential impacts of these activities could lead to accident, traffic congestion and annoyance from the road users especially at the untarred road that traverses the Project site to the Katsina-Kano Expressway. The distance between the Project site boundary and the expressway is approximately 100 m. The potential impact of mobilization activities on the socio-economic environment of the Project area is considered to be negative, indirect, short term, intermittent, and localized. The magnitude of the impact which is a function of duration, extent, scale, and frequency is considered low. The sensitivity of the receptor is adjudged as medium since the conditions of the expressway are noted to be in good state. Although the access road from the site to the expressway is often ply by some community residents using bicycles or motorcycles as mode of transport, the major settlements in the project's area of influence are situated over 1 km from the site. The impact significance is considered to be minor.

- ***Establishment of Construction Laydown Areas and Construction Workers Camp***

Prior to construction activities, the Project will involve the establishment of laydown areas for the storage of construction equipment and materials. Also, construction workers camp will be established. A land area of approximately 20000 m^2 is envisaged to be earmarked as laydown areas for the purpose of equipment storage and construction of workers camp. This will be established within the Project site. No additional land is required for construction laydown area and construction camp for both Phase 1 and Phase 2. The environmental components that are likely to be affected as a result of this activity include soil and terrestrial flora and fauna. Impact to soil includes soil compaction and potential spill contamination from construction equipment. The clearing of the laydown areas will permanently lead to loss of terrestrial flora and possibly fauna species. The impact is localized and the extent of the area to be used as laydown areas within the site is considered to be relatively small. The sensitive of the receptor (plant species) is low since the Project site is mostly characterized by herbaceous plants. The impact significance is therefore regarded as minor.

- ***Site Clearing and Preparation***

The Project site is characterized by secondary vegetation. The land will be cleared and prepared for construction activities. Site clearing will be done with the use of earth moving equipment. The principal potential impacts identified at this stage would be on the following components of the environment; terrestrial flora and fauna, soil, and ambient air. These are further analysed in the following paragraphs:

<u>Terrestrial Flora and Fauna</u>

Site preparation will involve the clearing of existing vegetation on the Project site. The site clearing activities will unavoidably lead to loss of terrestrial flora (vegetation) and potential negative impacts on terrestrial fauna species which may also include loss of foraging habitat.

The potential impact on the terrestrial flora is considered to be negative, direct, and site specific. The impact will be permanent due to the fact that clearing of vegetation for construction purposes cannot be reversed. The impact magnitude is considered to be high considering the size of the Project site (120 ha). However, the sensitivity/importance of the receptor is regarded as low since none of the plant species identified within the project site during the baseline survey was found to be critically endangered or endangered species based on IUCN 2014.3 classification. Only *Vitellaria paradoxa* which was *encountered* outside the Project site falls under the vulnerable category. There are no protected or spawning areas within the site. None of the following ecosystems of concern (threatened ecosystem, protected ecosystem, critical biodiversity area, area of high biodiversity and wetlands) is present on the site. The habitat type identified within the Project site is mostly grazing land. No wetland or farmlands were noted within the site during the field survey. The site is of low biodiversity, mostly dominated by shrubs and grasses typical of secondary Sahel savannah. Only scanty trees (not more than 10 in number) are present on the site; the height of the tallest tree is approximately 9 m and the width is approximately 1.4m. Based on field observations, no biodiversity features on the site are of national/provincial importance. The clearance of the site for the development of the proposed Project will not lead to any contravention of any international, national or provincial legislation, policy, convention or regulation. The significance of the potential impact of site clearing on the existing terrestrial flora species of the Project site is therefore considered to be moderate.

While the plant species are unable to avoid the point of impact, most fauna species may be able to migrate away from unfavourable areas. Animals are generally mobile and, in most cases, can move away from a potential threat. The tolerance levels of some animal species are of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from areas of impact. With regards to the clearing of the Project site for construction purpose, the potential impact on terrestrial fauna species may include loss of individual or localized population of fauna species. This is unlikely to lead to a change in conservation status of the species since none of the fauna species encountered or reported in the Project area belong to the IUNC classification of threatened animal species which include those classified as critically endangered, endangered or vulnerable. The sensitivity of the fauna species recorded on the site is low although the impact magnitude could be considered to be high due to the large area of the Project site (120 ha). The overall unmitigated impact significance is regarded as moderate.

Soil and Geology

The study area is underlain by Pre-cambrian complex. The site geotechnical survey revealed that the near-surface ground of the area was formed of compacted fine-grained sediments, such as clays and silts and a conglomerate with lateritic matrix. The results of a sieve analysis of the fine-grained sediments identified hard sandy clay. The proposed site clearing and preparation activities have potential negative direct impacts on soil environment of the Project area. The potential effects on soil include degradation due to site preparation e.g. compaction of soil as a result of the movement of earth moving equipment. Soil degradation is the removal, alteration, or damage to soil and associated soil forming processes, usually related to human activities. The stripping of vegetation or disturbance to the natural ground level over disturbance areas will negatively affect soil formation, natural weathering processes, moisture levels, soil density, soil chemistry, and biological activity. Soil degradation also includes erosion (due to water and wind), salinization, water-logging, soil excavation, removal or burial (as in the case of cut-and-fill operations) and soil compaction.

Site clearing and preparation activities could also cause negative indirect impacts such as increased siltation in other areas away from the site causing negative impact on water sources and agriculture with potential socio-economic consequences. Increased runoff from hard standing areas could result in creation of drainage lines, which could impact on site. Uncontrolled site clearance of vegetation could lead to direct surface soil exposure and hence erosion of soil which could be significant. Soil erosion is a natural process whereby the ground level is lowered by wind or water action and may occur as a result of, *inter alia* chemical processes and/or physical transport on the land surface. Accelerated soil erosion induced or increased by human activity is generally considered the most geological impact in any development due to its potential impact on a local and regional scale and as a potential threat to agricultural production.

However, it is not anticipated that any major watercourses or water-bodies will be directly impacted by the proposed solar power plant as there are no natural surface water bodies within the immediate surroundings of the Project site. The nearby Kankia Dam located approximately 250 m from the site is currently abandoned for repair. The dam has a rockfill embankment for controlling movement of water. The impact magnitude is considered high as the extent of soil erosion could be high especially if the site clearing activities are carried out in the wet season. However, the soil erodibility survey of the area indicates that the Project site has a low susceptibility to erosion, primarily due to low annual rainfall and high sunlight intensity resulting into increased rate of evaporation. The potential significance of the impact of site clearing on soil and geology of the area is considered moderate.

<u>Air Quality and Noise</u>

The pollutants which could impair air quality during site clearing activities are particulate matter in form of dust, and NOx, CO, SOx from combustion engines of the earth moving equipment that will be used for clearing. Intermittent noise emissions could also occur from the operation of the machinery. The impact magnitude is considered to be low since the activities will be short term, intermittent, localized and reversible. The site clearing activities will take less than 1 month. The sensitivity of the air shed of the Project area is also regarded as low based on the results of air quality measurements conducted in the area during the field data gathering. In addition, there are no residential communities within the immediate surroundings of the Project site that could be potentially affected by intermittent noise emissions associated with site clearing activities. The potential impact significance is thus considered to be minor.

Socio-economic

Clearing of the project site will lead to loss of vegetation such as herbs which occasionally serve as forage for domestic animals. The impact magnitude is considered negligible and localized since there are abundant shrubs and grasses in the immediate surroundings of the Project site. Also, there are no significant tree plants within the project site which serve as major source of firewood or medicine for residents of the potentially affected communities especially women group. Thus, the impact of site clearing on socio-economic activities in the project area is considered negligible.

5.5.1.2 Summary of Potential Negative Impact Associated with Pre-Construction Phase

Table 5.10 below summarizes the potential negative impacts associated with the pre-construction phase of the proposed PV Solar Power Plant.

Table 5.10: Summary of Potential Impact of Pre-Construction Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Site Acquisition/Land take	Land use for grazing	• Pastoral farmers from neighbouring communities will be precluded from using the site for grazing	Negligible
Mobilization of personnel, materials and equipment to site	Air Quality	• Air quality impacts from vehicular emissions (SPM, NOx, CO, SO_x) • Increase in noise levels	Negligible
	Socio-economic and health	• Increase in vehicular movement and traffic around the project site including for road accident	Minor
Establishment of laydown areas and construction workers camp	Soil	• Soil compaction • Spill contamination leading reduced soil quality	Minor
	Terrestrial flora and fauna	• Vegetation loss • Loss of fauna species	Minor
Site clearing and preparation	Terrestrial flora and fauna	• Vegetation loss • Habitat fragmentation • Disturbance/displacement of avifauna associated with noise from site clearing equipment • Direct impacts on vegetation and soil-dwelling organisms, indirect impacts on other animals	Moderate
	Soil	• Loss of top soil • Soil compaction and degradation • Increased erosion potential • Reduction in structural stability and percolative ability of soil	Moderate
	Atmosphere (Air Quality)	• Air quality impacts from vehicular emissions and fugitive dust (SPM, NOx, CO, SO_x • Increase in ambient noise levels	Minor

Activity	Receptor	Associated Impact	Significance
	Socio-economic	• Loss of plants that can serve as firewood	Negligible

5.5.1.3 Construction/Installation Phase

Construction work activities for the proposed Project will include excavation, earth filling, trenching, piling, and the construction of foundations, pathways, and drainages including upgrade of dirty road for site accessibility. The construction phase activities will also include installation of photovoltaic modules (on mounting structure) and other plant facilities such as transformers, inverters, water storage tanks and other ancillary facilities. Waste generation is also associated with the construction activities which could be significant if not properly managed.

The potential environmental and social impacts associated with the construction phase of the proposed solar power plant are assessed as follows:

Air Quality

Air quality could be impacted due to dust generation from earth moving equipment and emissions (such as SO_2, CO, NOx) from construction equipment such as excavation and levelling equipment, lifting cranes, and diesel powered generators (which may serve as source of electricity during construction work). Dust is also likely to be generated during extraction and removal of overlying materials as well as a windblown dust generated from cleared land and exposed materials stockpiles.

It is proposed that each construction phase of the Project would take up to approximately 8 months (less than 1 year). Although emissions from the construction equipment and operations of construction vehicles could increase the existing concentrations of gaseous pollutants in the ambient air of the project site beyond the permissible limit, the potential impact is considered to be short term, infrequent, localized and reversible. The impact magnitude is considered to be medium. The sensitivity of the air shed of the Project area is regarded to be low based on the results of *insitu* measurements undertaken during field data gathering. The overall potential impact significance of construction activities on ambient air of the project site and the immediate surrounding is regarded as minor.

Noise and Vibration

The existing ambient noise levels (Leq) recorded within the Project site ranged from 51.5 dBA to 62.1 dBA (with a mean value of 57.5 dBA) while in the wider surrounding environment, the noise levels ranged between 52.1 dBA and 70.9 dBA. The noise levels recorded in the study area were generally below the Federal

Ministry of Environment (FMEnv) ambient noise standards of 90 dBA and the World Bank Noise Level Guidelines of 70 dBA for industrial and commercial areas. However, ambient noise levels recorded in some of the locations sampled during the field data gathering undertaken as part of the EIA study were higher than the World Bank prescribed noise limit of 55 dBA for residential, institutional and educational receptors in the day time.

Potential sources of noise during construction phase of the Project are the heavy equipment and machinery, vehicular movement, and civil work activities. The operation of the construction equipment may lead to elevated noise levels which could lead to hearing impairment and annoyance. The noise levels from construction activities are however not envisaged to result in a maximum increase in background levels of 3 dBA at the nearest receptor location offsite. The potential impact magnitude is regarded low. The identified sensitive receptor to the potential noise impact is Gandi Primary School (a 2-block of classroom occupying about 40 pupils on the average) located approximately 30m west of the Project site. With the exception of this, there are no residential buildings within the immediate surroundings of the site. Though it is envisaged that the construction activities will mostly be restricted to the northern and eastern parts of the site limiting the noise exposure to the receptors, the impact is regarded as moderate.

There no nearby structures within the vibration impact threshold distances of the Project site boundary. Vibration impact during construction phase of the Project is considered to be negligible.

Soil and Geology

The proposed construction activities will include excavation, loosening of soil, stockpiling, mixing, wetting, filling and these activities carry potential negative direct impacts contributing to soil degradation and possibly accelerated erosion. Soil environment of the Project site could be impacted in terms of removal of topsoil and soil compaction, reduction in structural stability and percolative ability of soil, loss of soil dwelling organisms resulting from compaction during excavation activities, foundation works, erection of temporary buildings and passage of construction traffic. These activities could also cause negative indirect impacts such as increased siltation in other areas away from the site as a result of accelerated erosion. The impact magnitude is considered to be high. The soil environment of the project area is characterized with low nutrient levels and it has low susceptibility to erosion. The overall unmitigated impact significance is considered to be moderate.

Terrestrial Flora and Fauna

The construction activities may potentially cause disturbance to flora and fauna as a result of increase in human activity, noise level, creation of areas of bare soil, etc. which may alter the composition and diversity of plant species around the project site. In addition, the potential for plant species invasion is likely to increase as a result of increase in areas of bare soil around the project site. Also the disturbance associated with noise and movement of construction equipment and personnel at the project site may deter bird species from the area and disrupt the breeding of avifauna species. The potential impact is site specific and short term; impact magnitude is considered to be medium. The sensitivity of the receptor is adjudged to be medium due to the diversity of fauna species recorded in the area although there are no spawning areas within the project site for amphibian or fish species which could be impacted. The project area is also not known as a migratory route for avifauna species. The potential impact significance is regarded as minor.

Hydrology and Hydrogeology

The construction activities for the Project could lead to potential impacts on hydrology and hydrogeology of the Project area. These include increased sediment load in the drainage channels as a result of erosion; increased stormwater runoff from a decrease in infiltration; increased runoff from hardstanding areas which could result in creation of drainage lines. Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles or storage tanks. There could also be decrease in amount of groundwater as a result of groundwater abstraction for project activities. It is planned that at least one borehole will be dug onsite to serve as a source of water supply for the project activities. Currently, there is no borehole on the site. The nearest shallow hand dug well to the Project site is approximately 330 m north in Fanga Village, one of the villages/wards that made up of Kafin Dangi community. The depth of the well as at the time of site visit in March 2014 was approximately 70 m. Another shallow well close to the Project site is approximately 1 km southwest in Kauyan Dawa community with a depth of approximately 30 m. The hand dugs wells are mostly recharged during the rainy season. The possibility of groundwater contamination as a result of the construction activities is very minimal. It is very unlikely that water abstraction for the Project development will cause significant reduction in water aquifer of the area. However, additional geotechnical survey of the project site is planned to be conducted.

The potential impact on hydrology is localized, infrequent, short term and reversible. Impact magnitude is low. The identified sensitive receptor that could be impacted is Kankia Dam, located approximately 200 m southwest of the Project site. The dam was constructed about 12 years ago by the Kastina State Ministry of Water Resources to serve as source of water for irrigation and domestic use in Kankia. At the time of site visit in March 2014, the dam was found to be non-operational and under repair. The sensitivity of the receptor is considered to be medium. The overall potential impact significance is considered minor.

Socio-economic

The key social issues associated with the construction phase of the proposed Project include the following potential positive impacts: creation of employment, business opportunities, and the opportunity for skills development and on-site training.

The construction phase is expected to create approximately 200 employment opportunities where approximately 60 % will be low skilled positions (for examples, construction labourers and security staff) and semi-skilled workers (i.e. drivers, equipment operators, etc.) and 40 % will be available to skilled personnel. In terms of business opportunities for local companies, expenditure during the construction phase will create business opportunities for the regional and local economy. Opportunities are likely to exist for local contractors in Kankia and other neighbouring communities.

The potential opportunities for the local service sector would be linked to catering, cleaning, transport and security, etc. associated with construction workers on site. In addition, a proportion of the wage bill earned by construction workers over the construction period (8 months) is also likely to be spent in the regional and local economy. In terms of training, the foreign contractors are likely to provide on-site training and skills development opportunities. This is considered a significant positive impact.

On the other hand, the key negative issues associated with the construction phase of the proposed Project on the socio-economic environment are those related to the presence of construction workers on site and impact of heavy vehicles, including damage to roads, safety, noise and dust, and increased risk of fires associated with construction related activities.

With regards to the presence of construction workers on site, the manner in which the workers conduct themselves can affect the local communities in terms of disruption of existing family structures and social networks. The potential behaviours of workers, most especially male construction workers, may lead to an increase in levels of crime and drug and alcohol abuse, and an increase in incidence of sex workers and casual sexual relations, which may result in increase in sexually transmitted disease (such as HIV/AIDS infections) and unwanted pregnancies. Additional pressure may also be placed on existing infrastructure. Considering the relatively large number of labour force (about 200) during each construction phase of the Project, the potential risk to local family structures and social networks is regarded as high. This risk can also be heightened by the

vulnerability of the residents of the neighbouring communities of Gachi, Galadima, Kauyan Maina, Kafin Dagi and Kankia due to their low income and education levels especially those residing in Kafin Dangi and Kauya Maina communities.
Bearing in mind that the majority of the construction workers, especially unskilled labour force (approximately 60%) would come from the local communities, and temporary accommodation will be provided for expatriates on site, the potential impact significance is considered to be moderate.

Regarding the impact of construction vehicles, road access to the proposed site will be *via* gravel roads that connect the site to the Katsina-Kano Expressway. The movement of heavy construction vehicles during the construction phase activities may damage roads, create noise, and safety impacts for other road users and local communities in the area, specifically the residents of Kafin Dangi community and Gandi village. The potential damage to grave roads that connect the project site to the Katsina-Kano Expressway by heavy equipment can result in a number of potential negative impacts, including increased wear on motorcyles owned by local residents, impact on ease of access (e.g. time delays) to town. The distance between the gravel roads to the Katsina-Kano Expressway is approximately 100 m and the roads are not heavily used by the local residents. The potential impact significance is considered to be moderate.

<u>Visual Prominence</u>
The construction phase of the proposed Project will last for approximately 8 months. During this period, construction related traffic (i.e. in terms of traffic and construction workers) will frequent the area and may cause a visual nuisance to other road users and landowners in the area. The potential impact significance is considered minor since the immediate surroundings of the project site is not heavily populated. The major settlements in the project's area of influence are located approximately over 2 km away.

<u>Construction Workers Health, Safety, and Welfare</u>
Construction sites are potentially hazardous place. Occupational accidents may occur especially when those involved are unskilled. Such occupational accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the project especially if the man-hour losses are high. Potential impacts to construction workers include increased noise level and air emissions from construction activities (resulting from the use of heavy duty equipment and construction vehicles), injuries, respiratory tract disease infections, electrical shocks, and denial of rights. Considering that the majority of the workforce will be unskilled, the overall unmitigated impact significance is considered moderate.

5.5.1.4 Summary of Potential Negative Impact Associated with Construction Phase

Table 5.11 below summarizes the potential negative impacts associated with the construction phase of the proposed PV Solar Power Plant.

Table 5.11: Summary of Potential Impact Associated with Construction Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Construction/ Installation Activities	Atmosphere (Air Quality)	• Air quality impacts from diesel fired generators (SPM, NOx, CO, SO_x) • Increase in dust form cleared land and windblown stockpiles	Minor
	Atmosphere (noise impacts on nearby receptor)	• Increase in noise level from the operation of construction vehicles and construction equipment	Moderate
	Soil	• Increased erosion potential as a result of construction activities	Moderate
	Flora and Fauna	• Loss of plant species and increase in invasive species potential	Minor
	Hydrology and Hydrogeology	• Increased sediment load in the drainage channels as a result of erosion; increased stormwater runoff from a decrease in infiltration; increased runoff from hardstanding areas could result in creation of drainage lines	Minor
	Socio-economic and health	• Influx of people, increase in sexual transmitted diseases; pressure on existing infrastructure	Moderate
		• Road damage, traffic and safety impacts	Moderate
		• Employment opportunities for skilled and semi-skilled craftsmen from local communities	Positive
	Health, Safety, and Welfare of construction workers.	• Injury to construction workers and during construction activities • Poor welfare and working conditions for both skilled and unskilled worker engaged during construction phase	Moderate

5.5.1.5 Operation Phase

The activities associated with the facility operation include: operation of the PV panels, routine inspection, occasional cleaning of the PV panels with water to remove dirt and soil (especially during the dry season period), and routine maintenance.

Significant environmental issues specific to the operational phase of a solar plant include, amongst others: visual impacts through the visual dominance of the PV modules within the landscape; hydrological impacts due to increased erosion; and avian mortality through collisions/electrocutions with the power (transmission) line. Others include community health and safety associated with Electromagnetic field (EMF) radiation/interference from power lines. The potential environmental and social issues related to the operation phase of the proposed Project are assessed as follows:

Air Quality

Significant emission reductions can be accomplished through PV electricity (PVe) production since PVs do not generate chemical pollutants or greenhouse gases (GHGs) during their normal operation. The potential source of air emission during the facility operation is diesel powered generator (that may be provided onsite as backup power source for minimal facility operation), and occasional emissions from vehicles during facility maintenance. The overall impact significance is considered negligible. The impact is site specific and reversible.

Noise and vibration

The potential sources of noise during the operational phase of the Project are inverters and any onsite diesel powered generator. A total of 38 Medium Voltage Power Units are planned to be installed onsite. Each MV Power unit has 2 inverters. Noise emission from the inverters is not envisaged to be significant. Typically, noise emission from an inverter is approximately 30-35 dBA. The potential impact will be site specific, permanent and reversible. There no residential communities within the immediate surroundings of the site which could be significantly affected. Impact significance is considered to be negligible.

Flora and Fauna

Impacts on flora and fauna may arise from the operations of the solar PV facility. These may include loss of plant diversity, and increase in invasive species potential. Shift may also occur in the distribution of fauna communities e.g. (mammal and reptile) as a result of PV panels providing shade and protection from birds of prey. Birds may also experience disturbance and displacement. The impact significance is regarded as minor.

Soil

Soil impacts may include the loss of topsoil, soil compaction and increase in soil erosion around the cleared areas, roads and at the foot of the PV panels due to increased run-off and effect of wind. This may result in the formation of eroded gullies that further aggravate the surface soil loss. The soil susceptibility to erosion is low, primarily due to low rainfall and predominant sandy clay in the area. The impact significance is minor.

Hydrology and Hydrogeology

Hydrology and hydrogeology impacts may include decreased amounts of groundwater as a result of abstraction for the project activities. Liquid wastes (such as sanitary waste, used water from PV cleaning) generated during the facility operations may lead to groundwater contamination if not properly managed. The impact significance is considered minor due to the absence of existing groundwater resources in the immediate surroundings of the project site and limited presence of hazardous chemical or potential for contaminated water.

Visual Nuisance

As indicated in Chapter 4, the project site is not known to be a tourist route or to have any special scenic characteristics hence it has a limited potential for visual impacts on the receiving environment. During operation, the facility (primarily the PV panels) will be visible. The potential visual nuisance impacts of the facility operations include the following:

Potential Impact on Visual Character of the Landscape of the Project Area: The sense of place is characterized by a quiet, undeveloped landscape with views of wide and open flats. Views of this landscape are found over most of the study area, as such the area is considered to be sensitive to land use change. Potential visual impacts are expected to affect residents who traverse the link roads and paths around the project site and observers travelling along the Katsina-Kankia Express road. Due to the large extent of visual exposure of the proposed facility, the visibility of infrastructure such as the solar panel is expected to be high for areas in close proximity of the facility (distances of less than 500 m). The amount of traffic is relatively low with a moderate number of possible visual receptors. Thus the significance of visual impact in terms of visibility and exposure is anticipated to be moderate.

Potential Visual Impacts from Facility Lighting at Night Time: Obstructive disturbances may be experienced by road user and community residents as a result of increase in the ambient lightning levels especially at night time, arising from artificial lighting for security and other purposes. The anticipated visual impact is not, considered to be a fatal flaw from a visual perspective, considering the low incidence of visual receptors in the region and the contained area of potential visual exposure. The impact significance is considered moderate.

Socio-economic

The key social issues associated the operational phase of the Project include the following positive impacts:

- Creation of employment and business opportunities, and opportunities for skills development and training.
- The promotion of clean energy as an alternative energy source.

The operation phase will employ approximately 20 full time employees over a period of not less than 25 years. The proposed power plant will therefore create potential employment opportunities to the local communities in the project's area of influence. There is also the possibility to increase the local skills levels through the implementation of training programmes to local contractors. The communities in the project area also have the opportunities of benefiting from various Corporate Social Responsibility initiatives associated with the Project.

In addition, the Project operation will lead to the promotion of clean energy as an alternative energy source. The establishment of a clean, renewable energy facility will minimize the reliance on natural-gas fired energy and the generation of carbon emissions into the atmosphere. This is regarded as a significant positive impact.

The potential negative impacts to the socio-economic environment during the facility operation are related to visual impact and associated impact on sense of place and impacts on scarce water resources. The potential impact on water resources is considered to be negligible since the project will not rely on water sources from the communities. The significance of potential visual impacts is regarded as moderate as discussed above.

Health, Safety and Welfare of Staff during Plant Operation

During plant operations, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries) including work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions etc. The impact significance is considered to be moderate primarily due to the low number of staff required during facility operation.

5.5.1.6 Summary of Potential Negative Impact Associated with Operation Phase

Table 5.12 below summarizes the potential negative impacts associated with the operational phase of the proposed PV Solar Power Plant.

Table 5.12: Summary of Potential Impact Associated with Operation Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Operation and Maintenance	Air Quality	• Minimal dust and emissions from movement of vehicles and equipment during operation and maintenance	Negligible
	Soil	• Soil erosion around the cleared areas, roads and at the foot of the PV panels due to increased run-off and effect of wind result in in the formation of eroded gullies.	Minor
	Hydrology and Hydrogeology	• Decreased amounts of groundwater as a result of abstraction for the project activities • Obstructions such as foundations and roadways may concentrate water flows into catchment areas feeding surrounding drainage lines	Minor
	Flora and Fauna	• Loss of plant diversity and increase in invasive species potential • Shift in mammal and reptile communities due to PV panels providing shade and protection from birds of prey.	Minor
	Visual Impacts	• Landscape alterations resulting in unpleasant changes in the visual character of the area • Obstructive increase in ambient lightning levels especially at night time, as a result of artificial lighting for security and other purposes	Moderate
	Socio-economic	• Job employment (at least 20 people would be permanently engaged during the facility operation • Promotion of clean energy source	Positive

Activity	Receptor	Associated Impact	Significance
		• Skill acquisition and transfer of knowledge through training and retraining	
	Health, safety and welfare of staff during plant operation	• Electric shock, injuries to personnel associated with the facility operations, • Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions	Moderate

5.5.1.7 Decommissioning and Abandonment Phase

The Project would have a minimum lifespan of at least 25 years. Once the facility reaches the end of its lifespan, the PV arrays may be refurbished, replaced or upgraded to a newer technology to continue operating as a power generating facility or the facility could be closed and decommissioned. If decommissioned, all components would be removed and the site rehabilitated, returning to its current land use or better. The PV panels and other major equipment would be recycled as appropriate. The decommissioning and restoration of the site will involve many activities that may have some environmental and socio-economic impacts. It is anticipated that the impacts associated with decommissioning will be similar to those encountered during the construction phase.

5.5.2 Potential Impact of the proposed Transmission Line

5.5.2.1 Construction Phase

The proposed transmission line corridor is a 30 m wide strip of land with a length of approximately 4.1 km to the existing Kankia substation. The area is occupied by bare soil, grasses, shrubs, a few subsistence farmlands. A cemetery was noted close to the transmission line connection point to the Kankia substation (approximately 100m from the substation fence line). The corridor line has been selected to ensure that no settlements are affected along the transmission line route.

Construction of transmission lines for the evacuation of power from the proposed project site to the Kankia substation will involve civil works e.g. excavation, and tower installation. The potential air quality impact during these activities includes dust generation (containing particulate matter) and emissions (such as SO_2, NOx and CO) from construction vehicle. Fugitive and engine emissions could cause a localized impact on air quality and will occur intermittently during construction activities. Impact is infrequent, short term and localized. The impact significance is minor.

Noise emissions are expected to result from the civil work activities related to the power line installation. The impact from noise emission is expected to be localized, infrequent and short-term. The impact magnitude is considered to be negligible. The major sensitive receptors are predicted to be the construction workers as well as residents inhabiting the immediate vicinity of the transmission line right of way. The unmitigated noise impact significance is minor.

Installation of the transmission lines will require digging, trenching and excavation of top and subsoil to a depth of at least 3m. These activities may have attendant negative impacts on the soil environment. The magnitude and extent of the impacts depend on the characteristics of the soil and the nature of the construction activities that is responsible for the soil disturbance. The significant potential impacts to the soil environment will be alteration in soil structure and soil quality of the area. The impact significance is considered to be minor.

The proposed transmission line will cover approximately 4 km. An interval of approximately 200 m will be created between one power line and the next. Minimal vegetation clearing will occur at the area where each pylon will be erected. The removal of vegetation as a result of tower construction will be minimal since the area is sparsely vegetated as observed during baseline survey. The significant of impact is rated to be minor.

The transmission lines could have a visual impact on the resident in the immediate vicinity of the power line. However, due to the presence of existing 132 kV Katsina-Kano Transmission Line in the area, the significance of visual impact on local residents is considered minor.

The acquisition of lands for the construction of the transmission lines (especially at the stations where pylons will be erected) will lead to minimal loss of privately owned land along the right of way. The impact significance is minor.

5.5.2.2 Operation Phase

The operational phase of the transmission line will have little impact on the air quality since most of the gaseous emissions associated with this project are generated during the construction phase. Thus, the significant of this impact is negligible.

Vibration or humming noise will be noticeable during the operational phase as the transmission lines become older. This usually occurs when the conductor mounting hardware becomes weaker over the years. Though, it can be repaired during maintenance of utility. Sounds which might result to noise are expected to occur along the transmission lines during period of high humidity. These are peculiar to high-voltage transmission lines and are weather dependent. They are caused by the ionization of electricity in the moist air near the wires. This noise may have an effect on the residents living around the transmission route of way. The potential noise level from the power line is unlikely to exceed the FMEnv limits of 90 dBA respectively for 8-hour exposure. Therefore, the impact significance is predicted to be minor.

The height of transmission towers and the electricity carried by transmission lines can pose potentially fatal risk to birds and bats through collision and electrocution during the normal or regional and seasonal migration of these animals. Avian collisions with power lines can occur in large numbers if transmission lines are located within daily flyways or migration corridors, or if groups are traveling at night or during low light conditions. In addition, bird and bat collisions with power lines have the tendency to cause power outage and fire (Janss, 2000). Based on this backdrop, the overall impact significance is rated moderate although the proposed transmission route is not known to be a migratory route for birds.

Electric and magnetic field radiations occur wherever and whenever electricity is produced. Transmission lines happen to be a carrier of electricity. Though human is exposed to wide range of electric field every day, these might have an adverse impact on the health most especially those close to high magnetic field environment. There is a possibility that magnetic field generated as a result of transmission line might have an adverse impact on human health. Scientists have not been able to prove it, as most studies show a weak association between magnetic field and adverse health effects. Based on this premise, the significant of impact of the transmission line on public health is considered minor.

There are no airports in the vicinity of the proposed transmission route. Based on the field observation, the proposed transmission line route is not regarded as a flight path. Thus, potential impact of the proposed high voltage power line on aviation is negligible.

The summary of activities associated with the construction and operation of the proposed transmission line is provided in Table 5.13.

Table 5.13: Summary of Potential Impact Associated with the Construction and Operation of the proposed Transmission Line

Activity	Receptor	Associated Impact	Significance
Construction Phase	Air Quality	• Dust and emissions from the movement of vehicles and equipment during civil work activities • Noise and vibrations resulting from construction activities	Minor
	Soil	• Increase in potential for soil erosion compaction and changes in soil properties as a result of construction activities such as digging, trenching and excavation at locations where pylons will be erected.	Minor
	Flora and Fauna	• Disturbance, displacement of terrestrial fauna during construction activities	Minor
	Visual Impacts	• Landscape alterations resulting in unpleasant changes in the visual character of the area	Minor
	Socio Economic Receptors	• Land acquisition along transmission corridor	Minor
Operational Phase	Air Quality/noise	• Changes in air quality • Noise humming around power lines	Negligible
	Avifauna	• Avian collision with power lines	Moderate
	Public Health and Safety	• Health concerns due to Electric and Magnetic fields exposure	Minor

5.5.3 Cumulative Effects Arising from the Proposed Project

Cumulative impacts are those impacts resulting from the combined effects of past, present or reasonably foreseeable actions owing to the project aspects and activities outside the project (GSI, 2003). The concept of cumulative effects is an important one. It holds that, while impacts may be small individually, the overall impact of all environmental changes affecting the receptors taken together can be significant. When a resource is nearing its tolerance threshold, a small change can push it over.

The cumulative impacts associated with the proposed PV power plant primarily relate to those impacts associated with visual and traffic related impacts as well as impact due to Electromagnetic field (EMF) interference from transmission line.

Potential cumulative visual impacts may occur with special reference to the existing 132kV single circuit transmission line from Kano to Katsina, located nearby the proposed transmission line route for the PV power plant. The proposed Project will include construction of a dedicated project transmission line connecting the power plant to the Kankia substation. The line will extend approximately 1.1 km from the Project site to the existing 132 kV power line corridor and will follow this route for approximately 4 km to the Kankia substation. There is a potentially cumulative visual impact within the region as a result of the two facilities. In addition, there is cumulative EMF radiation level impact on the general public as a result of the two power lines. The cumulative effects are however considered to be low.

Potential cumulative traffic related impacts may occur especially during pre-construction and construction phase of the Project with reference to the number of vehicles plying the Katsina-Kano Expressway. A Construction Traffic Management Plan will be developed and implemented (refer to Chapter 7) Potential cumulative impact during operation phase of the power plant is considered negligible since there no current or past development projects within the immediate surroundings of the site.

5.6 Risk and Hazard Assessment

5.6.1 Overview

Risk assessment is the determination of quantitative or qualitative estimate of risk related to a concrete situation and a recognized threat (also called hazard). The assessment of the risks and hazards associated with the proposed project involves the following steps:

- Identification of hazards/risks
- Likelihood of occurrence
- Consequence/severity of the hazards

The risk assessment matrix is then developed as presented in Figure 5.3.

0 – 5 = Low Risk 6 – 10 = Moderate Risk 11 – 15 = High Risk 16 – 25 = extremely high unacceptable risk		Severity of the potential injury/damage				
		Insignificant damage to Property, Equipment or Minor Injury 1	Non-Reportable Injury, minor loss of Process or slight damage to Property 2	Reportable Injury moderate loss of Process or limited damage to Property 3	Major Injury, Single Fatality critical loss of Process/damage to Property 4	Multiple Fatalities Catastrophic Loss of Business 5
Likelihood of the hazard happening	Almost Certain 5	5	10	15	20	25
	Will probably occur 4	4	8	12	16	20
	Possible occur 3	3	6	9	12	15
	Remote possibility 2	2	4	6	8	10
	Extremely Unlikely 1	1	2	3	4	5

Figure 5.3: Risk Assessment Matrix

5.6.2 Project Specific Risks and Hazards

The potential risks and hazards associated with the construction and operation of the proposed PV power plant and the transmission line are described below:

Fire and Explosion

The major risk associated with the PV plant operation is fire and explosion. Photovoltaic systems are subject to electrical faults like any other electrical installation such as short circuits, ground faults and reverse currents. These faults and other failures of the system, including cable insulation breakdowns, rupture of a module, and faulty connections, can result in hot spots that can ignite combustible material in their vicinity. Wrongly installed or defect DC/AC inverters have been the reason of several photovoltaic fires as well.

Fire could possibly occur during operation of the photovoltaic power plant. Any outbreak of uncontrolled fire in the plant area can escalate to dangerous dimensions which could lead to multiple fatalities and catastrophic loss of business. The overall significance is high. Careful handling is necessary to mitigate fire and explosion risks. Detailed of the mitigation measures are provided in Section 6.4 of the next chapter.

Electrocution

Hazards most directly related to power transmission lines occur as a result of electrocution from direct contact with high-voltage electricity or from contact with tools, vehicles, ladders, or other devices that are in contact with high-voltage electricity. Although electrocution with power line is rare in the project area, the likelihood of the hazard happening is remotely possible and its severity if occurs may result into major injury and fatality. The significance of the hazard is therefore considered moderate.

Security Threat and Attack

Security systems are essential for a suitable operation of a solar farm in order to avoid damage and possibly plant downtime from theft and vandalism. The power plant may be subject to sabotage or attack and thus generate less electricity than planned as a result of uprising. Although, the current insurgency in the country is limited to some states in the North East geopolitical zone, the likelihood of terrorist attack at the project site is considered to be of remote possibility. The severity of the attack if happens would be a major injury and critical loss of process and damage to property. The risk significance is rated moderate.

Occupational Hazards

Workers may be exposed to occupational hazards when working at elevation during construction. The assembly of towers and installation of power line can pose a physical hazard to workers using lifts and elevated platforms and those located below due to the potential for falling objects. Also, there could be electrical hazards to workers. Common electrical accidents result in shocks and/or burns, muscle contractions, and traumatic injuries associated with falls after the shock. The likelihood of the hazards occurring is considered to be possible while its severity may lead to reportable injury and limited damage to property. The overall significance is rated moderate.

5.7 Summary

In summary, the key potential adverse impacts and risks asscoaited with the proposed project activities have been evaluated in this chapter. The significance of these impacts and risks could be minimized to acceptable levels with the implementation of appropriate mitigation measures. Sound and cost-effective mitigation measures for the identified negative impacts are presented in the next chapter of this report.

CHAPTER SIX:

MITIGATION MEASURES

CHAPTER SIX

MITIGATION MEASURES

6.1 Introduction

Following the detailed description of the associated and potential impacts of the proposed Project in Chapter 5, the recommended mitigation measures for the identified negative impacts are presented in this chapter as well as the enhancement measures for the potential positive impacts. PASL will have principal responsibility for the implementation of all measures presented in this chapter, but may delegate responsibility to its contractors, where appropriate. The mitigation measures assigned to third party contractors shall be properly monitored.

6.2 Mitigation Measures Approach

Mitigation refers to measures or interventions necessary to avoid, minimize, reduce or offset adverse impacts. Approach for selecting appropriate mitigation measures followed the framework stated by UNEP (2002):

- Avoid adverse impacts as far as possible by the use of preventive measures;
- Minimize or reduce adverse impacts to "as low as practicable" level;
- Remediate or compensate for adverse impacts which cannot be mitigated or residual impacts which cannot be further reduced.

In proffering mitigation measures for the various negative impacts identified in the previous chapter, preference was given to avoidance or prevention of adverse impacts and where not feasible, measures which are practicable and cost-effective using best available technology were suggested to reduce and/or minimize the impacts while rehabilitation, restoration or compensation was considered as the last resort.

6.3 Mitigation Measures for the Identified Significant Negative Impacts

The recommended mitigation measures for the identified negative impacts associated with the proposed Photovoltaic (PV) Power Plant and the associated infrastructure are highlighted in Tables 6.1 to 6.3. The unmitigated potential negative impacts ranked as negligible are not included in the tables. The recommended mitigation measures are considered adequate to address the adverse impacts identified in the Chapter 5 of this report. There are no potential long-term impacts associated with the Project that cannot be mitigated to acceptable levels of residual impact.

6.4 Mitigation Measures for the Identified Project Risks and Hazards

The mitigation measures for the identified project risks and hazards are highlighted below:

Fire and Explosion

- Only PV modules which comply with international and local standards for electrical performance and safety shall be used.
- Only solar cables suitable for outdoor applications and severe weather conditions shall be used
- Inverters shall not be mounted on combustible walls such as wood panels or combustible sandwich panels
- Inverters shall be easily accessible and protected from severe weather conditions.
- The local fire department shall be informed of and familiarized with the photovoltaic installation.
- PV systems shall only be installed by qualified contractors.
- PV systems shall be inspected regularly by qualified professionals.
- PV systems shall be regularly checked for damage from rodents and other pests, which could compromise wiring or insulation.
- Emergency response plan shall be developed and inmplemented
- Fire suppression system and equipment (such as fire extinguishers, fire notices, warning signs) shall be installed at different locations within the power plant

Electrocution

Recommended techniques to prevent this project hazards include:

- Use of signs, barriers (e.g. use of steel posts surrounding transmission towers), and education/public outreach to prevent public contact with transmission line;
- Grounding conducting objects (e.g. fences or other metallic structures) shall be installed near power lines, to prevent shock.

Security Threat and Attack

- No authorized person(s) shall be allowed into the facility without adequate check
- A 24-hour site security shall be put in place
- PASL shall maintain regular communication with the Nigerian Police and other relevant local security.

Occupational Hazards

- Installation of fixtures on tower components to facilitate the use of fall protection systems;

- Provision of an adequate work-positioning device system for workers
- Hoisting and lifting equipment should be rated and maintained and operators trained in their use.
- Appropriate Personal Protective Equipment shall be worn
- Elctrical installation shall be carried out by trained personnel in line with the approved procedures

6.5 Enhancement Measures for Identified Positive Impacts

6.5.1 Direct Employment and Training

The Project will give rise to direct employment opportunities across different skill levels, from unskilled to highly skilled labour. It is estimated that during each of the construction phases, at least 200 job opportunities would be created. Training for local people from skilled technicians may also be possible.

The following measures will be implemented to ensure that direct employment and training opportunities are maximised:

- A Labour and Employment Management Plan (LEMP) will be produced prior to construction, detailing percentages and numbers of the workforce to be sourced from the local area and various demographics as well as influx management. The plan will follow local and international employment guidelines and the requirements of relevant IFC Performance Standards.
- The EPC contractor will provide notification to identified representatives of Local Government of the specific jobs and the skills required for the project, prior to the commencement of construction. Subsequently, the Local Government will notify the local population prior to the commencement of construction of job opportunities and relevant skills/qualifications required to be employable on the Project.
- The EPC contractor will initiate training and skills development programmes prior to the commencement of construction, as a means of ensuring that members of the local workforce are up-skilled and can be employed on the Project.

During operational phase of the power plant, a smaller number of job opportunities will be created (about 20 people will be permanently employed). This will be a mixture of skilled labour (such as electrical and mechanical technicians) and unskilled labour (such as PV module cleaners and security personnel). Sourcing of this workforce will also be covered in the LEMP.

6.5.2 Procurement and Indirect Employment

The construction and operation of the proposed PV Power facility will create opportunities for the supply of goods and services to the Project and in turn, indirect employment will be created in the supply chain. Other opportunities may be possible for local companies to provide catering, waste / recycling and landscaping facilities as well as goods and service providers such as carpentry, road work etc.).

The following enhancement measures will be implemented to ensure that business opportunities emanating from the Project are maximised:

- Local and regional procurement targets will be included in the Project's LEMP.
- PASL will include requirements for local employment in the contract that it establishes with the EPC Contractor and ensure its implementation.
- The developer will offer assistance to local companies to ensure that barriers to entry are reduced; for example by assisting companies to complete the required tender documents.
- PASL will build a good relationship with the host communities through the provision of community development programmes.

Table 6.1: Mitigation Measures for the Potential Negative Impacts of the proposed Project

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
Pre-construction Phase					
Mobilization of personnel, materials and equipment to site	Socio-economic	Increase in vehicular movement and traffic around the project site including potential for road accident	Minor	○ The EPC Contractor will develop and implement a construction traffic management plan (CTMP). ○ Arrangements and routes for abnormal loads (if required) will be agreed in advanced with the relevant authorities and the appropriate permit will be obtained for the use of public roads. ○ All access routes within the site will be identified and clearly demarcated. ○ Speed limits (of less than 30 km/h) will be adhered to on the Project site. ○ Off-road driving will be prohibited. ○ All vehicles used for the project should be regularly serviced and maintained. ○ PASL shall ensure that driver competency is assessed and where required driver training is provided. ○ Construction workers will be bussed to site, where required.	Negligible
Site clearing and preparation including establishment of laydown areas and construction workers camp	Soil	Removal of top soil and soil compaction associated with vegetation clearance and site preparation	Moderate	○ Laydown or infrastructure assembly areas not required during the operational phase of the PV power facility will be re-vegetated with indigenous vegetation to prevent erosion immediately after these areas are no longer required for construction. Any steep or large embankments that are expected to be exposed during the rainy months shall	Minor

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				either be armoured with fascine like structures or vegetated. ○ Regular diversion berms shall be built on gravel compacted roads. ○ The removal of vegetation and soil cover shall be restricted to only those areas necessary for the development. Soil conservation measures shall be implemented such as stockpiling topsoil or gravel for the remediation of disturbed areas. ○ Disturbed areas will be rehabilitated as soon as possible to prevent erosion. ○ Work areas will be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.	
Site clearing and preparation including establishment of laydown areas and construction workers camp	Terrestrial Flora and Fauna	○ Vegetation loss ○ Habitat fragmentation ○ Disturbance /displacement of avifauna associated with noise from site clearing equipment ○ Direct impacts on vegetation and soil-dwelling organisms, indirect impacts on other animals	Moderate	○ No herbicides shall be used on site. ○ Only areas within the site needed for the project components shall be cleared ○ Cleared areas which are not being used will be re-vegetated using plants or seeds of locally occurring species, as soon as practical. ○ All no-go areas will be clearly demarcated.	Minor
Site clearing and preparation	Atmosphere (Air quality)	• Air quality impacts from vehicular	Minor	○ Site clearing equipment shall be run and maintained under optimum fuel efficient conditions.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
		emissions and fugitive dust (SPM, NOx, CO, SO_x • Increase in noise levels		○ Noise impacts shall be reduced by enclosing and insulating noise emitting processes or equipment as much as practicable.	
Construction/Installation Phase					
Construction/ Installation work activities	Soil and Geology	Reduction in structural stability and percolative ability of soil resulting from compaction during excavation activities, laying foundations, erection of temporary buildings and passage of construction traffic.	Moderate	○ Excavation works shall not be executed under aggressive weather conditions. ○ Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion. ○ Disturbed areas shall be rehabilitated as soon as possible to prevent erosion. ○ Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint. ○ Construction vehicles will remain on designated and prepared compacted gravel roads. The additional creation of access roads will be kept to a minimum. Where roads need to be created, a dual tyre track road will be used rather than clearing the entire road width. ○ Fuel, oil and used oil storage areas shall be contained in bunds of 110 per cent capacity of the stored material. Fuels will be stored in above-ground storage tanks. ○ Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
	Hydrology and Hydrogeology	○ Increased sediment load in the drainage channels as a result of erosion ○ Increased runoff from hardstanding areas could result in creation of drainage lines, which could impact on site infrastructure. ○ Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles or storage tanks. ○ Decreased amount of groundwater as a result of groundwater abstraction for project activities. ○ Increase stormwater runoff from a decrease in infiltration and increased surface runoff	Minor	○ The EPC Contractor will be required to design appropriate drainage system that takes due regards of the natural drainage system Where roads intersect natural, defined drainage lines, suitably sized pipe culverts or drive through causeways shall be installed or constructed; ○ Fuel, oil and used oil storage areas will be contained in bunds of 110 per cent capacity of the stored material. ○ Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of at a registered landfill site. ○ Waste receptacles shall be provided within a secured area for collection of solid waste. ○ Construction vehicles and equipment will be serviced regularly, and will be serviced off site.	Negligible
	Flora	○ Loss of vegetation ○ Introduction of alien plants which may	Moderate	○ Soil disturbance and vegetation clearing will be kept to minimum. ○ No herbicides will be used on site.	Minor

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
		prevent the natural recovery of the natural vegetation on the site		○ All construction equipment is to be cleaned (mud and soil removed) at source before being brought to site so as to minimise the introduction of alien species. ○ If sand or other natural materials for building are required and brought onto site, the stored heaps will be monitored for the growth and germination of alien species and will be regularly cleared during construction. ○ Cleared areas which are not being used will be re-vegetated using plants or seeds of locally occurring species. ○ Regular monitoring will be undertaken (at least every 6 months) to ensure that alien plants are not increasing as a result of the disturbance that has taken place. ○ A post construction rehabilitation plan will be compiled with the aid of a rehabilitation specialist.	
	Terrestrial Fauna	Impact on Fauna due to: ○ Increased human activity and associated noise; ○ Possible increase in hunting due to increased numbers of workers on site; ○ Increased potential of soil erosion and contamination of soil, which will impact	Minor	○ Fires will only be allowed within fire-safe demarcated areas. ○ All hazardous materials will be stored in the appropriate manner to prevent contamination of the site. ○ All fuels and oils will be stored in bunds of 110 per cent of tank capacity. Any accidental chemical, fuel and oil spill that occur onsite will be cleaned up in a manner appropriate to the nature of the spill.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
		directly on soil-dwelling organisms, and indirectly on other animals.		○ The site fencing (where required) will be constructed in a manner which allows for the passage of small and medium sized mammals, at least at strategic places, such as along drainage lines or other areas of dense vegetation. The fence will be designed to protect the solar PV plant but also withstand any animal conflict. ○ Should the development require night-lighting, these will be of the low-UV emitting types, such as most LEDs, which attract significantly less insects. ○ All construction and construction related activity will be restricted to demarcated areas. ○ No unauthorized persons shall be allowed onto the site. ○ In order to reduce collisions of vehicles with fauna, a 30 km/hr speed limit will apply to all roads and vehicles using the site. ○ Personnel shall receive environmental education so as to ensure that that no hunting, killing or harvesting of plants and animals occurs at any stage during the Project. A disciplinary procedure for workers that are caught conducting such activities shall be put forward. ○ The development footprint will be kept as small as possible and natural strips of vegetation will be allowed to persist between the rows of arrays.	

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				○ Foundation holes for pylons shall be barricaded to ensure that animals are not injured by falling in the holes	
Civil works activities and installation of transmission lines	Avifauna	○ Disturbance associated with noise and movement of construction equipment and personnel at the site may deter many bird species from the area ○ Habitat alteration during the construction of transmission lines and associated roadways.	Minor	○ The minimum amount of vegetation along the transmission route shall be cleared ○ The footprint of all construction activities and access roads shall be restricted as much as practically possible ○ Disruption of any nest of avifauna species along the transmission route shall be avoided.	Negligible
Civil work activities, movement of construction vehicles	Air Quality	○ Emissions from construction vehicles and machinery. ○ Particulate emissions due to soil disturbance	Minor	○ Spraying water on soil before excavation and periodic road wetting to reduce nuisance dust levels. ○ Visual inspection of dust pollution from roads and the construction site and appropriate intervention if dust levels are too high; ○ Speed restriction of construction vehicles to a speed of 30 km/h or less; ○ Regular maintenance and servicing of machines and engines; ○ Use of clean fuels e.g., unleaded and de-sulphurized fuels, if available ○ Ensure that vehicles sizes are optimised to reduce the number of journeys required	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				and most suitable delivery routes are identified ○ Grievance procedure for dust complaints; ○ The use of appropriate Personal Protective Equipment (PPE) such as dust masks in particular for construction workers. ○ PASL shall as much as possible ensure that EPC contractors operate only modern and well maintained equipment and machinery for construction activities	
Civil work activities, movement of construction vehicles	Noise emission to sensitive receptors	Noise emission with associated effects on sensitive receptors	Moderate	○ Ensure construction vehicles are turned off when not in use. ○ Ensure that engines and other noise making equipment are in good working order and well maintained, and that all have original noise suppression equipment (e.g. mufflers) intact and in working order. ○ Ensure that equipment and general construction activities are limited to normal working hours (8.00hr to 17.00hr during weekdays; and Saturdays between 9.00hr-16.00hr). ○ Ensure that the major construction activities are limited to a particular area within the site.	Minor
Civil work activities,	Visual Prominence	Visual nuisance to road users due to construction related traffic that will frequent the project area	Minor	○ Site offices and structures will be limited to single storey and sited carefully to reduce visual intrusion. Colours will reflect hues of the surrounding vegetation and/or the ground.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				○ The EPC Contractor will be required to ensure that areas used in construction that are not within the operational area are rehabilitated and restored to previous natural vegetation. ○ The project site will be kept free of waste, except in designated areas. Any wastes distributed by winds will be regularly cleaned up. ○ All lighting will be kept to a minimum within the requirements of safety and efficiency. Where such lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillage will be used.	
Construction work activities; presence of construction workers on site	Socio-economic	Disruption of family structure and social networks; increase in level of crime and drug and alcohol abuse, increase in incidence of sex workers and casual sexual relations, which may result in HIV/AIDS infections and unwanted pregnancies	Moderate	○ The EPC Contractor will develop an induction programme, including a Code of Conduct, for all workers (including contractors and their workers) prior to construction activities. ○ A copy of the Code of Conduct to be presented to all workers and signed by each person. The Code of Conduct will address the following aspects: - respect for the norms and values of local communities; - no hunting or unauthorised taking of products or livestock; - zero tolerance of illegal activities by construction personnel including:	Minor

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				unlicensed prostitution and/or solicitation; illegal sale or purchase of alcohol; sale, purchase or consumption of drugs; illegal gambling or fighting; - compliance with the Traffic Management Plan and all road regulations; - description of disciplinary measures for infringement of the CoC. ○ If workers are found to be in contravention of the Code of Conduct, which they will be required to sign at the commencement of their contract, they shall face disciplinary procedures that could result in dismissal. Stock theft shall be noted as a dismissible offence. ○ Grievance procedure that is easily accessible to local communities shall be developed, through which complaints related to contractor or employee behaviour can be lodged and responded to. PASL shall respond directly to such complaints. Key steps of the grievance mechanism include: ○ Circulation of contact details of ‘grievance officer’ or other key developer contacts.	

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				○ Creation of awareness among local communities (including all directly affected and neighbouring residents) regarding the grievance procedure and how it works. ○ Establishment of a grievance register to be regularly updated, this should include all responses and response times. ○ PASL shall ensure that the EPC Contractor develops a means of monitoring access to the site, prohibiting unauthorized access to the site and ensuring that all visitors report to the site office. ○ No employment will take place at the entrance to the site. Only formal channels for employment will be used, and recruitment shall take place only at designated times and locations. ○ PASL through its EPC Contractor shall develop and implement an HIV/AIDS policy and information document for all workers directly related to the project. The information document will address factual health issues as well as behaviour change issues around the transmission and infection of HIV/AIDS. ○ PASL through its EPC Contractor shall in addition to creating awareness education about HIV and AIDS and	

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				other sexually transmitted diseases, also ensure the distribution of protective sexual equipment (condoms) to both the contractor's personnel and to active residents in the potentially affected communities. PASL shall ensure that efforts to distribute sexually protective equipment's amongst residents of the potentially affected is done after due consultation with health care service providers in these surrounding areas in order to align its efforts with prevailing social context in the Potentially project affected area.	
Construction activities including movement of project vehicles	Socio-economic	Road traffic including accidents	Minor	○ The EPC Contractor will develop a construction traffic management plan (CTMP). ○ All access routes within the site will be identified, clearly demarcated and constructed. ○ Speed limits (of less than 30 km/h) will be adhered to on the Project site. ○ Off-road driving will be prohibited. ○ All vehicles used for the project should be regularly serviced and maintained. ○ Ensure that driver competency is assessed and where required driver training is provided.	Negligible
Construction activities	Health, safety, and welfare of	Risk of injury and health related issues, rights denial etc	Moderate	○ Development and implementation of a robust H&S Management Plan by the EPC Contractor. The H&S Plan will be	Minor

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
	construction workers			developed following all relevant national and international standards, including IFC PSs. ○ Construction works shall be limited to the day time as much as possible. ○ Provision of bill boards at the construction site gates notifying people of the construction activity and timings. ○ Speed limits within the project site access roads and immediate vicinity will be limited to 30 km/hr. ○ Implementation of Health and Safety communication and training programmes to prepare workers to recognise and respond to workplace hazards. Daily toolbox talks prior to commencement of construction activities shall be implemented and regular drills conducted involving the neighbours. ○ Provision of adequate personal protective equipment (PPE) to workers. All employees will be required to wear the appropriate PPE whilst performing their duties. ○ Provision of regularly maintained fire fighting equipment and in easily accessible areas as well as ensuring site personnel are well trained in their use, as well as maintaining them regularly. ○ Safety training focused on operational procedures, emergency procedures and safe working practices, information on	

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				specific hazards, first aid and fire-fighting will be included in the induction, prior to the commencement of construction ○ Training of workforce on communicable diseases and Sexually Transmitted Diseases (STDs) and community interactions in general. ○ The EPC Contractor will be required to define worker accommodation requirements for construction workforce, and ensure that all contractors and subcontractors implement Worker Accommodation Guidelines, and undertake monthly audits to ensure compliance with these on contractors working on the Project. ○ The developer and the EPC Contractor will put in place a worker grievance mechanism that will be accessible to all workers, whether permanent or temporary, directly or indirectly employed. The grievance mechanism shall be open to the EPC Contractor and subcontractor workforce in the event that their grievance is not adequately resolved by their direct employer, PASL will then have the authority to act to resolve this grievance.	
Operation Phase					
Facility operation	Soil and Geology	Loss of topsoil, soil compaction and soil erosion	Minor	○ Areas of bare soil will be re-vegetated with local and appropriate plant species.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
including routine maintenance				○ Bi-annual monitoring of erosion, especially in the vicinity of roads, PV arrays and other hard-standing surfaces, will be conducted before and after the rainy season to ensure erosion sites can be identified early and remedied.	
Facility operation including routine maintenance	Hydrology and Hydrogeology	○ Impacts on groundwater as a result of fuel and oil spillage, or pollution from cleaning of PV panels with water containing mild detergents. ○ Decreased amounts of groundwater as a result of abstraction for the project activities. ○ Reduction in groundwater recharge through infiltration as a result of paved surfaces and PV panels. ○ Obstructions such as foundations and roadways may concentrate water flows into catchment areas feeding surrounding drainage lines, increasing erosion.	Minor	○ Design and implement appropriate drainage system that takes due regard of, and protects, the natural drainage at the site. ○ Monitor drainage across the site after periods of heavy rain and assess adequacy of site drainage; identify potential issues and where necessary implement improvements to the drainage system. ○ Site will be managed to ensure the project area remains fully vegetated throughout the project lifetime. ○ The EPC Contractor will be required to develop a water conservation plan to identify opportunities to reduce water consumption, for both construction and operational phases of the project, to reduce abstraction rate. ○ Any fuel, oil/used oil and chemicals on site will be stored in designated and appropriate storage facilities. Relevant operational staff shall receive training on the correct handling and emergency response procedures.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
	Terrestrial Flora	○ Damage to natural vegetation through movement of vehicles and maintenance activities. ○ Damage due to management of vegetation, i.e. brush cutting etc. ○ Introduction of alien species due to the increased levels of human activity and creation of areas of bare soil at the site	Minor	○ Vegetation clearing through brush cutting for maintenance activities will be done manually wherever possible. The use of herbicides will be avoided. The potential to use sheep will be considered to maintain vegetation growth (goats or cattle are inappropriate within solar projects). ○ Vegetation that needs to be reduced in height will be mowed or brush-cut to an acceptable height, and not to ground level except where necessary. ○ Any cleared areas which do not have some vegetation cover to protect the soil will be re-vegetated with local species and monitored to ensure recovery is taking place. ○ Collection or harvesting of any plants on the site shall be forbidden throughout all phases of the project. ○ Exclusive use of designated roads and accesses for vehicles; no off-road driving shall be permitted. ○ Regular monitoring for alien plants within the PV arrays will be undertaken at least every 6 months ○ Regular alien clearing will be conducted using good practice method for the species concerned. The use of herbicides will be avoided. ○ Bare soil will be kept to a minimum, and some grass or low shrub cover will be encouraged under the PV panels.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				○ Undertake monitoring of flora within the site, as part of annual ecological monitoring programme.	
	Fauna	Habitat loss for resident species. Shift in mammal and reptile communities due to PV panels providing shade and protection from birds of prey.	Minor	○ If the site must be lit at night for security purposes, this will be done with low-UV type lights (such as most LEDs), which do not attract insects. Night lighting will be directed downwards so as to avoid nuisance and visual impacts to neighbours. ○ No fires will be allowed on-site. ○ No unauthorized persons will be allowed onto the site. ○ In order to reduce collisions of vehicles with fauna, a 30 km/hr speed limit will apply to all roads and vehicles using the site. ○ No hunting shall be permitted within the site. ○ Undertake monitoring of fauna within the site, as part of annual ecological monitoring programme. This will also include recommendations for potential ecological enhancement measures that are compatible with a solar project.	Negligible
	Avifauna	○ Disturbance or displacement of large terrestrial species and raptors by routine maintenance activities. ○ Minimal risk of increased mortality of large terrestrial species	Minor	○ Ensure that all new above ground transmission lines are marked with bird flight diverters along their entire length, to increase the visibility of the power lines; particularly in areas where larger birds are likely to pass such as near drainage lines, dams or pans and hills. Bird flight diverters, either static or dynamic markers,	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
		and raptors, as well as overflying birds, may result from collisions with the transmission line or by electrocution on new power infrastructure.		are generally fitted to the upper, earth wire in most power line configurations with a recommended distance between each other of 15 to 25 m. Where new lines run in parallel with existing, unmarked power lines, this approach has the added benefit of reducing the collision risk posed by the older line. ○ Use bird-safe transmission structures (ideally with critical air gaps greater than 2 m), including insulation of electrical components and horizontal arrangement of the phases, which reduces the height of the conductors thereby minimising the risks of collision and electrocution of birds. ○ Any electrocution and collision events that occur should be recorded, including the species affected and the date. This can be done, for example, by site security during their regular patrol; staff to be provided with an environmental checklist. It is important to note that if repeated collisions occur, then further mitigation and avoidance measures will be implemented. ○ Exclude birds physically from high risk areas of live infrastructure and comprehensively insulate such areas to avoid bird electrocution; ○ Minimising the disturbance impacts associated with the operation of the facility by scheduling maintenance activities to avoid disturbances at sensitive times.	

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
	Air Quality	Minimal dust and air emissions from movement of vehicles and equipment during facility operation and maintenance	Minor	○ Speed control of operation and maintenance vehicles on site to 30 km/h or less; ○ Use of clean fuels e.g., unleaded and de-sulphurised fuels, if clean fuel is available.	Negligible
	Visual Prominence	Visual impacts: site is visible from receptors travelling along the Kastina-Kano Express road (IBB way), which is not known as a tourist route and receives relatively low levels of traffic.	Moderate	○ Site offices and structures will be limited to single storey and sited carefully to reduce visual intrusion. Colours will reflect hues of the surrounding vegetation and/or the ground. Roofs will be grey and non-reflective. Door and window frame colour will reference either the roof or wall colours. ○ The fencing will be grey in colour. ○ Vegetation outside and around the perimeter fencing will be allowed to grow, to provide some screening of the site; particularly along the eastern boundary of the site to screen the project from the road. ○ Substations will be set into the ground as much as possible and the structures will be painted a grey green colour. ○ The area will be kept free of waste, except in designated waste storage areas. Any wastes distributed by winds will be regularly cleaned up. ○ All lighting will be kept to a minimum within the requirements of safety and efficiency. Motion detected lighting should be considered if it does not impact the site security.	Minor

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				○ Where such lighting is deemed necessary, low-level LED lighting, which is shielded to reduce light spillage and pollution, will be used. ○ No naked light sources will be directly visible from a distance. Only reflected light will be visible from outside the site. ○ Security and perimeter lighting will also be shielded so that no light falls outside the area needing to be lit. Unnecessarily tall light poles will be avoided. ○ Landscape restoration of areas not fully restored during construction. ○ All structures (including panels and buildings) will be restricted to a height of less than 6m, excluding transmission towers.	
	Health, Safety and Welfare of staff including worker's right	Exposure to injuries, electrical shock, rights denial etc	Moderate	○ Develop and implement human resources (HR) policy relevant to scale of the Project. ○ The HR policy will include the following key issues, among others: – Provision of clear and understandable information regarding rights under national labour and employment law, and any applicable collective agreements, including those related to hours of work, wages, overtime, compensation, etc. – Provision of employment, compensation/remuneration and working conditions, including working hours, terms of employment, based on	Minor

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				equal opportunity and fair treatment, avoiding discrimination on any aspects. – Retrenchment policy including alternatives analysis prior to decision. – Implementation of a grievance mechanism. – Adoption and implementation of a sexual harassment policy. – Adoption of open attitude towards freedom of association. – All workers will be able to join unions of their choice and have the right to collective bargaining. – A worker grievance mechanism that will be made known to all workers ○ Develop and implement occupational health and safety policy and procedures including emergency plan. Staff shall be trained on emergency preparedness and responses	
Decommissioning Phase					
Removal of PV panels during decommission ing	Soil	Soil contamination due to waste generation; soil compaction.	Minor	○ An approved decommissioning plan by the regulatory bodies shall be implemented prior to demolition activities. ○ PV panels shall be taken offsite for appropriate recycling. ○ All major electrical items will be removed from site and recycled appropriately. ○ All supporting structures and other materials will be removed from site and appropriately recycled	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Impact Rating	Mitigation Measures	Residual Impact
				○ All impacted soil area shall be re-vegetated with native plant species. ○ Site remediation shall be carried once conspicuous contamination is noted.	
Demolition of buildings and associated facilities during decommission-ing	Air Quality	Air quality impairment by gaseous and particulate pollutants; Increase in dust level.	Minor	○ An approved decommissioning plan by the regulatory bodies shall be implemented prior to demolition activities. ○ PASL shall ensure regular cleaning of equipment to avoid excessive build- up of dirt and mud. ○ PASL shall ensure strict adherence to health and safety policy during the demolition activities.	Negligible
Demolition of buildings and associated facilities during decommission-ing	Noise – sensitive receptors	Discomforting noise from equipment and related activities with attendant health effects.	Minor	○ An approved decommissioning plan by the regulatory bodies shall be implemented prior to demolition activities. ○ Hand-held concrete breakers shall be employed where necessary.	Negligible

CHAPTER SEVEN:

ENVIRONMENTAL MANAGEMENT PLAN

CHAPTER SEVEN

ENVIRONMENTAL MANAGEMENT PLAN[9] (EMP)

7.1 Introduction

This chapter presents the Environmental Management Plan (EMP) for the proposed Solar Photovoltaic Power Plant (Solar farm) in Kankia, Kankia LGA of Katsina State.

EMP 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.

The associated and potential impacts of the proposed Project have been analyzed in Chapter 5 of this report. The results show that if the recommended mitigation measures are implemented, the impacts of the Project are not severe and are thus acceptable. In order to ensure the environmental and social considerations and mitigation measures of the EIA are implemented, an EMP has been developed. The purpose of the EMP is to ensure that those recommended mitigation measures are translated into practical management actions, which can be adequately resourced and integrated into the Project phases.

The EMP has been developed to meet international and national standards on environmental and social management performance. It covers the pre-construction, construction, operation and decommissioning phase of the Project (Tables 7.1 to 7.3). It details the mitigation and enhancement measures PASL has committed to implement throughout the life cycle of the Project and includes desired outcomes; performance indicators; monitoring; and timing for actions and responsibilities.

PASL will have principal responsibility for all measures outlined in the EMP, but may delegate responsibility to its contractors, where appropriate and monitor the implementation.

7.2 Objectives of the EMP

The EMP is essential for successfully implementing the Project's environmental performance throughout the life of the Project. Having this framework in place ensures a systematic approach to bringing environmental and social

[9] For the purpose of this report and in line with the requirements of the Federal Ministry of Environment, the term EMP is considered to be synonymous with Environmental and Social Management Plan (ESMP) and encompasses both biophysical and socio-economic environment

considerations into decision-making and day-to-day operations. It establishes a framework for tracking, evaluating and communicating environmental and social performance and helps ensure that environmental risks and liabilities are identified, minimized and managed.

The EMP will be a living document and will continue to develop during the design and construction phases to enable continuous improvement of the Project's environmental performance.

The specific objectives of the EMP are to:

- Promote environmental and social management and communicate the aims and goals of the EMP;
- Ensure that all workers, subcontractors and others involved in the Project meet legal and regulatory requirements with regard to environmental management;
- Incorporate environmental and social management into Project design and operating procedures;
- Address concerns and issues raised in the EIA's stakeholder engagement process and those that will likely continue to arise during the Project's lifetime;
- Serve as an action plan for environmental and social management for the Project;
- Provide a framework for implementing Project environmental and social commitments (i.e. mitigation measures identified in the EIA);
- Prepare and maintain records of Project environmental and social performance (i.e. monitoring, audits and non-compliance tracking).

7.3 Environmental and Social Management Organization

PASL is committed to providing resources essential to the implementation and control of the EMP. These include appropriate human resources and specialized skills, training, programs and capacity building, communication procedures, documentation control and a procedure for the management of change.

PASL shall engage dedicated personnel competent on the basis of appropriate education, training, and experience to manage and oversee the Health, Safety and Environment (HSE) aspects of the Project. The HSE personnel shall ensure that the Project and subcontractors operate in accordance with the applicable regulatory HSE requirements and plans; and also monitor implementation of environmental and social protection measures.

7.3.1 Awareness, Training, and Capacity Building

PASL shall identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environmental or social conditions. The Project recognizes that it is important that employees at each relevant function and level are aware of the company's environmental policy; potential impacts of their activities; and roles and responsibilities in achieving conformance with the policy and procedures.

This will be achieved through a formal training process. Employee training will include awareness and competency with respect to:

- Environmental and social impacts that could potentially arise from their activities (including dust, noise, soil contamination etc.);
- Necessity of conforming to the requirements of the EIA and EMP, in order to avoid or reduce those impacts;
- Roles and responsibilities to achieve the required conformity, including those in respect of change management and emergency response.

Employees responsible for performing site inspections will receive training by drawing on external resources as necessary. Training will be organized as and when required and based on formally identified needs.

Similarly, the Project will require that each of the subcontractors institute training programs for its personnel. Each subcontractor is responsible for site HSE awareness training for personnel working on the job sites. The subcontractors are also responsible for identification of any additional training requirements to maintain required competency levels.

The sub-contractors training program will be subject to approval by PASL and it will be audited to ensure that: training programs are adequate; all personnel requiring training have been trained; and competency is verified.

In addition, capacity building on the operation and maintenance of the power plant and the transmission line in form of both internal and external trainings shall be provided to workers.

7.3.2 Communication

PASL will maintain a formal procedure for communicating with the regulatory authorities and communities as contained in its Stakeholder Engagement Plan (SEP). Meetings will be held, as required, between PASL and the appropriate regulatory authorities and community representatives to review environmental performance, areas of concern and emerging issues. Dealings will be transparent and stakeholders will have access to personnel and information to address concerns raised.

The Project will also develop and implement a grievance mechanism whereby community members can raise any issues of concern. Grievances may be verbal or written and are usually either specific claims for damages/injury or complaints or suggestions about the way that the Project is being implemented. When a grievance has been brought to the attention of the Project team, it will be logged and evaluated. The person or group with the grievance is required to present grounds for making a complaint or claiming loss so that a proper and informed evaluation can be made.

Where a complaint or claim is considered to be valid, then steps are required to be undertaken to rectify the issue or agree compensation for the loss. In all cases, the decision made and the reason for the decision will be communicated to the relevant stakeholders and recorded. Where there remains disagreement on the outcome then an arbitration procedure may be required to be overseen by a third party (e.g. Government official). Local community stakeholders will be informed on how to implement the grievance procedures.

7.3.3 Documentation

PASL will control HSE documentation, including management plans; associated procedures; and checklists, forms and reports, through a formal procedure. All records will be kept on site and will be backed up at several offsite locations (including secure cloud storage facilities as may be required). Records will be kept in both hard copy and soft copy formats. And all records will be archived for future purpose.

In addition, the document control procedure will describe the processes that the Project will employ for official communication of both hardcopy and electronic document deliverables. Also, it will describe the requirement for electronic filing and posting and for assignment of document tracking and control numbers.

The subcontractors will be required to develop a system for maintaining and controlling its own HSE documentation and describe these systems in their respective HSE plans.

7.3.4 Operational Control Procedures

Each potentially significant impact identified in the EIA will have an operational control associated with it that specifies appropriate procedures, work instructions, best management practices, roles, responsibilities, authorities, monitoring, measurement and record keeping for avoiding or reducing impacts. Operational controls are monitored for compliance and effectiveness on a regular basis through a monitoring and auditing procedure described in the EMP.

Operational control procedures shall be reviewed and, where appropriate, amended to include instructions for planning and minimizing impacts, or to at least reference relevant documents that address impact avoidance and mitigation.

7.3.5 Emergency Preparedness and Response

PASL shall prepare plans and procedures to identify the potential for, and response to, environmental accidents and health and safety emergency situations and for preventing and mitigating potentially adverse environmental and social impacts that may be associated with them.

Emergency preparedness and response will be reviewed by PASL on at least an annual basis and after the occurrence of any accidents or emergency situations to ensure that lessons learnt inform continuous improvement. Emergency exercises will be undertaken on a regular basis to confirm adequacy of response strategies. Investigations of accidents or incidents will follow formal documented procedures.

7.3.6 Facilities Surveillance

This is a salient system maintenance requirement for the environmental sustainability of the Project. PASL shall carry out constant equipment and facilities surveillance to detect on time, the malfunctioning or deterioration of equipment and/or facilities. The surveillance shall aim at taking prompt corrective/repair measures on detected faults.

7.3.7 Managing Changes to Project Activities

Changes in the Project may occur due to unanticipated situations. Adaptive changes may also occur during the course of final design, commissioning or even operations. The Project will implement a formal procedure to manage changes in the Project that will apply to all project activities.

The objective of the procedure is to ensure that the impact of changes on the health and safety of personnel, the environment, plant and equipment are identified and assessed prior to changes being implemented.

The management of change procedure will ensure that:

- Proposed changes have a sound technical, safety, environmental, social and commercial justification;
- Changes are reviewed by competent personnel and the impact of changes is reflected in documentation, including operating procedures and drawings;
- Hazards resulting from changes that alter the conditions assessed in the

EIA have been identified and assessed and the impact(s) of changes do not adversely affect the management of health, safety or the environment;
- Changes are communicated to personnel who are provided with the necessary skills via training to effectively implement changes;
- The appropriate PASL person accepts the responsibility for the change.

7.3.8 Additional Management Plans

Additional detailed policies and plans will be developed to support the implementation of this EMP. The timing of the development of the plans may be staged, ensuring that the appropriate focus and level of detail is provided for construction and operational activities. Where required, the documents will be finalized by PASL in consultation with the Federal Ministry of Environment, Katsina State Environmental Protection Agency and other key stakeholders. The documents will be prepared strictly in line with the requirements set out in the relevant IFC Performance Standards and the World Bank/IFC EHS policies and guidelines as well as other applicable national and local regulations and guidelines.

The additional management plans required for the proposed Project include:

- Local and Employment Management Plan (LEMP);
- Waste Management Plan (WMP)
- Site Security Plan (SSP)
- Construction Traffic Management Plan (CTMP)
- Health and Safety Management Plan (H&SMP)
- Human Resources Management Plan
- Corporate Social Responsibility (CSR) Plan
- Emergency Response Plan (ERP)
- Land Acquisition Management Plan for the transmission right of way
- Site Closure and Restoration Plan.

7.4 Stakeholder Engagement Plan (SEP)

A SEP has been developed for the proposed project. The objectives of developing stakeholder engagement plan for the proposed Project include the following:

- Ensuring stakeholder inclusion and involvement across the various phases of the project;
- Ensuring clarity and understanding through an open, inclusive and transparent process of culturally appropriate engagement and communication undertaken to ensure that stakeholders are well informed about the proposed Project;
- Building and maintaining productive relationship between PASL and its various stakeholders through supporting open dialogue;

- Engaging vulnerable groups through an open and inclusive approach to consultation thus increases the opportunity for stakeholders to provide comment and voice their concerns on the proposed Project;
- Managing expectations to ensure that the proposed Project does not create or allow unrealistic expectations to develop amongst stakeholders about proposed Project benefits. The engagement process will serve as a mechanism for understanding and managing stakeholder and community expectations, where the latter will be achieved by disseminating accurate information in an accessible way.
- Ensuring compliance with both local regulatory requirements and international best practice.
- Ensuring stakeholders are free of external manipulation or coercion.

Details of the Stakeholder Engagement Plan are provided in Appendix 12. The SEP is will be updated and adjusted as the project progresses.

PASL is committed to implementing stakeholder management as part of its operations. As such PASL will ensure that the responsibility for implementing the SEP is duly assigned and all components of the plan are well-defined within its organizational processes. PASL shall also commit to providing the necessary support to implement the SEP. On-going consultation will be undertaken with Potentially Affected Parties (PAP), including those that use the land unofficially for grazing. The management structure for the SEP includes the following elements.

Systems: PASL will pursue its Stakeholder engagement activities as scheduled in a systematic manner that creates predictability in the eyes of the stakeholder in order to supports and foster of a relationship based on trust.

Structure: PASL will establish a Stakeholder focused-structure within its organizational processes to provide the needed decision-making authority to enable quicker turnaround time on Stakeholder engagement activities and grievance feedback.

Skills: PASL will ensure that the required internal capacity for effective Stakeholder engagement is provided for the implementation of the SEP.

PASL communication strategy shall be focus on the specific objective of engagement and the option considered most suitable to effectively pursue consultation with the concerned stakeholders. Thus, all tradition communication tools for stakeholder engagement shall be applied in a manner to suit the specific consultation requirement and situation. As such, at the local level (local government and community), the primary focus of engagement shall be direct communication via face-to-face or verbal techniques such as public meetings

FGDs, key informant Interviews. This would be adopted to reinforce a two-way dialogue. The use of facilitators or interpreters at the local level would be adopted when necessary to ensure the information dissemination is effective and the community properly understand the project and are able to fully express their opinion.

PASL shall provide a feedback mechanism to ensure stakeholders affected by or interested in the proposed Project can present their input (e.g. opinions, requests, suggestions and grievances) for consideration and, if required, seek redress. The feedback mechanism shall function in a non-judgmental manner and record all feedback received. Grievances are any complaints or suggestions about the way a project is being implemented. They may take the form of specific complaints for damages/injury, concerns about routine project activities, or perceived incidents or impacts. Identifying and responding to grievances supports the development of positive relationships between projects host communities and other affected stakeholders. Grievances can be an indication of growing stakeholder concerns (real and perceived) and can escalate if not identified and resolved. The management of grievances is therefore a vital component of stakeholder management and an important aspect of risk management for a project.

It is anticipated that PASL will employ a Community Liaison Officer (CLO) who will serve to meet all community liaison responsibilities, in addition to the implementation and operation of the project grievance mechanism, thus fulfilling the role of Grievance Officer and CLO.

Any grievance received from stakeholders either through phone/letter, meeting, or any other correspondence will be recorded in Grievance Log and its significance assessed. The Grievance Officer will delegate resolution of grievance to relevant personnel and a response will be developed and communicated to the affected stakeholders. The grievance mechanism shall be periodically monitored by the Plant Manager or a designated Senior Management Staff.

7.5 Checking and Corrective Action

Checking includes inspections and monitoring as well as audit activities to confirm proper implementation of checking systems as well as effectiveness of mitigations. Corrective actions include response to out-of-control situations, non-compliances, and non-conformances. Actions also include those intended to improve performance.

7.5.1 Inspection

Health, Safety and Environment inspections will be conducted weekly on a specific basis and formally at least once every three (3) months. The results of the inspection activities will be reported to PASL to be addressed.

7.5.2 Monitoring

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;
- *Compliance Monitoring*: This 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.

PASL shall adopt a systematic monitoring schedule that will comprise both effects and compliance monitoring plans for the implementation of the Project. Baseline requirements are already embodied in Chapter 4 of this report and are such not covered in this chapter. Monitoring shall be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Monitoring parameters are included in the EMP.

The FMEnv guidelines require an environmental monitoring plan as part of an EIA. The aim of the monitoring programme is to ensure that the negative environmental impacts identified in this EIA are effectively mitigated in the construction, operations and decommissioning stages of the Project.

Specifically, the objectives of instituting a monitoring programme for this Project are to:

- Ensure compliance with the applicable local and IFC's environment and social standards and guidelines;
- Ensure that regulatory standards/limits for parameters of concerns are not exceeded;

- Monitor changes in existing physical, chemical and biological characteristics of the ancillary environment of the Project area. Early warning of environmental damage is thus provided so that urgent action may be taken if needed, to reduce in earnest the unwanted impact.
- Determine whether any detected changes in environmental components are caused by the Project or by other factors.
- Determine the effectiveness of the mitigation measures as well as check mitigation measures are correctly implemented.
- Highlight areas of concern undetected during the EIA study and provide a basis for recommending additional mitigation measures.

7.5.3 Auditing (Internal and External)

Beyond the routine inspection and monitoring activities, audits will be carried out internally by PASL to ensure compliance with regulatory requirements as well as its own HSE standards and policies. Audits to be conducted will also cover the subcontractor self-reported monitoring and inspection activities. The audit shall be periodic as required, with at least one audit undertaken at the beginning of each construction period and every 3 years during operational phase of the power plant facility. The audits will be performed by qualified staff and the results will be reported to PASL. All identified gaps will be addressed.

The audit will include a review of compliance with the requirements of the EIA and EMP and include, at a minimum, the following:

- Completeness of HSE documentation, including planning documents and inspection records;
- Conformance with monitoring requirements;
- Efficacy of activities to address any non-conformance with monitoring requirements.

There will be a cycle of audits into specific areas of the Project such as waste management. The frequency of audits will be risk based and will vary with the stage of the Project and will depend on the results of previous audits.

In addition, periodic auditing of the plant and operations shall be embarked on every three (3) years as required by the local regulatory authorities (FMEnv, NESREA etc.).

7.5.4 Corrective Action

Investigating a near miss or actual incident after it occurs can be used to obtain valuable lessons and information that can be used to prevent similar or more serious occurrences in the future. PASL will implement a formal non-compliance and corrective action tracking procedure for investigating the causes of, and identifying corrective actions to, accidents or environmental or social non-compliances. This will ensure coordinated action between PASL and its subcontractors.

7.5.5 Reporting

PASL shall keep the regulatory authorities informed of the Project performance with respect to HSE matters through reports that will be made available to the regulators when required. PASL will provide appropriate documentation of HSE related activities, including internal inspection records, training records, and reports to the relevant authorities. Subcontractors are also required to provide HSE performance reporting to PASL on a regular basis through weekly and monthly reports.

Table 7.1: Environmental Management Plan: Pre-Construction and Construction Phase

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
1.	Damage to indigenous natural vegetation. Damage to and/or loss of topsoil.	Bush clearing and levelling of equipment storage area(s) Access to and from the equipment storage area.	To minimize impacts on the social and biophysical environment To limit equipment storage to the demarcated area.	As far as possible, minimize vegetation clearing and levelling for equipment storage areas. The removal of vegetation and soil cover shall be restricted to only those areas necessary for the development. Soil conservation measures shall be implemented such as stockpiling topsoil or gravel for the remediation of disturbed areas. No herbicides shall be used on site. Cleared areas which are not being used will be re-vegetated using plants or seeds of locally occurring species Rehabilitate all disturbed areas at the construction	No claims regarding damage due to unauthorized removal of vegetation. All damaged areas successfully rehabilitated one year after completion. Requirements of IFC Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources	EPC Contractor	Pre-construction and construction phase	Regular audits of the construction camps and areas of construction onsite.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 1500

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				equipment camp as soon as construction is complete.						
2.	Soil contamination, exposure of site to external influence (security of materials)	Open excavations (foundations and cable trenches); Movement of construction vehicles in the area and on-site.	To secure the site against unauthorized entry	Secure site, working areas and excavations in an appropriate manner, as where necessary to control access, fence and secure area. Fence and secure EPC Contractor's equipment camp. All development footprints for roads, buildings, underground cables, laydown areas should be fenced off with two strand wire and clearly indicated with flags and/or danger tape strips. There is to be no disturbance outside these demarcated areas. Supply adequate waste collection bins at site where construction is being undertaken. Establish the necessary ablution	Site is secure and there is no unauthorized entry. No members of the public or landowners injured.	EPC Contractor	Pre - construction and construction phase	An incident reporting system will be used to record non-conformances to the EMP.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 5000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				facilities with toilets and provide adequate sanitation facilities and ablutions for construction workers at appropriate locations on site. Dispose of all solid waste collected at an appropriately registered waste disposal site. Waste disposal shall be in accordance with all relevant legislation.						
3.	Opportunities and benefits associated with the creation of local employment	Engagement of construction workers	To employ as many as possible of the low-skilled workers from the local area.	Ensure that as many as possible of the low-skilled workers are sourced from the local area. Where required, implement appropriate training and skills development programmes prior to the initiation of the construction phase. Identify potential opportunities for local businesses.	Employment and business policy document that sets out local employment and targets completed before construction phase commences. Semi and unskilled labour locally sourced. Applicable requirements of IFC Performance Standard 2 on Labour and working conditions	EPC Contractor	Before construction phase commences	Monitor indicators to ensure that they have been met for the construction phase.	PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 5000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
4.	The presence of construction workers can impact negatively on family structures and social networks, especially in small, rural communities. Increase in alcohol and drug use. Increase in crime levels. Increase in teenage and unwanted pregnancies. Increase in sexually transmitted diseases (STDs).	The presence of construction workers who live outside the area and who are housed in local towns	To avoid and/or minimize the potential impact of construction workers on the local community which can be achieved by maximizing the number of locals employed during the construction phase and minimizing the number of workers housed on the site.	Ensure that a portion of the low-skilled workers is sourced from the local area. Construction workers should be recruited from the local area in and around the towns Develop a Code of Conduct to cover the activities of the construction workers. Ensure that all workers are informed at the outset of the construction phase of the conditions contained in the Code of Conduct.	Employment policy and tender documents that sets out local employment and targets completed before construction phase commences. Portion of semi and unskilled labour locally sourced. Code of Conduct drafted before commencement of construction phase Applicable requirements of IFC Performance Standard 2 on Labour and working conditions	EPC Contractor	The Code of Conduct should be signed by PASL and the EPC Contractors before mobilization to site	Monitor indicators to ensure they have been met for the construction phase.	PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 10000
5.	Heavy vehicles can generate dust impacts, and can damage roads.	The movement of heavy vehicles and their activities on the site can result in dust impacts and damage to roads.	To avoid and or minimize the potential dust impacts associated with heavy vehicles, and minimize damage to roads.	Implement dust suppression measures for heavy vehicles such as wetting roads on a regular basis and ensuring that vehicles used to transport sand and building materials are fitted with tarpaulins or covers	Dust suppression measures implemented for all heavy vehicles that require such measures during the construction phase. Drivers should be made aware of the potential safety	EPC Contractor	Construction phase	Monitor indicators to ensure that they have been met for the construction phase.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 3000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				if wind conditions necessitate such. Ensure that all drivers are qualified and are made aware of the potential noise, dust and safety issues. Ensure that drivers adhere to speed limits. Ensure that damage to roads is repaired before completion of construction phase.	issues and enforcement of strict speed limits when they are employed					
6.	Decrease in air quality: Dust and particulates from vehicle movement to and on-site, foundation excavation, road construction activities, road maintenance activities, temporary stockpiles, and vegetation clearing affecting the surrounding residents and visibility.	Clearing of vegetation and topsoil. Excavation, grading, scraping, levelling, digging . Transport of materials, equipment, and components on internal access roads. Re-entrainment of deposited dust by vehicle movements.	To ensure emissions from all vehicles and construction engines are minimized, where possible, for the duration of the construction phase. To minimize nuisance to the community from dust emissions	Roads must be maintained to a manner that will ensure that nuisance to the community from dust emissions from road or vehicle sources is not visibly excessive Ensure that damage to roads is repaired before completion of construction phase. Appropriate dust suppressant must be applied on all	No complaints from affected residents or community regarding dust or vehicle emissions. Dust suppression measures implemented for all heavy vehicles that require such measures during the construction phase commences. Drivers must be made aware of the potential safety issues and enforcement of	EPC Contractor	Site establishment Duration of construction	Monitoring must be undertaken to ensure emissions are not exceeding the prescribed levels *via* the following methods: Immediate reporting by personnel of any potential or actual issues with nuisance	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 5000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
	Release of minor amounts of air pollutants from vehicles and construction equipment.	Wind erosion from topsoil and spoil stockpiles and unsealed roads and surfaces. Fuel burning vehicle and construction engines.	and to comply with workplace health and safety requirements for the duration of the construction phase	exposed areas and stockpiles as required to minimize/control airborne dust. Vehicles moving outside the construction site carrying material that can be wind-blown must be covered with tarpaulins if required by the wind conditions. Strictly control vibration pollution from compaction plant or excavation plant. Disturbed areas must be re-vegetated as soon as practicable. Grievance procedure must be put in place for dust complaints; The use of appropriate Personal Protective Equipment (PPE) such as dust masks in particular for	strict speed limits when they are employed. Applicable requirements of IFC Performance 3 on Resource Efficiency and Pollution Prevention			dust or emissions to the Site Manager. A complaints register must be maintained, in which any complaints from residents/the community will be logged, and thereafter complaints will be investigated and acted upon.		

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				construction workers. Vehicles and equipment must be maintained in a roadworthy condition at all times.						
7.	Loss of indigenous natural vegetation due to construction activities.	Vegetation clearing. Construction of access roads. Placement of power line and cables. Contamination of the soil by construction vehicles & machinery. Storage of materials required for construction.	To minimize footprints of disturbance of vegetation/ habitats on-site. To minimize loss of indigenous vegetation.	The construction impacts must be contained to the footprint of the project development Limit unnecessary impacts on surrounding natural vegetation must be avoided	Loss of natural vegetation equivalent to the exact footprint of the proposed project. Applicable requirements of IFC Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources	EPC Contractor	Construction phase	Before construction, determine required number of hectares to accommodate footprint of proposed infrastructure. After construction, determine amount of natural vegetation lost due to construction.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 500
8.	Avifauna collision and electrocution events with the overhead transmission line.	Overhead transmission line.	To maintain a low number of collision and electrocution events.	Disruption of nest of avifauna species along the transmission route shall be avoided. The power line should be kept as low as possible taking into account	Zero collision or electrocution events. Applicable requirements of IFC Performance Standard 6 on Biodiversity Conservation	EPC Contractors PASL	Construction Phase	Observation of electrocution or collision events with the power line. Monitor power line	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 1000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				engineering and legal requirements. The span lengths should be kept as short as possible taking into account engineering and legal requirements. Ensure that all new above ground transmission lines are marked with bird flight diverters along their entire length, to increase the visibility of the power lines; particularly in areas where larger birds are likely to pass such as near drainage lines, dams or pans and hills. Bird flight diverters, either static or dynamic markers, are generally fitted to the upper, earth wire in most power line configurations with a recommended distance between each other of 15 to 25 m. Where new lines run in parallel	and Sustainable Management of Living Natural Resources			servitude for dead birds.		

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				with existing, unmarked power lines, this approach has the added benefit of reducing the collision risk posed by the older line. Use bird-safe transmission structures (ideally with critical air gaps greater than 2 m), including insulation of electrical components and horizontal arrangement of the phases, which reduces the height of the conductors thereby minimising the risks of collision and electrocution of birds. Any electrocution and collision events that occur should be recorded, including the species affected and the date. This can be done, for example, by site security during their regular patrol; staff to be provided with an environmental						

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				checklist. It is important to note that if repeated collisions occur, then further mitigation and avoidance measures may need to be implemented. Exclude birds physically from high risk areas of live infrastructure and comprehensively insulate such areas to avoid bird electrocution; Minimising the disturbance impacts associated with the operation of the facility by scheduling maintenance activities to avoid disturbances at sensitive times.						
9.	Invasion of natural vegetation surrounding the site by declared weeds or invasive alien species.	Construction, environmental management.	There is a target of no alien plants within project control area	Avoid creating conditions in which alien plants may become established. Keep disturbance of indigenous vegetation to a minimum.	For each alien species: number of plants and aerial cover of plants within project area and immediate surroundings. Applicable requirements of	EPC Contractor	Construction phase Operational phase	Monitoring of area by EPC during construction Annual audit of project area and immediate surrounding	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 3000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				Rehabilitate disturbed areas as quickly as possible. Do not import soil from areas with alien plants. Establish a monitoring programme to detect and quantify any alien species that may become established and identify the problem species immediately	IFC Performance Standard 6 on Biodiversity Conservation Sustainable Management of Living Natural Resources			s by qualified botanist.		
10.	Soil degradation. Soil erosion. Increased deposition of soil into drainage systems. Increased run-off over the site.	Construction activity – removal of vegetation, excavation, stockpiling, compaction, and pollution of soil. Rainfall - water erosion of disturbed areas. Wind erosion of disturbed areas. Concentrated discharge of water from construction activity.	To minimize extent of disturbance areas. To minimise activity within disturbance areas. To minimise soil degradation (mixing, wetting, compaction, etc). To minimise soil erosion	Restrict construction activity within disturbance areas. Access roads to be carefully planned and constructed to minimise the impacted area and prevent unnecessary excavation, placement, and compaction of soil. Minimise removal of vegetation which adds stability to soil.	No activity outside disturbance areas. Acceptable level of activity within disturbance areas No activity in restricted areas .	EPC Contractor	Construction Phase	Monthly inspections of the site. Monthly inspections of surroundings, including drainage lines.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 1000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
			and deposition of soil into drainage lines	Rehabilitate disturbance areas as soon practicable when an area is vacated. Soil conservation: Stockpile topsoil for re-use in rehabilitation phase, protect stockpile from erosion. Control depth of excavations and stability of cut faces/sidewalls.						
11.	Poor storm water management and the alteration hydrological regime.	Placement of hard engineered surfaces.	Reduce the potential increase in surface flow velocities and the impact on the localized drainage systems.	Install stilling basins to capture large volumes of run-off, trapping sediments, and reduce flow velocities. The EPC Contractor will be required to design appropriate drainage system that takes due regards of the natural drainage system Where roads intersect natural, defined drainage lines, suitably sized pipe culverts or drive	Water quality and quantity management Applicable requirements of IFC Performance Standard 3 on Resource Efficiency and Pollution Prevention	EPC Contractors	Pre-construction, Construction Operational phases	Storm water monitoring plan.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 5000

S/ N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				through causeways shall be installed or constructed; Fuel, oil and used oil storage areas will be contained in bunds of 110 percent capacity of the stored material. Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of at a registered landfill site.						
12.	The potential scarring of the landscape due to the creation of new access roads/tracks or the unnecessary removal of vegetation	The viewing of the above mentioned visual scarring by observers near the solar facility.	Minimal disturbance to vegetation cover in close vicinity to the proposed solar facility and its related infrastru-cture.	Implement an environmentally responsive planning approach to roads and infrastructure to limit cut and fill requirements. Adopt responsible construction practices aimed at containing the construction activities to specifically demarcated areas thereby limiting the removal of natural	Vegetation cover that remains intact with unnecessary access roads or erosion scarring in close proximity of the solar facility.	EPC Contractor	Construction phase	Monitoring of vegetation clearing during the construction phase.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 1000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				vegetation to the minimum. Rehabilitate all disturbed areas to acceptable visual standards. Maintain the general appearance of the facility in an aesthetically pleasing way. All lighting will be kept to a minimum within the requirements of safety and efficiency. Where such lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillage and pollution, will be used. The containment of light emitted in order to eliminate the risk of additional night time visual impacts.						

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				Minimal usage of security and other lighting. Ensure that proper planning is undertaken regarding the placement of lighting structures. Undertake regular maintenance of light fixtures.						
13.	Traffic congestion, particularly on narrow roads or on road passes where overtaking is not permitted. Risk of accidents. Deterioration of road pavement conditions (both surfaced and gravel road) due to abnormal loads.	Traffic congestion increase. Site preparation and earthworks. Foundations or plant equipment installation. Mobile construction equipment movement on-site.	To minimise impact of traffic associated with the construction of the facility on local traffic. To minimise potential for negative interaction between pedestrians or sensitive users and traffic associated with the facility construction	All relevant permits for abnormal loads must be applied for from the relevant authority. The EPC Contractor will develop a construction traffic management plan (CTMP) All access routes within the site will be identified, clearly demarcated and constructed. Speed limits (of less than 30 km/h) will be adhered to on the Project site. Off-road' driving will be prohibited.	No traffic incidents involving PASL personnel or appointed EPC Contractors. Appropriate signage in place. No complaints resulting from traffic congestion, delays or driver negligence associated with construction of the solar energy facility.	EPC contractor	Construction Phase	Monitoring of dust produced by traffic movement. Monitoring of traffic control measures to ensure they are effective. A complaints register will be maintained, in which any complaints from the community will be logged.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 6000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
			To ensure all vehicles are roadworthy and all materials/equipment are carried appropriately and within any imposed permit/ licence conditions Prevent damage to roads by construction vehicles.	All vehicles used for the project should be regularly serviced and maintained. Ensure that driver competency is assessed and where required driver training is provided.				Complaints will be investigated and, if appropriate, acted upon. An incident reporting system will be used to record non-conformances to the EMP.		
14.	Inefficient use of resources resulting in excessive waste generation. Litter or contamination of the site or water through poor waste management practices.	Vehicles associated with site preparation and earthworks. Power line construction activities. Packaging and other construction wastes. Hydrocarbon use and storage. Spoil material from excavation, earthworks, and site preparation.	To ensure that the storage and handling of chemicals and hydrocarbons on-site does not cause pollution to the environment or harm to persons. To comply with waste management guidelines.	Spill kits must be made available on-site for the cleanup of spills and leaks of contaminants. Corrective action must be undertaken immediately if a complaint is made, or potential/actual leak or spill of polluting substance identified. This includes stopping the contaminant from further escaping, cleaning up the affected environment as	No spilling of chemicals or hydrocarbons Clean work environment	EPC contractor	Construction Phase	Observation and supervision of fuel storage and handling practices and vehicle maintenance throughout construction phase. A complaints register must be maintained, in which any complaints from the	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 3000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
			To minimise production of waste. To ensure appropriate waste storage and disposal.	much as practically possible and implementing Spilled cement must be cleaned up as soon as possible and disposed of at a suitably licensed waste disposal site. Routine servicing and maintenance of vehicles must not to take place on-site (except for emergencies). Transport of all hazardous substances must be in accordance with the relevant legislation and regulations. Construction EPC Contractors must provide specific detailed waste management plans to deal with all waste streams. Specific areas must be designated on-site for the temporary management of				community will be logged. Observation and supervision of waste management practices throughout construction phase. Waste collection will be monitored on a regular basis. An incident reporting system will be used to record non-conformances to the EMP.		

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
				various waste streams, i.e. general refuse, construction waste (wood and metal scrap), and contaminated waste as required. Disposal of waste must be in accordance with relevant legislative requirements, including the use of licensed Contractors.						
15.	Environmental integrity of site undermined resulting in reduced visual aesthetics, erosion, compromised land capability	Temporary construction areas. Temporary access roads/tracks.	To ensure and encourage site rehabilitation of disturbed areas. To ensure that the site is appropriately rehabilitated following the execution of the works, such that residual environmental impacts	All temporary facilities, equipment, and waste materials must be removed from site. All temporary fencing and danger tape must be removed once the construction phase has been completed. Necessary drainage works and anti-erosion measures must be installed, where required, to minimise loss of topsoil and control erosion.	All portions of site, including construction equipment camp and working areas, cleared of equipment and temporary facilities. Topsoil replaced on all areas and stabilised where practicable or required after construction and temporally utilised areas. Disturbed areas rehabilitated and acceptable plant	EPC Contractor	Following execution of the works	Inspection of rehabilitated areas in order to determine effectiveness of rehabilitation measures implemented during the operational lifespan of the facility.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 3000

S/N	Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation (in US Dollars)
			(including erosion) are remediated or curtailed	Disturbed areas must be rehabilitated/re-vegetated with appropriate natural vegetation and/or local seed mix. Re-use of native/ indigenous plant species removed from disturbance areas in the rehabilitation phase to be determined by a botanist as applicable. Re-vegetated areas may have to be protected from wind erosion and maintained until an acceptable plant cover has been achieved.	cover achieved on rehabilitated sites.					

Table 7.2: Environmental Management Plan: Operation Phase

Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation
Disturbance to or loss of vegetation and/or habitat	Movement of employee vehicles within and around site	To maintain minimised footprints of disturbance of vegetation/habitats on-site To ensure and encourage plant regrowth in non-operational areas of post-construction rehabilitation.	Vehicle movements must be restricted to designated roadways. An environmental manager must be appointed during operation whose duty it will be to minimise impacts on surrounding sensitive habitats. Existing roads must be maintained to ensure limited erosion and impact on areas adjacent to roadways.	No further disturbance to vegetation. Continued improvement of rehabilitation efforts	PASL	Throughout the operation phase	Observation of vegetation on-site. Regular inspections to monitor plant regrowth/performance of rehabilitation efforts and weed infestation compared to natural/undisturbed areas.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 2000
Environmental integrity of site undermined resulting in reduced visual aesthetics, erosion, compromised land capability	Constructions areas. Access roads. Other disturbed areas.	To ensure and encourage site rehabilitation of disturbed areas.	A botanist familiar with the vegetation of the area should monitor the rehabilitation success and alien plant removal on an annual basis. Fire breaks should be established, where appropriate and applicable. Appoint an environmental manager during operation whose	Successful rehabilitation of disturbed areas.	Plant Manager, PASL	Throughout the operation phase	Alien plant monitoring and removal should be undertaken on an annual basis.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 3000

Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation
			duty it will be to minimise impacts on surrounding sensitive habitats.						
Disturbance to or loss of fauna and/or habitat. Direct mortalities.	Movement of vehicles within and around site. Power line, and access roads.	To keep number of vehicle movements to a minimum. To maintain minimised footprints of disturbance of vegetation/habitats onsite. To ensure and encourage site rehabilitation.	Vehicle movements restricted to designated roadways. Adherence to reduced vehicle speeds (as prescribed by the environmental manager) by any vehicles moving on the site to reduce potential for direct mortalities.	No further disturbance to faunal populations on the site. Continued improvement of faunal protection efforts.	Plant Manager, PASL	Throughout the operation phase	Observation and recording of mortalities associated with the solar energy facility	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 2000
Collision and electrocution events with the overhead power line.	Overhead power line.	To maintain a low number of collision and electrocution events.	Fit the earth wire with bird marking/deterrent devices (i.e. in defined problem areas) which have proved to be extremely effective in preventing bird collisions by making the line more visible. Notes of electrocution and collision events must be noted further mitigation measures.	Zero collision or electrocution events.	Plant Manager, PASL	Throughout the operation phase	Observation of electrocution or collision events with the power line Monitor power line servitude for dead birds.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 1000

Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation
Enhanced visual intrusion. Impact on ambient lighting conditions.	Size/scale of power tower. Security associated lighting. Access roads. Power line and water storage/treatment reservoirs. Other associated infrastructure.	To minimise potential for visual impact. Minimise contrast with surrounding environment and visibility of the associated infrastructure. The containment of light emitted from the facility in order to eliminate the risk of additional night-time visual impacts	Care must be taken in the planning and placement of light fixtures in order to reduce visual impacts associated with glare and light trespass. Maintain the general appearance of the facility in an aesthetically pleasing way. Undertake regular maintenance of light fixtures. Limit access to the solar energy facility site, power line	Minimised visual intrusion on surrounding areas. Appropriate visibility of infrastructure to aircraft. The effective containment of light.	Plant Manager, PASL	Throughout the operation phase	The monitoring of the condition and functioning of the light fixtures during the operation phase of the project.	EHS Coordinator, PASL Regulatory authorities (FMEnv, KATSEPA)	Approximately 3000
Inefficient use of resources resulting in excessive waste generation. Litter or contamination of the site or water through poor waste management practices.	Transformers Fuel and oil storage. Maintenance building. General waste generation	To comply with waste management guidelines. To minimise production of waste. To ensure appropriate waste disposal. To avoid environmental harm from waste disposal.	Hazardous substances (such as used/new transformers) must be stored in sealed containers within a clearly demarcated designated area. Storage areas for hazardous substances must be appropriately sealed and bunded. All structures and/or components	No complaints received regarding waste on site or indiscriminate dumping. Internal site audits identifying that waste segregation recycling and reuse is occurring appropriately.	EHS Coordinator PASL	Throughout the operational phase	Waste collection must be monitored on a regular basis. Waste documentation must be completed and available for inspection on request.	Regulatory authorities (FMEnv, KATSEPA)	Approximately 2000

Potential Impact	Activity/ Risk source	Desired Outcome	Mitigation Measures	Performance Indicator	Responsibility for EMP Implementation	Time frame	Monitoring	Responsibility for Monitoring	Estimated Cost for implementation
			replaced during maintenance activities must be appropriately disposed of at an appropriately licensed waste disposal site or sold to a recycling merchant for recycling. Waste handling, collection, and disposal operations must be managed and controlled by a waste management contractor. Hazardous waste (including hydrocarbons) and general waste must be stored and disposed of separately.	Provision of all appropriate waste manifests. No contamination of soil or water.					

Table 7.3: Environmental Management Plan: Decommissioning Phase

Potential Impact	Source of Impacts	Desired Outcome	Description of Mitigation Measures	Performance Indicator	Monitoring Methods	Timing/ Frequency	Responsibility for EMP Implementation	Responsibility for Monitoring	Estimated Cost (US Dollars)
The negative air quality impacts identified during decommissioning activities are dust emission, site vehicle emission and emissions arising from traffic.	Source of impacts for air quality includes demolition of building and associated facilities; and vehicle movement.	Minimize emission impacts on sensitive receptors	▪ An approved decommissioning plan by the regulatory bodies shall be implemented prior to demolition activities. ▪ Dust control measures such as the use of water for dust suppression shall be implemented. ▪ Vehicles are certified with efficient engine performance and minimal air pollution following regular servicing and maintenance are engaged ▪ Movement of vehicles is restricted during adverse weather condition.	Federal Ministry of Environment (FMEnv.) permissible limit World Banks Air Quality Guidelines	Dust mitigation programme as part of Site Closure and Restoration Plan	Daily during decommissioning phase	Decommissioning Contractor	EHS Coordinator PASL Regulatory authorities (FMEnv, KATSEPA)	2000
Noise nuisance impacts from demolition activities.	Source of impacts for noise include demolition of buildings and associated facilities; vehicle movement.	Reduce noise nuisance at receptor.	▪ Site demolition equipment is run and maintained under optimum fuel efficient conditions; ▪ Noise impacts are reduced by enclosing and insulating noise emitting processes or equipment where possible. ▪ Ensure that engines and other noise making decommissioning equipment are in good working order and well maintained, and that all have original noise suppression equipment (e.g. mufflers) intact and in working order. ▪ Equipment and general demolition activities that produce noise shall be limited to normal working hours	Noise at sensitive receptors not to exceed Nigerian and WHO limits	Noise monitoring at sensitive receptors during decommissioning. Measurements of noise levels will be conducted using an integrated sound meter.	Weekly during decommissioning	Decommissioning Contractor	EHS Coordinator PASL Regulatory authorities (FMEnv, KATSEPA)	1000

Potential Impact	Source of Impacts	Desired Outcome	Description of Mitigation Measures	Performance Indicator	Monitoring Methods	Timing/ Frequency	Responsibility for EMP Implementation	Responsibility for Monitoring	Estimated Cost (US Dollars)
Potential contamination from spills	Demolition activities	Minimize risk of soil contamination and siltation of water resources.	▪ Minimization of excavation during decommissioning to reduce erosion. ▪ Rehabilitation and re-vegetation of the site following demolition and levelling ▪ PV panel and major equipment will be recycled ▪ Implement waste management plan as part of Site Closure and Restoration Plan.	Visual inspection Site Closure and Restoration Plan	Visual inspection and photographic record.	Daily during decommissioning phase	Decommissioning Contractor	EHS Coordinator PASL Regulatory authorities (FMEnv, KATSEPA)	1000
Waste Generation	Decommissioning activities	Reduce waste generation and ensure wastes are appropriately managed	▪ PASL shall ensure that PV panel and major equipment are returned to the manufacturer for recycling ▪ Wastes that cannot be reused will be disposal offsite in a dump site approved by KATSEPA	Applicable requirements of IFC Performance Standard 3 on Pollution Prevention National Environmental Protection (Management of Solid and Hazardous Wastes)	Volume of waste generated Waste consignment notes	Throughout decommissioning phase	PASL	Regulatory authorities (FMEnv, KATSEPA)	5000
Potential groundwater contamination from spills	Decommissioning activities	Prevent contamination of groundwater resources/ aquifers	▪ Store hydrocarbons, fuel and lubricant in tight storage containers with bund walls. ▪ Training of relevant staff in safe storage and handling practices, and rapid spill response and clean up techniques.	Nigerian Water Quality Standard for Drinking Water. World Health Organization	Groundwater sampling and laboratory analysis. The groundwater monitoring parameters	Post decommissioning	Decommissioning Contractor	EHS Coordinator PASL Regulatory authorities	3000

Potential Impact	Source of Impacts	Desired Outcome	Description of Mitigation Measures	Performance Indicator	Monitoring Methods	Timing/ Frequency	Responsibility for EMP Implementation	Responsibility for Monitoring	Estimated Cost (US Dollars)
			▪ An approved decommissioning plan by the regulatory bodies shall be implemented prior to demolition activities. ▪ Implement a site-specific SHE management system integrating a strong emphasis on the protection of water resources.	(WHO) limits for potable water.	will include heavy metals and hydrocarbons among others.			(FMEnv, KATSEPA)	
Employment and economy issues during decommissioning include: loss of direct and contracted employment; loss of indirect business opportunities; decline in economic productivity and household income	Decommissioning	Minimize impacts on Employment issues associated with loss of Employment following decommissioning of project	▪ Facilitate Small Medium Enterprise and support sustainable development ▪ Identify and facilitate training opportunities for local workforce ▪ Provide training to local and regional workforce on career development and management of personal finances ▪ Provide training to local and regional contractors on effective business management.	Applicable requirements of IFC Performance Standard 4 on Community Health, Safety and Security	Employment and Procurement Policies	Prior to decommissioning	PASL		7500
As with the construction and operation phases the potential workplace health and safety impact will include: accidents, safety related to dismantling of equipment and cables, explosion, fire, noise nuisance, traffic related accident etc.	Decommissioning activities	Minimize any potential accidents that may occur during decommissioning particularly with demolition and removal activities	▪ Conduct tool box talks on a daily basis ▪ Routine safety checks in line with standard safety procedures. ▪ Provision and use of required personal protective equipment. ▪ Provision of fire fighting suppression system and regular communication with local fire services.	Nigerian H&S law (Nigerian Institute of Safety Professionals, Factories Act 1990), the adherence to Occupational Health and Safety Guideline, and incidents record	Health & Safety Management Policy	Throughout decommissioning	PASL HSE	Regulatory authorities (FMEnv, KATSEPA)	1000

Potential Impact	Source of Impacts	Desired Outcome	Description of Mitigation Measures	Performance Indicator	Monitoring Methods	Timing/ Frequency	Responsibility for EMP Implementation	Responsibility for Monitoring	Estimated Cost (US Dollars)
			▪ Warning signs in place, including those for electrical equipment safety warning.						
Potential public health and safety impact during decommissioning include traffic accident, fire outbreak, explosion	Decommissioning Activities	Minimize the likelihood of incidents or accidents to the general public.	▪ Members of the public shall only be allowed to decommissioning site on the approval site HSE office and will be enforced to use appropriate personal protective equipment. ▪ An approved decommissioning plan by the regulatory bodies shall be implemented prior to demolition activities.	Nigerian H&S law (Nigerian Institute of Safety Professionals, Factories Act 1990), the adherence to Public Health Guideline, and incidents record Applicable requirements of IFC Performance Standard 4 on Community Health, Safety and Security	Health & Safety Management Policy	Throughout decommissioning	Decommissioning Contractor	EHS Coordinator PASL Regulatory authorities (FMEnv, KATSEPA)	500

CHAPTER EIGHT:

DECOMMISSIONING AND ABANDONMENT

CHAPTER EIGHT

DECOMMISSIONING AND ABANDONMENT PLAN

8.1 Introduction

This chapter presents an overview of the decommissioning plan for the proposed Project. Decommissioning refers to the process of removing all the operating assets of a project after completion of its life cycle from the project site. This process includes the dismantling and removal of equipment and plant structures; the removal of surface installations; and re-vegetation to bring back the Project site to its original status as much as possible.

The proposed Project is being developed for a projected 25-year operational life time. However, with regular maintenance, it is anticipated that the useful life of the Project could extend well beyond the design life span.

Consistent with industry standards, decommissioning activities will commence when the power plant facilities are at the end of their life span and are no longer required for operations. In the event of decommissioning, PASL shall ensure that the decommissioned site is left in a safe and environmentally acceptable condition. A standard decommissioning, abandonment and closure programme shall be invoked. The task will include:

- Restoration of the Project environment to baseline conditions (as much as practicable) in line with legislative and regulatory requirements;
- Assessing the residual impact, if any, the Project has on the environment;
- Monitoring the abandoned Project environment as necessary
- Identification of appropriate recycling routes for panels and major electrical items, and/or where safe and appropriate re-use.

8.2 Decommissioning Programme

When PASL decides to decommission and shut down the power plant permanently, a comprehensive abandonment, decommissioning and closure plan shall be developed taking into account the most cost-effective and best practicable methods, legal requirements and industry practices at that time.

The decommissioning plan will be submitted to the Federal Ministry of Environment (FMEnv) and other relevant regulatory agencies for approval, at least two (2) years prior to scheduled abandonment and decommissioning.

The plan will specify all activities that will be undertaken during the decommissioning and abandonment phase of the Project. In addition, the decommissioning plan will contain processes that lead to a complete restoration of the Project environment suitable for its planned re-use as well as the schedule of activities. PASL will only begin decommissioning activities after due approval of decommissioning plan by the regulatory agencies.

Typically, the following steps shall be undertaken for decommissioning:

- To ensure that due consideration is given to all options a detailed evaluation of facilities decommissioning options will be carried out. The evaluation will consider environmental issues in conjunction with technical, safety and cost implications to establish the best practicable environment friendly options for the Project decommissioning.
- A risk assessment will be conducted to ensure that nothing, which could be constituted as a hazard for other users of the site or for the environment in general, will be left at the site. The site will be left in a safe and environmentally acceptable condition.
- The appropriate regulatory authorities (and concerned stakeholders including the host communities) shall be consulted and notified of the Project status.
- Hazard identification and analyses shall be conducted to determine special safety concerns to be addressed.
- An appropriate Health, Safety and Environment (HSE) plan shall be implemented to ensure the decommissioning activities for the power plant are carried out in an environmentally sound manner and in conformity with existing environmental safety laws and regulations guiding such operations.
- Third party notifications shall be carried out before any demolition and shall be conducted in a phased sequence.
- An effective waste management plan shall be developed for the decommissioning activities. The decommissioning options for redundant structures and equipment will include: the complete dismantling of structures and equipment and the return of all components to the equipment manufacturer for recycling. Appropriate recycling opportunities will be identified; this may require transporting the components out of the country to appropriate facilities.

8.3 Abandonment

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

- Identification of the components of the power plant that will be abandoned and/or removed;
- The proposed methods for abandonment or re-use of the plant equipment/material applicable;
- Processes put in place to mitigate potential environmental impacts associated with the abandonment process; and
- Appropriate site rehabilitation programs (including re-vegetation of the site with native plant species) to return the Project environment to its original status (as much as possible).

8.4 Site Remedial Measures

- Dismantling of all equipment and associated facilities;
- Removal of all concrete structures;
- Remediation of any impacted soil;
- Backfilling with clean soil/sand where required; and
- Re-vegetation of the site with native plant species.

The decommissioning, abandonment and/or closure programme shall generally be managed by a team of competent personnel, and witnessed by relevant regulatory officials. A close out report shall be prepared and archived for future reference.

CHAPTER NINE:

CONCLUSIONS

CHAPTER NINE

CONCLUSIONS

9.1 Conclusions

PASL is planning to establish a Photovoltaic solar energy facility and associated infrastructure in Kankia, Kankia LGA of Katsina State. The proposed total capacity of the solar facility is 80 MWp, which is planned to be developed in two (2) phases.

The EIA of the proposed Project has been undertaken in accordance with the EIA Act No 86 of 1992, the EIA Act CAP E12 Law of Federal Republic of Nigeria, 2004 and the requirements of the Development Finance Institutions (DFIs) such as the International Finance Corporation (IFC).

The study involved a number of key steps including: desktop review, scoping, stakeholder consultation, field sampling and analysis, potential impact identification and evaluation, development of impact management plan, and reporting.

The essence of the EIA process was aimed at ensuring informed decision-making and environmental accountability, and to assist in achieving environmentally sound operation throughout the life cycle of the proposed Project.

Consistent with the regulatory standards, the assessment of the environmental status and the socio-economic aspects of the proposed Project's area of influence was carefully carried out using universally accepted methodology. Evaluation of associated and potential impacts of the Project identified both positive and negative interactions with the receiving biophysical and socio-economic environment.

The positive implications of establishing the solar power plant project on the identified site within the Kankia LGA, Katsina State include:

- The potential to harness and utilize solar energy resources.
- The National electricity grid in Katsina State would benefit from the additional 80 MWp power (electricity) to be generated.
- Promotion of clean, renewable energy.
- Creation of local employment, business opportunities and skills development in the project area.

There are no human uses of the Project site that will be permanently displaced and no relocation of community residents is required. There are no culturally significant sites or heritage resources within the project area that would be negatively impacted. No environmental fatal flaws were identified with the establishment of the proposed power plant.

The most significant threat to avifauna communities would be from collisions with the overhead power line. The loss of habitat, disturbance, or any interaction with the facility is not anticipated to have a significant negative impact on bird communities in the area. The anticipated visual impact is not, considered to be a fatal flaw from a visual perspective, considering the low incidence of visual receptors in the region and the contained area of potential visual exposure.

The potential negative effects identified were mostly of minor to moderate significance. The significance levels of the majority of identified negative impacts can generally be reduced by implementing the recommended mitigation measures including good industry practices.

Based on the nature and extent of the proposed Project, the local level of disturbance predicted as a result of the construction and operation of the solar power plant and associated infrastructure, the findings of the EIA, and the understanding of the significance level of the potential environmental impacts, it is believed that the potential negative impacts associated with the proposed Project can be mitigated to an acceptable level. Also, an Environmental Management Plan (EMP) has been established to assess the efficiency and the effectiveness of the mitigation measures and long-term monitoring of the Project.

PASL will ensure the proposed Project is developed and operated in an environmentally sustainable manner, in compliance with national and IFC environmental and social standards and by properly managing the processes/activities that may bring about disturbances to the environment through the implementation of the recommended mitigation measures.

REFERENCES

REFERENCES

1. Alloway B.J (1990). Heavy metals in Soil. Blackies and John Wiley Sons Inc. Glasgow, London, pp. 29-39.
1. Azura – Edo, (2013). *Environmental Impact Assessment for the construction of Azura-Edo Independent power project.*
2. Canter, L.W. (1977). *Environmental Impact Assessment,* McGraw-Hill Book Company, New York, 20-29.
3. Central Intelligence Agency CIA (2011). *World Fact book.*
4. Dee, N., J. Baker, N. Drobny, K. Duke, and D. Fahringer. (1972). *Environmental evaluation system for water resource planning (to Bureau of Reclamation, U.S. Department of Interior)*. Battelle Columbus Laboratory, Columbus, Ohio, January, 188 pages.
5. Environmental Accord (2014). *Baseline wet season survey*.
6. Final EIA report of proposed 20MW Photovoltaic (Solar) Power Project in Kankia, Katsina State.
7. Federal Environmental Protection Agency (1991). Guidelines and standards for environmental regulation in Nigeria
8. Federal Environmental Protection Agency (1994). Environmental impact assessment procedural Guideline
9. Federal Ministry of Environment (1999): National Guidelines and Standards for Water Quality in Nigeria.
10. Geophysical Service Incorporated (2003). St Lawrence Survey. Environmental Assessment Report. Prepared by Canning & Pitt Associates Inc. and assisted by Robert Hamelin& Associates.
11. International Union for Conservation of Nature (1994): *IUCN Red List Categories*. Prepaed by the IUCN Species Survival Commission. IUCN, Gland, Switzerland
12. International Union for Conservation of Nature Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 24 December 2014
13. Janss, G. F. E. 2000. Avian mortality from power lines: a morphologic approach of a species-specific mortality. Biol. Conserv. 95:353–359.
14. Leopold, L. B., F. E. Clarke, B. B. Hanshaw, and J. E. Balsley. 1971. A procedure for evaluating environmental impact. U.S. Geological Survey Circular 645, Washington, D.C.
15. McHarg, I. 1968. A comprehensive highway route selection method. Highway research record, 246:1–12, 1968.
16. Nigeria Bureau of Statistics (NBS) 2010. Annual Abstract Of Statistics,
17. Nigeria Renewable Energy Master plan, 2006. Available at www. energy.gov.ng (Retrieved: 8th December, 2014
18. Olajide O. (2003). Steps towards sustainable Natural Forest Management for non-timber forest products in Nigeria Proceedings of the 29th Annual Conference of the Forestry Association of Nigeria (eds. S.O Akindele, S.O and Popoola, L) 6th-11th2003, Cross River

state, Nigeria. pp. 303-308.

19. Sambo, A. S., 2008. Paper presented at the "National Workshop on the Participation of State Governments in the Power Sector: Matching Supply with Demand", 29 July 2008, Abuja.
20. United Nations Environment Programme (UNEP) (1996). General guideline for an environmental monitoring programme.
21. United Nations Environment Programme (UNEP) (2002). EIA Training Resource Manual. Mitigation and Impact Management (2nd edition).
22. Watson, Jeff (2001). How to Determine a Sample Size: Tip sheet #60, University Park, PA: Penn State Cooperative Extension.
23. World Bank (2010). *The World Bank Annual Report 2010*.
24. World Bank Group (2007): Environmental, Health, and Safety (EHS)- General EHS Guidelines
25. World Health Organization, (2010). *World Health Statistics.* p130
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