FINAL REPORT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED IMPROVED BREEDING, BEEF, MILK PRODUCTION AND PASTURE DEVELOPMENT FOR ENHANCED PRODUCTIVITY OF INDIGENOUS CATTLE IN SOKOTO STATE

BY

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SUBMITTED TO

FEDERAL MINISTRY OF ENVIRONMENT

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LIST OF ACRONYMS AND ABBREVIATIONS

AIDS	Acquired Immuno-Deficiency Syndrome
ALARP	As Low as Reasonably Practicable
ASAP	As Soon as Possible
BOD	Biological Oxygen Demand
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CHSSP	Community Health, Safety and Security Plan
CLO	Community Liaison Officer
COVID 19	Corona Virus Disease 2019
CSO	Civil Society Organization
dB	Decibel
DO	Dissolved Oxygen
EAu	Environmental Audit
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
ERP	Emergency Response Plan
ESDD	Environmental and Social Due Diligence
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FGN	Federal Government of Nigeria
FRN	Federal Republic of Nigeria

GDP	Gross Domestic Product
H&S	Health and Safety
HIV	Human Immuno-Deficiency Virus
HSE	Health Safety and Environment
IEE	Initial Environmental Examination
IFC	International Financing Corporation
LFN	Laws of the Federation of Nigeria
LGA	Local Government Area
MDAs	Ministries, Departments & Agencies
MgO	Magnesium Oxide
MOU	Memorandum of Understanding
NGO	Non-governmental Organization
NH3	Ammonia
NH4+	Ammonium ion
NIMET	Nigerian Meteorological Agency
O_3	Ozone
OSH	Occupational Safety and Health
OSHMS	Occupational Safety and Health Management System
PAP	Project Affected Person
PPE	Personal Protective Equipment
S	Sulphur
S&H	Safety and Health
SMART	Specific, Measurable, Achievable, Relevant and Time-Bound
SME	State Ministry of Environment
SOSG	Sokoto State Government

STIs	Sexually Transmitted Infections
SWP	Safe Work Procedures
ToR	Terms of Reference
Zn	Zinc

LIST OF ORGANIZATIONS

FEPA	Federal Environmental Protection Agency
FMEnv	Federal Ministry of Environment
NESREA	National Environmental Standards and Regulations Enforcement Agency
NAPRI	National Animal Production Research Institute
SOSMEnv	Sokoto State Ministry of Environment
SOSMAgric	Sokoto State Ministry of Agriculture
SEPA	Sokoto Environmental Protection Agency
OSHA	Occupation Safety and Health Administration
UNEP	United Nations Environmental Programme
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
SOSG	Sokoto State Government

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Finally, we would like to express our deep appreciation to the Federal Ministry of Environment and the Sokoto State Ministry of Environment for their regulatory support and guidance throughout the study.

We look forward to the implementation of this project with the expectation that it will significantly improve the livelihoods of millions of people in the State.

EXECUTIVE SUMMARY

Background

Sokoto State has been rated the largest state in terms of livestock resources in Nigeria (Personal communication). Its geographical location also makes it a host to livestock trooping from Niger Republic and Mali among other neighboring countries. Sokoto State also has important livestock markets such as Achida, Illella, Gada, Kara Market, Bodinga, Dandin-mahe, Teke, Tangaza among others.

Based on the above facts a technical feasibility on the existing Sokoto Cattle breeding Programme (Phase I) was commissioned and has recorded successes, and this has invariably underscored the need to upscale it from initial 13 commercial livestock farm clusters to include most of rural pastoralists.

Components of this project includes activities to support and upgrade the development of productivity enhancing infrastructures for animal forage to discourage the pastoralists from moving and roaming about in search for greener pasture.

In addition, the state government had earmarked 10 ha of land at Dogon Daji for Pasture Development to support the Sokoto Cattle Breeding Programme. The production of pasture for livestock feed which was identified as one of the major drivers for enhanced beef and milk production and which was lacking in the previous programme.

It is also interesting to highlight that Sokoto State has a modern abattoir and dairy plant which would be upgraded and utilized, as components of the proposed project, as infrastructures for achieving an enhanced meat and milk industry in the State.

Apart from the existing veterinary clinics in all the 23-local governments, effort has been at advanced stage in providing a state-of-the-art specialist veterinary hospital, fully equipped with all the necessary materials and laboratories to ensure healthy livestock in the state.

A major constraint being faced by the Sokoto State Government in the execution of the Improved Cattle Breeding Project and its associated components is dearth of financial capital. Consequently, the State Government approached the African Development Bank (AfDB) to give it a loan to finance the project along with the above identified components.

However, in Nigeria and many other environmentally conscious countries, for development projects of this nature and magnitude the conduct of an Environmental and Social Impact Assessment (ESIA) is a major and mandatory requirement. Similarly, the African Development Bank has established an Integrated Safeguard System (ISS) for a comprehensive project review and ensuring across the board perspectives of environmental and social linkages. The ISS provides guidelines on the conduct of Environmental and Social Impact Assessments (ESIAs) through its Environmental and Social Assessment Procedures (ESAPs).

Therefore, to comply with the requirements of AfDB and the Nigerian Government, an ESIA must be conducted for the proposed project. In this regard the Sokoto State Government commissioned ENARMAC Nigeria Limited to carry out the ESIA for the above-described project and its component, which is the subject of this report.

The ESIA Study

In Nigeria, ESIA is mandatory before implementation of major projects. ESIA is conducted according to the provisions and regulations stipulated in the Environmental Impact Assessment (EIA) ACT 86, CAP E12, of the Laws of Federation of Nigeria, 2004.

The objectives of this ESIA are to:

- ✓ Establish baseline information on both natural and built environment including the socio-economic activities associated with the project area;
- ✓ Assess and possibly quantify positive and negative impacts of the proposed project;
- ✓ Design effective measures to mitigate the negative impacts and enhance positive ones;
- ✓ Outline management clauses and enforcement mechanisms to be included in the contract for the implementation of the mitigation measures; and
- ✓ Prepare a monitoring and management plan indicating parameters to be monitored, responsibilities and outputs.

Methodology

The ESIA Study covered an initial review of relevant literature followed by field work in the form of scoping and gathering of environmental baseline data. During scoping, consultations were held with various stakeholders whose concerns were incorporated into the ESIA Terms of

Reference. On the basis of information obtained from the above activities, potential positive and negative impacts of the project were identified.

Policy and Legal Frameworks

The ESIA was carried out within the frameworks of local and international laws as well as environmental guidelines and regulations which were detailed in chapter two of this document. In the policy framework, guidelines and strategies are defined for securing for all Nigerians a quality of environment adequate for their health and well-being; conserving and using the natural resources for the benefit of present and future generations; raising public awareness and promoting understanding of the essential linkages between the environment, resources and development; and cooperation with other countries, international organizations and agencies to achieve optimal use of trans-boundary spaces in order to protect environmental resources.

Need For the Project

Sokoto State comprises of 23 local governments and has been rated the first largest state in terms of livestock resources in the country (Personal communication). Its geographical location also makes it a host to livestock trooping from Niger Republic and Mali among other neighboring countries. Sokoto State has a total of 2.66million hectares of land area of which 2.43 million hectares is arable made up of

450,000 hectares irrigable and 1.98 million hectares for upland farming, of which 565 are being cultivated. The state has important livestock markets such as Achida, Illella, Gada, Kara Market, Bodinga, Dandin-mahe, Teke, Tangaza among others. As highlighted earlier, the system of rearing livestock in Nigeria and Sokoto in particular is still largely dependent on the traditional pastoralism which accounts for the majority of beef and meet production with about 90% of the livestock being raised in the hands of transhumance and nomadic pastoralists. Unfortunately, this system can no longer sustain our needs and demand for animal derived protein and only offer few economic advantages to livestock owner. However, our livestock resources could harness to improve the standard of living of populace, generate revenue, mitigate food crisis and advance the state in all aspects of economic and human endeavors. Thus, with over 5million people and 2.66 million hectares of land of which 2.43 million hectares is arable, there is huge potentials for making the state a hub to livestock production in the country.

Benefits of the project

Developing new breed of livestock should go hand in hand with provision of nutritional feed to ensure profitable produce and healthy population growth. Also, the project is aligned with the Nigerian Government's development priorities, including the Economic Recovery & Growth Plan (ERGP) 2017-2020, which focuses on tackling constraints to growth, leveraging the livestock/agric sectors and promoting social inclusion; including investment in infrastructure, improvement of the business environment, job creation and youth employment. Above all, the present insecurity particularly in the northwestern Nigeria is attributed to the less attention from government to pastoralist that relies on traditional way of keeping animals. These projects would

therefore provide improved skills in livestock improvement for better socioeconomic well-being of the citizenry.

Envisaged Sustainability

The sustainability of the project is multifaceted. It is based on several components which include socio-economic and technical sustainable frameworks, among others. Social sustainability of the project is hinged on the policy of ensuring cordial relationship with stakeholders and communities by the contractor and the proponent through consultation throughout the various phases of the project. It has also been planned that local people will be given priority in terms of employment in the construction and operational phases of the project.

Environmental sustainability of the project is predicated on the fact that the local pastoralist will be carried along through training and support to ensure that the present traditional livestock keeping is done away with for the much needed paradigm shift towards total socioeconomic development of the citizenry. Modern livestock keeping through skill acquisition would come a long way in supporting the present and future generations of the nomadic pastoralists.

Project Location

a. The Sokoto milk production/dairy plant, Sokoto (12°28.065'N, 004°49.196'E) is also located in the heart of Sokoto town surrounded by residential area.

b. The proposed Sokoto Specialist Vet Hospital, Sokoto (Longitude 12°58.603'N, Longitude: 005.16.288'E) is also located along Gusau Road in Kwannawa residential area outskirts of Sokoto town.

c. The proposed modern Pasture farm Estate (Longitude 12°28.309'N, Longitude: 004.49.014'E), is located at the rural setting of Dogon Daji in Tambuwal Local Government of Sokoto State. This project occupies a 10 hectare land adjacent to the Dogon Daji savanna forest that spans over 1000 hectares.

d. The Sokoto Meat Production and Modern Abattoir (12.58.633'N Longitude: 005.16.244'E), is a project to be located at Sokoto metropolitan area. The area is densely populated and it would therefore on a spot market whenever meat is processed for local and external consumption.

ENVIRONMENTAL BASELINE DESCRIPTION

Baseline Data Acquisition Method:

Field data gathering and sampling was carried out for dry season only and this took place from 20th – 25th September 2021. Through a review of relevant literature on the project environment, field studies were done which include; sampling and in-situ measurements, as well as laboratory analysis of the collected samples. Stakeholders were consulted and via questionnaires, Focused Group Discussions and personal interviews, public consultations were held with different members of the public on issues relating to the potential ecological and socio-economic impacts of the proposed project.

Ecological studies

On the spot assessment of ecological parameters were undertaken in this ESIA. Floral compositions were observed and their frequency recorded. Plant species were recorded and identified. Avifauna common in all the project areas were observed and identified with the assistance of locals. Common reptiles and mammals in all areas were also enquired upon and recorded.

In situ Measurements

As recommended by FEPA (1991), in situ measurements were carried out on some physical parameters of the project environment. These parameters included:

Air quality;

Noise;

- ✓ Suspended particulate matter (SPM), COx, SOx, NOx, NH3, H2S, HC; and
- ✓ Water quality (pH, temperature, dissolved oxygen concentration, total dissolved solids, conductivity, turbidity and salinity).

Sampling involved the following components:

- ✓ Vegetation
- ✓ Flora and fauna/wildlife

- ✓ Soil
- ✓ Surface and ground water

Socio-Economic Studies

The primary data for the study was obtained from structured questionnaires; community surveys and Focus Group Discussions (FGDs).The questionnaire was designed to generate information on demographic structure and socio-cultural characteristics of the inhabitants; local economy and available infrastructure among others. The objective of the group discussions was to identify community's perceptions on the proposed project, problems associated with it, and how such problems may be mitigated. Information from such discussions was used to confirm/cross check the veracity of some of the answers provided in the questionnaires.

Soil Physico-chemical Characteristics

Soil in the project area composed of sand, silt and clay, respectively, in order of abundance. Other physico-chemical properties of the soil in the project area such as conductivity, chloride, salinity, nitrate, phosphate, sulphate, exchangeable cations, magnesium, sodium, potassium, calcium, etc., were analyzed and found to be within stipulated limits of FMEnv.

Heavy Metals in Soil

Soil from the study area was analyzed for heavy metals. Vanadium, Arsenic, Mercury and Barium were not detected. However, concentrations of Copper (Cu), Zinc (Zn), Iron (Fe), Cadmium (Cd), Lead (Pb), Nickel (Ni) and Manganese (Mn) were all found to be below the stipulated FMEnv's limits.

Oil and Grease were not detected from soil samples collected. However, Total Organic Content (TOC), for top and bottom soil had a mean value of 2.38 (mg/kg).

Physico-Chemical Properties of Water in the Project Area

Physico-chemical parameters for surface and ground water in the project area such as pH, Conductivity, Total Dissolved Solids (TDS), Dissolved oxygen (DO), Salinity, Total Suspended Solids (TSS), Turbidity, Phosphate, Nitrate and Chloride concentrations were found to be below the stipulated regulatory limits of FMEnv.

Similarly, heavy metals that included Copper (CU), Zinc (Zn), Iron (Fe) and Lead (Pb) were tested for in the ground and surface water samples collected from the project area. The test results showed that the concentrations of these heavy metals were within regulatory limits of

FMEnv. Cadmium (Cd), Manganese, Vanadium, Arsenic, Mercury, Nickel and Barium were also tested for and none of them was detected.

Air Quality Studies

Air quality characteristics were monitored in twenty (10) points along the proposed project's locations. Overall, results from air quality monitoring in the project area showed that the concentrations of gaseous pollutants were within the limits set by the regulatory authority (FMEnv).

Noise Level Studies

Noise level measurements were carried out directly at selected points in the project location by using a very sensitive noise level meter. The main sources of noise were vehicles along major roads and domestic activities going on in the areas close to the roads. Results of noise characteristics determination have shown that noise along the project area is within tolerable limits set by FMEnv.

Climate Change risks

The key Climate Change risks identified in the project area include vegetation cover removal and likelihood of water pollution due to the proposed used of chemical fertilizer, pesticide etc during pasture development.

Stakeholders' Engagement Plan

Stakeholders are those who are to be affected to varying degrees by the impacts of a project or installation. There are two classes of stake holders- Primary and Secondary. The primary impact stakeholders are the communities on which the project is located, while secondary impact stakeholders are the State Government, Local government Area, who responsible for the welfare of the affected communities, the naturalists, conservationists and the environmental NGO groups all over the country.

The objective of consultation:

- To identify and mitigate impacts before the project gets underway;
- To avoid conflicts by addressing issues promptly;
- To ensure that any fears or apprehension about the nature, scale and impact of the project have been fully addressed;

- To avoid misunderstanding about the development
- Inform Stakeholders on the proposed infrastructures and activities and seek their informed opinion about the socio-environmental risks and opportunities potentially associated with the project as well as take the measures and actions in order to manage the anticipated impacts;
- Generate a social and institutional dialogue in order to assess and strengthen the project's social acceptability;
- Identify key stakeholders that are affected, and/or are able to influence the Project and its activities;
- Identify the most effective methods and structures through which to disseminate project information, and to ensure regular, accessible, transparent and appropriate consultation;
- Establish formal grievance/resolution mechanisms;

In this regard, communities in the project area have been interviewed to ascertain the level of socio-economic impact the project will have on them when completed. Semi-structured questionnaires were administered to various groups in the communities after due consultations with the community heads. Consultation would continue throughout the project cycle in line with the above outlined objectives.

Stakeholders Engagement Strategy

The strategy for the engagement of stakeholders depends on the type of stakeholder involved. For Secondary stakeholder such as state government, local government, Federal Government Agencies and NGO and Trade Union consultation as done through written correspondence and meetings was used as a means of engagement while Primary Stakeholders such as the community leaders, the communities, vulnerable groups and others, questionnaire and oral interview was used. This was done through direct and indirect visitations, as well focus group discussions.

Grievance Redress Mechanism

Grievance Redress Mechanism will be put in place for the successful implementation of the proposed project. This mechanism describes the step-by-step process for registering and

addressing grievances and provides specific details regarding a cost-free process for registering complaints, response time, and communication modes.

Impacts Assessment Methodology

It is essential that an environmental assessment is carried out to identify significant impacts early in the project cycle so that environmental recommendations can be built into the design.

The objectives of the impact assessment process were to:

- ✓ Identify potential negative and positive environmental and social impacts of the proposed project activities;
- ✓ Empirically predict the likelihood and magnitude of such impacts and evaluate the significance of changes likely to result from them; and
- ✓ Design effective mitigation (for the negative impacts) and enhancement measures (for positive impacts) to be implemented through an Environmental and Social Management Plan (ESMP).

The first stage in the identification of impacts, as mentioned earlier, is to establish the scope of the investigations needed for each of the environmental components. This was carried out, in this study, using a combination of desk study, consultation with stakeholders and field survey to characterize the ambient environment. Then, the potential impacts were assessed and mitigation measures identified. The significance of the environmental impacts of the project was also established.

Methods and Techniques Used in Assessing Environmental and Social Impacts

Detailed analysis of methodology and techniques used in identifying the potential impacts of the proposed transmission line project are presented in the report. The importance of potential impacts was assessed on the basis of the nature, extent, intensity and duration of the impact, as well as on the sensitivity of the concerned environmental and social components and perceptions of the public. Irreversible or unavoidable impacts were clearly identified. Cumulative effects were also addressed considering other initiatives, i.e. existing, planned, and/or reasonably anticipated in the future.

Associated and Potential Impacts

The following impacts were identified from the analysis carried out using appropriate methodologies.

Significant Positive Impacts

Significant positive impacts identified in the construction phase include provision of skill acquisition training and local employment and procurement opportunities to the host communities as well as boost in local trading activities. In the operational phase of the project, infrastructural development that would encourage establishment of commercial and industrial businesses and bring about a reduction in greenhouse gas emission from the development of pasture species is a significant positive impact as well as improved productive/healthy livestock breeds with high returns in milk, beef and other produce. Achievement of these would extend business beyond Sokoto State and Nigeria at large but, a chance to reach to the international markets for economic development.

Significant Negative Impacts

Negative impacts include loss of farmlands by farmers using the acquired lands for the project. Other identified but less significant impacts in the construction phase include occupational accidents which may include falls from height during construction/equipment installation activities as well as disruption of traffic as a result of construction activities and transportation of equipment and the potential for spread of communicable diseases such as HIV/AIDs and other STDs.

Mitigation and Enhancement Measures

As mitigation measures against HIV/AIDs and operational accidents in the construction phase, employees and communities would be sensitized on HIV/AIDs protection and prevention measures as well as on prevention measures against occupational accidents and appropriate use of PPEs. Enhancement measures for positive impacts in construction phase of the project will include giving project host communities' procurement opportunities whenever possible as well as employing them as project employees and developing their capacity through on- the-job training during project execution.

Environmental and Social Management and Monitoring Plan

A robust Environmental and Social Management and Monitoring Plan has been designed for this project giving details of management measures including actions to be taken, stakeholder roles

and responsibilities, time frames and monitoring schedule for ensuring that all potential impacts are effectively managed.

Objectives of the ESMP

The Environmental and Social Management and Monitoring Plan for this project aims at ensuring the following:

- ✓ That environmental, social and health & safety factors are carefully managed throughout the project cycle.
- ✓ That the project complies with regulatory stipulations and guidelines;
- ✓ That there is sufficient allocation of resources on the project budget so that the scale of ESMP-related activities is consistent with the significance of project impacts;
- ✓ That environmental performance is verified through information on impacts as they occur;
- ✓ That project implementation responds to unforeseen events and to changes not considered in this ESIA;
- ✓ That there is provision of feedback for continuous improvement in environmental performance;
- ✓ That institutional arrangements required to implement the environmental impact mitigation and enhancement measures are specified and include a monitoring program, for selected environmental parameters, to assess the success of the mitigation/enhancement measures, as well as their timely execution; and
- ✓ That an implementation schedule for the mitigation and enhancement measures is provided.

Scope of the ESMP

The scope of this ESMP includes giving guidelines to all parties involved in the implementation of the proposed project in fulfillment of its environmental and social requirements. The ESMP has the following long-term objectives:

- ✓ Ensuring that environmental management conditions and requirements are implemented during the construction and post-construction period;
- ✓ Ensuring that the interests of the general public and other stakeholders are considered throughout the construction and operational phases of the project; and

- ✓ Ensuring that maximum socio-economic benefits accrue to the project area and the entire country.

Conclusions

The Environmental and Social Impact Assessment for the proposed project was carried out in compliance with existing national and international guidelines and regulations. Relevant stakeholders were duly consulted during the study to ensure the success of the implementation of the environmental and socio-economic management frameworks for the project.

The study has investigated the baseline conditions of the affected area, identified the potential environmental impacts of the project and proffered appropriate mitigation measures to be carried out under the Environmental and Social Management Plan designed for the project. The associated and potential impacts of the proposed project were identified and significantly include, in the construction phase, loss of vegetation cover land and other means of livelihood (farming activities in particular).

Other identified but less significant impacts in the construction phase include occupational accidents as well as disruption of traffic as a result of construction activities and transportation of equipment and the potential for spread of communicable diseases such as HIV/AIDs and other STDs.

On the other hand, the proposed project is expected to, in the construction phase, significantly boost local trading activities as well as provide employment and procurement opportunities for the local community.

In its operational phase, the project is expected to positively mitigate Climate Change because of its high potential for reducing Carbon dioxide (CO_2) as a result of carbon sequestration of pasture species. The project also has, in the operational phase, a very high potential for enhancing socio-economic status of the communities in the project area as well as the regional and national economies. A potential negative impact identified in the operational phase of the project is the tendency to over stretch existing social infrastructure as a result of influx of more people and new businesses attracted by new opportunities.

In conclusion, the proposed project is environmentally and socially justified and acceptable to the entire project stakeholders, as long as the Environmental and Social Management Plan is strictly implemented. The project is therefore recommended for an integrated implementation with the Environmental and Social Management Plan.

Recommendations

To ensure the success of the environmental and social management of the proposed cattle breeding improvement and the other components which are the subjects of this ESIA, the following are recommended:

- ✓ Recommendations presented in the ESMP should be strictly implemented to address the identified potential environmental and socio-economic impacts of the project of the project;
- ✓ Stakeholders and the general public should be fully involved in the constructional and operational phases of the project to ensure the success of the project;
- ✓ Since the contractor(s) will be expected to strictly implement the ESMP developed in this report, there is therefore a need to ensure strict supervision and continuous monitoring by FMEnv, Sokoto State Ministries of Agriculture, Environment and Rural Development as well as the Environmental Consultant.

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND

Sokoto State has been rated the largest state in terms of livestock resources in Nigeria. Its geographical location also makes it a host to livestock trooping from Niger Republic and Mali among other neighboring countries. Sokoto State also has important livestock markets such as Achida, Illella, Gada, Kara Market, Bodinga, Dandin-mahe, Teke, Tangaza among others.

On the other hand, the system of rearing livestock in Nigeria and Sokoto is still largely dependent on the traditional pastoralism which accounts for most of the beef and meet production with about 90% of the livestock being raised in the hands of transhumance and nomadic pastoralists. Unfortunately, this system can no longer sustain the needs and demand for animal derived protein and only offer few economic advantages to the livestock owners. However, the livestock resources could be harnessed to improve the standard of living of the populace, generate revenue, mitigate food crisis, and advance the state in all aspects of economic and human endeavors. Thus, with over 5million people and 2.66 million hectares of land of which 2.43 million hectares is arable, there is huge potentials for making the state a hub to livestock production in the country. Worthy of mention are bountiful endowments of indigenous animal species such as Sokoto Red Goat, Sokoto Gudali, White Fulani and Red Bororo known widely for quality leather, milk and premium beef. A study has shown that, Sokoto Gudali and Azawak are more profitable than any other indigenous cattle in view of their better feed conversion.

Based on the above facts a technical feasibility on the existing Sokoto Cattle breeding Programme (Phase I) was commissioned and has recorded successes, and this has invariably underscored the need to upscale it from initial 13 commercial livestock farm clusters to include most of rural pastoralists. To achieve this, the state government had secured 3,000 ha of land at Rabah and about 1000ha cleared, demarcated to produce pasture and livestock feed which was identified as one of the major drivers for enhanced beef and milk production and which was lacking in the previous programme. Similarly, pilot equipment system has been installed at this center for irrigational activities. The success thus far recorded for the pasture production at Rabah, makes it desirable to extend similar development in the two remaining Senatorial zones of Sokoto State. So far, Sokoto Gudali cattle have been crossed with exotic breed beef cattle (Sokoto Gudali vs Brangus) and likewise with the dairy one (Jersy VS White Fulani; Jersy VS Sokoto Gudali) to improve both meat and milk. It was noted that, apart from the new offerings, farmers have recorded an appreciable milk yield (from average 4ltrs to 15L) and 3 out of the 13 cluster farmers have been into commercial yoghurt production. For these, livestock farmers have registered interest in getting involved with the programme.

Naturally, developing new breed of livestock should go hand in hand with provision of nutritional feed to ensure profitable produce. Also, the project is aligned with the Nigerian Government's development priorities, including the Economic Recovery & Growth Plan (ERGP) 2017-2020, which focuses on tackling constraints to growth, leveraging the power of the private sector and promoting social inclusion, including investment in infrastructure, improvement of the business environment, job creation and youth employment.

The component of this project includes activities to support and upgrade the development productivity enhancing infrastructures for animal forage to discourage the pastoralists from moving and roaming about in search for greener pasture. To this end, Sokoto State Government has completed gazette of 9 grazing reserves (estimated to be 14,663.926 ha) out of the 19 grazing lands and beckoned major cattle routes throughout the state to ensure smooth access to livestock. The nine gazetted cattle grazing reserves will be stocked with a protein-rich and resilient grasses and legumes in addition to watering facilities, in the forms of earth dams, solar powered boreholes to improved access to feed and fodder to animals especially by encouraging the ownership of pastures and buffering or supplementing animal feeds during adversities to ensure all year-round availability of affordable feed.

In addition to the above, the state government had earmarked 10 ha of land at Dogon Daji for Pasture Development to support the Sokoto Cattle Breeding Programme. The production of pasture for livestock feed which was identified as one of the major drivers for enhanced beef and milk production and which was lacking in the previous programme.

It is also interesting to highlight that Sokoto State has a modern abattoir and dairy plant which would be upgraded and utilized, as components of the proposed project, as infrastructures for achieving an enhanced meat and milk industry in the State.

Additionally, apart from the existing veterinary clinics in all the 23-local governments, effort has been at advanced stage in providing a state-of-the-art specialist veterinary hospital, fully equipped with all the necessary materials and laboratories to ensure healthy livestock in the state.

A major constraint being faced by the Sokoto State Government in the execution of the Improved Cattle Breeding Project and its associated components is dearth of financial capital. Consequently, the State Government approached the African Development Bank (AfDB) to give it a loan to finance the project along with the above identified components.

However, in Nigeria and many other environmentally conscious countries, for development projects of this nature and magnitude the conduct of an Environmental and Social Impact Assessment (ESIA) is a major and mandatory requirement. Similarly, the African Development Bank has established an Integrated Safeguard System (ISS) for a comprehensive project review and ensuring across the board perspectives of environmental and social linkages. The ISS provides guidelines on the conduct of Environmental and Social Impact Assessments (ESIAs) through its Environmental and Social Assessment Procedures (ESAPs).

Therefore, to comply with the requirements of AfDB and the Nigerian Government, an ESIA must be conducted for the proposed project. In this regard the Sokoto State Government commissioned ENARMAC Nigeria Limited to carry out the ESIA for the above-described project and its component, which is the subject of this report.

1.2 PROJECT OBJECTIVES

The main objective of the project is to adopt modern cattle breeding and pasture development techniques using modern technologies for the rapid improvement of indigenous cattle in Sokoto State so as to achieve optimum productivity in milk, meat and livestock produce.

The specific objectives of the project however include: -

- To improve the over 3million cattle breeds in Sokoto State
- To ensure the availability of livestock feed of high nutritious value to livestock
- To use both grass and legumes species in the pasture development initiatives
- To use both local and exotic grass and legume species that are certified friendly to the environment
- Increase access to livestock nutrition by identifying, testing and delivering superior feed strategies and options especially using locally sourced raw materials,
- Ensure value addition and encourage private sector participation in livestock feed

agribusiness

- Develop /rehabilitation of the gazetted cattle grazing reserves, demarcate cattle routes and provide watering platform,
- Provide quality pasture using drought tolerant legumes and forages for all year-round pasture
- Provide feed storage facilities in the forms of silos and silage for use during extreme dry season and in the case of adversities
- Provide concentrates and mineral supplements for improved dairy and beef performances
- Provide enabling legislations and enforcement to conserve and preserve the developed pasture environment
- Reduce herder's/farmers conflict through the demarcation of all grazing areas and cattle routes

- Encourage youth and women participation in modern pasture and livestock production.
- Encourage youth and women participation in modern milk production and processing.
- To ensure the availability of livestock and livestock products as sources of proteins for reduced hunger and malnutrition
- To improve livestock health and health service delivery for optimum productivity,
- Increase access to livestock nutrition by identifying, testing and delivering superior feed strategies and options especially using locally sourced raw materials,

In pursuing the above objectives, the project shall recognize and comply with all applicable regulations, guidelines and standards of the Federal Republic of Nigeria as issued by the appropriate agencies including:

- Federal Ministry of Environment.
- Federal Ministry of Agriculture & Rural Development
- Sokoto State Ministry of Environment
- Sokoto State Ministry of Agriculture
- Sokoto State Ministry of Animal Health and Fisheries
- Sokoto State Ministry of Rural Development
- 23 Affected Local Government Areas

International Conventions/Guidelines and Agreements to which Nigeria is a signatory shall also be adhered to undertake robust consultations with all stakeholders and respect agreements and understandings reached with any party develop and implement Environmental and Social Impact Assessment (ESIA).

To ensure that this proposal is in accordance with statutory requirements, a wet-season Environmental and Social Impact Assessment (ESIA) study is planned to be conducted to fast track the implementation of the project. The result of the ESIA process will be translated into specific actions and will be used as the basis for communication to obtain relevant approvals from the FMEnv.

This Terms of Reference (ToR) document has therefore been developed to:

- Outline the general scope of the ESIA study including the overall data requirements on the proposed project and affected environment.
- Define the procedures/protocols for identification and assessment of associated and potential impacts.
- To select appropriate mitigation measures for such impacts and develop an effective Environmental and Social Management Plan (ESMP) for the project.
- Define the relevant framework of legal and administrative requirements of the project.

The ToR approved by the Federal Ministry of Environment (FMEnv) have been used as guidelines in executing the ESIA study for the proposed project.

This project shall comply with the Environmental Impact Assessment Act CAP E12, LFN2004. The EIA has been carried out in line with relevant sections of the FEPA (now FMEnv) EIA Sectoral Guidelines on infrastructure and Agriculture & Rural Development.

1.3 THE PROPONENT

Sokoto State Government is the proponent of this project. Sokoto State Ministry of Agriculture, Sokoto State Ministry of Animal Health and Fisheries as well as Sokoto State Ministry of Rural Development are the State Government Ministries charged with the delivery of this project by the Sokoto State Government.

1.4 PROJECT LOCATION

The proposed project will have footprints in all the 23 Local Government Areas of Sokoto State as mini–Artificial Insemination (AI) and Embryo Transfer (ET) centres would be established while existing veterinary clinics in the same 23 LGAs would be rehabilitated to support cattle breeders in their localities.

Model cattle ranches would be established at Rabah, Dogon Dagi and Silame covering the three senatorial zones of the state; milk collection centers and meat processing plants will be developed during the second stage within Sokoto Metropolis; and the specialist veterinary clinic will be established in Dange Shuni area of Sokoto town, in Dange Shuni Local Government Area.

The map of Figure 1.1 shows the proposed project locations.

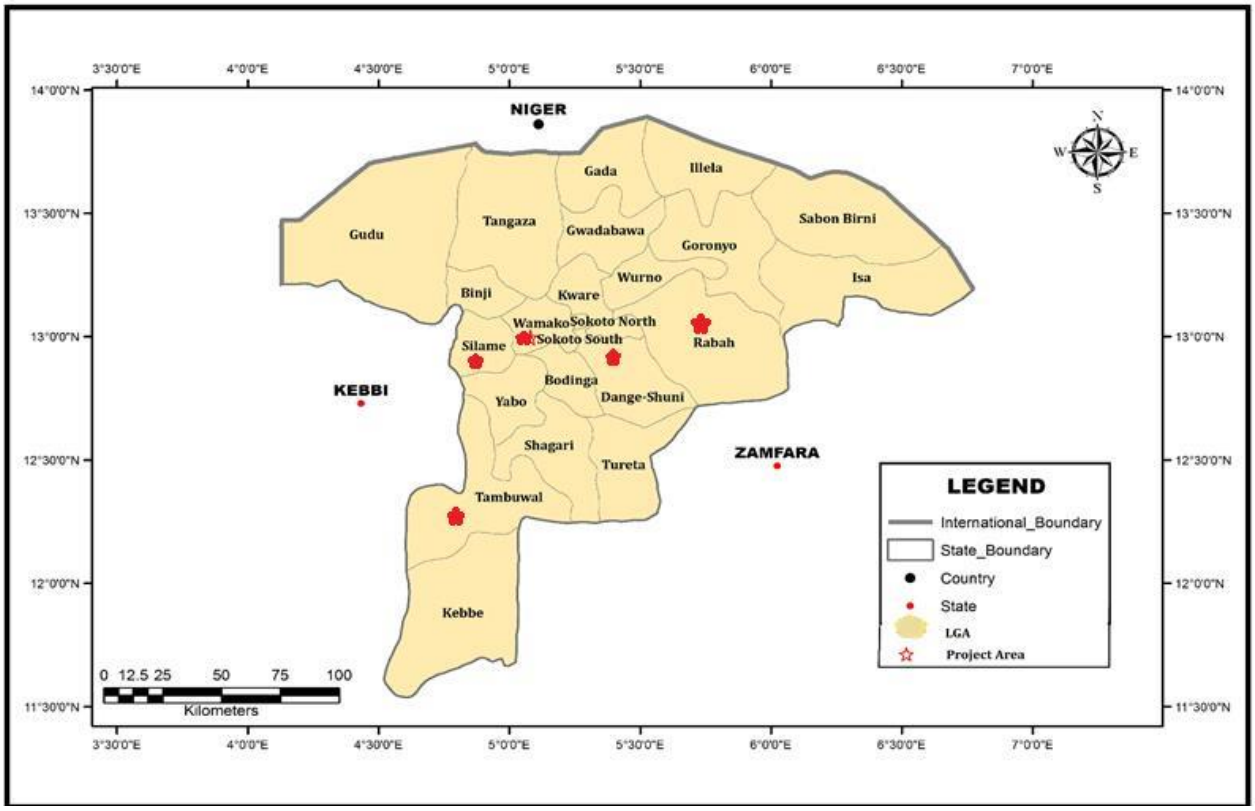


Figure 1. 1: The proposed project locations

1.5 OBJECTIVES OF THE ESIA

Environmental Impact Assessment (ESIA) is one of the environmental management tools used worldwide to ensure sustainable development and compliance with local, regional and international regulations relating to environmental protection and conservation. The objectives of this ESIA are therefore to:

- ✓ Improve the environmental aspects of the proposed project design to ensure an environmentally sustainable design;
- ✓ Ensure compliance with environmental policies, regulations and legislations;
- ✓ Minimize negative environmental impacts on the project environment;
- ✓ Safeguard valued environmental, socio-economic and cultural resources in the project area;
- ✓ Protect human health, safety and welfare in the immediate and extended project

environments;

- ✓ Mitigate the negative impacts and enhance positive impacts associated with the project;
- ✓ Provide design environmental management and monitoring plans to be implemented throughout the project life cycle; and
- ✓ Facilitate informed decision making, including formulating the environmental terms and conditions for implementing the project proposal.

1.6 METHODOLOGY

The study involved desktop studies, field research, stakeholders' consultation, impact assessment and proffering of mitigation measures and the development of an Environmental and Social Management Plan (ESMP). The approach used involved the use of a blend of multidisciplinary standard methods used in obtaining basic data for impact prediction/identification which was followed up with designing of appropriate mitigation measures.

The ESIA Methodology adopted for this study is shown in Figure 1.2.

Figure 1. 2: ESIA methodology

1.6.1 Desktop Studies

Desktop studies were undertaken to acquire information on climate, geology, soil, groundwater, socio-economics, and other environmental components of the proposed project area. The materials consulted included textbooks, articles, maps, and previous EIA reports, such as the Proposed 3rd Line Cement Production Expansion and 48MW Gas Fired Power Plant in KM 10 Kalambaina Road Wamakko LGA, Sokoto State by Cement Company of Northern Nigeria as well as the The Proposed OCP Fertilizer Blending Plant Project at Kalambaina Wamakko Local Government Area of Sokoto State by OCP Nigeria Limited.

1.6.2 Impact Identification and Evaluation

The potential adverse and beneficial impacts of the proposed project were identified by considering and studying the interactions of the environmental components with the existing environment at the mobilization/site preparation, civil works/construction, and maintenance phases. The EIA Sectoral Guidelines for Infrastructure Projects (FEPA 1995), the World Bank Environmental Assessment Source Book (1991), and the conceptual project description among

other sources/references were used in the process. Evaluation of the identified impacts was carried out using such criteria as legal/regulatory requirements in respect of planned activities, magnitude of impact, risk posed by impacts, public perception and importance of affected environmental components.

1.6.3 Impact Mitigation

In proffering mitigation measures to prevent, reduce or control the adverse impacts of the proposed project, professional judgment (based on scientific deduction), project experience, knowledge of the ecosystem in which the proposed project shall be located and consensus of opinions among others were considered.

1.6.4 Terms of Reference

The Terms of Reference (TOR) used in guiding the execution and implementing the ESIA of the proposed project is as detailed below:

- ✓ To define relevant framework of legal and administrative requirements for the project;
- ✓ To carry out a detailed one wet season environmental baseline studies of the project environment;
- ✓ Define the procedures/protocols for identification and assessment of associated and potential impacts;
- ✓ To identify and assess the associated and potential impacts of the proposed project; and
- ✓ To identify appropriate mitigation measures for such impacts; and
- ✓ To develop an effective Environmental and Social Management Plan for the project.

1.6.5 National EIA Procedure

The FMEnv developed a National EIA Procedure (FEPA 1985) in response to the promulgation of the EIA Act No. 86 of 1992. The procedure indicates the steps to be followed from project conception to commissioning to ensure that the project is implemented with maximum consideration for the environment.

The procedure for EIA involves the project proposal stage where the project proponent notifies

FMEnv of the proposed project in writing.

This stage is followed by the screening phase, during which the Ministry will carry out, an Initial

Environmental Examination (IEE) and assign the project into a category based on some of its characteristics such as magnitude, environmental risks and their significance, etc. The location of the project if in Environmentally Sensitive Areas (ESAs) is also an important criterion in project categorization. There are three categories (I, II, III) in FMEnv's EIA/EMP Procedural Guideline. Category 1 projects are subjected to full-scale EIA/EMP. Projects listed in Category II may not require a full-scale EIA/EMP except when such a project is in an Environmentally Sensitive Area (ESA) and in this case the project will be automatically assigned to Category I. The requirement for Category II projects is a partial EIA/EMP. Category III projects are those expected to have essentially beneficial impacts on the environment. For projects in this category, the Ministry will issue an Environmental Impact Statement (EIS). Projects in this category include family planning programme, environmental awareness projects, etc.

Another stage of FMEnv's EIA/EMP procedure which comes up after the project proposal stage in the scoping stage, the main feature of which is that the proponent will be required to submit a Terms of Reference (TOR) for the proposed EIA study. This stage is followed by actual implementation of the EIA/EMP study, preparation of Draft Final and Final EIA/EMP Reports, review process and approval/certification.

Figure 1.3 below is a schematic summary of the national EIA process.

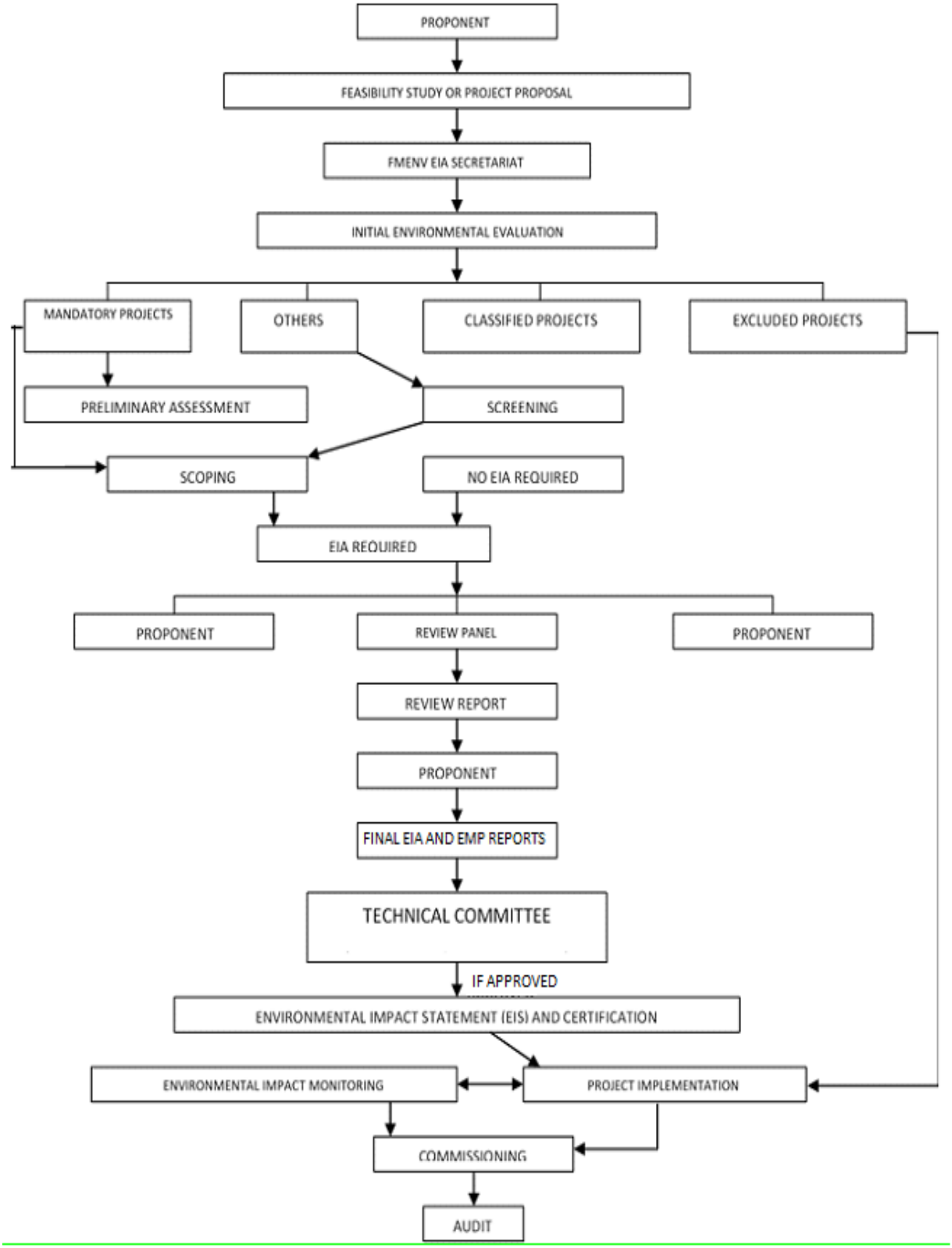


Figure 1. 3: Nigerian EIA Procedure

1.7 ADMINISTRATIVE AND LEGAL FRAMEWORK

This section gives brief discussions on applicable administrative and legal provisions for ensuring environmental protection during implementation and entire life cycle of the proposed project.

1.7.1. Relevant National Policies

Several policies that play vital roles in environmental protection have been approved by Nigerian government. Some of these policies are outlined in following subsections.

1.7.1.1 National Policy on Environment, 1989 (revised 1999)

The aim of the National Environmental Policy of Nigeria is the achievement of Sustainable

Development of the country as stated in Section 20 of its 1999 Constitution which provides that

‘’the State shall protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria’’. In addition, Nigeria is a signatory to several international treaties and conventions governing environmental issues.

In the policy, guidelines and strategies are defined for securing for all Nigerians a quality of environment adequate for their health and well-being; conserving and using the natural resources for the benefit of present and future generations; raising public awareness and promoting understanding of the essential linkages between the environment, resources and development; and cooperation with other countries, international organizations and agencies to achieve optimal use of trans-boundary spaces in order to protect environmental resources.
Environmental protection policy framework in Nigeria is guided by the following environmental concepts:

- ✓ Public Trust Doctrine;
- ✓ Environmental Offsetting Principle;
- ✓ Polluter Pays Principle;
- ✓ User Pays Principle;
- ✓ Precautionary Principle;

- ✓ Pollution Prevention Pays Principle;
- ✓ Inter-generational Equity Principle;
- ✓ Intra-generational Equity Principle; and
- ✓ Participation Principle.

1.7.1.2 National Climate Change Policy and Strategy

Nigeria has a National Adaptation Strategy and Response Plan (NASPA) on Climate Change as well as a Climate Change Department in its Federal Ministry of Environment. Among its other mandates, the Department is to implement the Climate Change Convention and the Kyoto Protocol activities. Nigeria has several policies and strategic initiatives which when properly implemented can mitigate climate change and serve as adaptive measures. Many of the policy initiatives are anticipatory adaptation measures and plans which can be further developed into policy options for climate change response in the country.

1.7.1.2.1 Guiding Principles

The Nigerian climate change policy is guided by a number of principles including the following:

- ✓ The strategic climate change response is consistent with national development priorities;
- ✓ Climate change is addressed within the framework of sustainable development which ensures that response is sensitive to issues of equity, gender, youth, children and other vulnerable groups;
- ✓ National energy use is pursued within the broad context of sustainable development;
- ✓ The policy is integrated with other interrelated policies that promote economic and environmental efficiency;
- ✓ Climate change is cross-cutting and demands application across various governmental, communal, industrial, business and concerned stakeholder sectors;
- ✓ Climate change response provides viable entrepreneurial opportunities.

1.7.1.3 National Policy on Erosion, Flood Control and Coastal Zone Management, (2005)

The above policy and its Action Plan are designed to ensure coordinated and systematic measures in the management and control of the hazards of erosion and floods to reduce their impacts on the people and the environment. Some of the key strategies are as follows:

- ✓ Evolving a mechanism for forecasting, monitoring and control of erosion and floods;
- ✓ Reviewing the land use laws and regulations;
- ✓ Promoting and strengthening training at all levels in erosion and flood prevention, management and control; and
- ✓ Creating public awareness to encourage participation.

1.7.2 Legal Provisions

Generally, there are several national and international laws and regulations dealing with development, health and environmental matters. The major laws applicable to this project include:

1.7.2.1 Environmental Impact Assessment (EIA) CAP E12, LFN 2004

This deals with considerations of environmental impact in respect of public and private projects.

Section 2 (1) requires an assessment of public or private projects likely to have a significant (negative) impact on the environment.

Section 2 (4) requires an application in writing to the FMEnv before embarking on projects for their environmental assessment to determine approval.

Section 13 establishes cases where an EIA is required and

Section 60 creates a legal liability for contravention of any provision

Federal Ministry of Environment Sectoral and Procedural Guidelines for EIA

FEPA Act, Cap 131, LFN, 1990 allocates powers of environment legislation making and enforcement to the Federal Environmental Protection Agency (FEPA) now (FMEnv). In-line with its functions, defunct FEPA has published the EIA Sectoral Guidelines (revised in

September 1995). The guidelines cover major development projects and are intended to inform and assist proponents in conducting EIA studies. In September 1995, FMEnv published EIA Sectoral Guidelines for Infrastructure projects. The guidelines are intended to assist in the proper and detailed execution of EIA studies of infrastructure and projects in consonance with the EIA Act. The guidelines were used to guidethe conduct of this EIA.

1.7.2.2 Forestry Law CAP 55, 1994

This law prohibits any act that may lead to the destruction of or cause injury to any forest produce, forest growth or forestry property in Nigeria. It also prescribes the administrative framework for the management, utilization and protection of forestry resources in Nigeria.

Abiding by this law was one of the considerations that guided the choice of the proposed site for this project.

1.7.2.3 National Environmental Standards and Regulations Enforcement Agency (NESREA) Act

The National Environmental Standards and Regulations Enforcement Agency (NESREA) is a parastatal of the FMENV established in July 2007 by the NESREA Act. NESREA is charged with the responsibility of enforcing all environmental laws, guidelines, policies, standards and regulations in Nigeria. It also has the responsibility to enforce compliance with provisions of international agreements, protocols, conventions and treaties on the environment.

Some of the responsibilities of NESREA include the following:

- ✓ Enforce compliance with laws, guidelines, policies and standards on environmental matters;
- ✓ Liaise with, stakeholders, within and outside Nigeria on matters of environmental standards, regulations and enforcement;
- ✓ Enforce compliance with the provisions of international agreements, protocols, conventions and treaties on the environment including climate change, biodiversity conservation, desertification, forestry, oil and gas, chemicals, hazardous wastes, ozone depletion, marine and wildlife, pollution, sanitation and such other environmental agreements as may from time to time come into force;
- ✓ Enforce compliance with policies, standards, legislations and guidelines on the following:
    i. water quality, Environmental Health and Sanitation, including pollution

abatement;

ii. sustainable management of the ecosystem, biodiversity conservation and the development of Nigeria's natural resources;

iii. sound chemical management, safe use of pesticides and disposal of spent packages thereof; and

iv. regulations on the importation, exportation, production, distribution, storage, sale, use, handling and disposal of hazardous chemicals and waste, other than in the oil and gas sector;

- ✓ Enforce through compliance monitoring, the environmental regulations and standards on noise, air, land, seas, oceans and other water bodies other than in the oil and gas sector;
- ✓ Ensure that environmental projects funded by donor organizations and external support agencies adhere to regulations in environmental safety and protection;
- ✓ Enforce environmental control measures through registration, licensing and permitting Systems other than in the oil and gas sector;
- ✓ Conduct environmental audit and establish data bank on regulatory and enforcement mechanisms of environmental standards other than in the oil and gas sector;
- ✓ Create public awareness and provide environmental education on sustainable environmental management, promote private sector compliance with environmental regulations other than in the oil and gas sector and publish general scientific or other data resulting from the performance of its functions; and
- ✓ Carry out such activities as are necessary or expedient for the performance of its functions.

The Federal Government through NESREA has developed Environmental Regulations which have been published in the Federal Republic of Nigeria Official Gazette and are now in force.

Applicable NESREA regulations relevant to this project are briefly discussed below.

1. National Environmental (**Construction Sector)** Regulations, 2010. S. I. No. 19. The purpose of these Regulations is to prevent and minimize pollution from construction, decommissioning and demolition activities.
2. National Environmental **(Noise Standards and Control)** Regulations, 2009. S. I. No. 35. The main objective of the provisions of this Regulation is to ensure tranquillity of the human environment or surrounding and their psychological wellbeing by

regulating noise levels.

3. National Environmental (**Soil Erosion and Flood Control)** Regulations, 2010. S. I. No. 12. The overall objective of these Regulations is to check all earth-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.
4. National Environmental **(Control of Vehicular Emissions from Petrol and Diesel Engines)** Regulations, 2010. S. I. No. 20. The purpose of these regulations is to restore, preserve and improve the quality of air. The standards contained herein provide for the protection of the air from pollutants from vehicular emission.
5. National Environmental (**Sanitation and Wastes Control)** Regulations, 2009. S. I. No. 28. The purpose of this Regulation is to provide the legal framework for the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution.
6. National Environmental (**Surface and Groundwater Quality Control)** Regulations, 2010. S. I. No. 22. The purpose of this Regulation is to restore, enhance and preserve the physical, chemical and biological integrity of the nation's surface waters, and to maintain existing water uses.
7. National Environmental **(Permitting and Licensing System)** Regulations, 2009. S. I. No. 29. The provision of this Regulation enables consistent application of environmental laws, regulations and standards in all sectors of the economy and geographical region.
8. National Environmental **(Ozone Layer Protection)** Regulations, 2009. S. I. No. 32. These provisions seek to prohibit the import, manufacture, sale and the use of ozone-depleting substances.

Thus, a robust ESMP was designed which is based on measures that will make sure that the above regulations are respected and strictly adhered to.

1.7.2.4 Land Use Act Cap. L5, 2004

The Land Use Act of 1978 vests all land situated in the territory of each State (except land vested in the Federal Government or its agencies) solely in the Governor of the State, who would hold such land in trust for the people and would henceforth be responsible for allocation of land in all urban areas to individual residing in the State and to organizations for residential, agriculture, commercial and other purposes. Similar powers with respect to non-urban areas are conferred on Local Governments. The Law commenced from 27th March 1978.

The above act guided the acquisition of farmlands to be used for the proposed project.

1.7.2.5 Nigerian Urban and Regional Planning Act Cap N138, LFN 2004

The Urban and Regional Planning Act is aimed at overseeing a realistic, purposeful planning of the country to avoid overcrowding and poor environmental conditions. In this regard, the following sections become instructive:

- Section 30 (3) requires a building plan to be drawn by a registered architect or town planner.
- Section 39 (7) establishes that an application for land development would be rejected if such development would harm the environment or constitute a nuisance to the community.
- Section 59 makes it an offence to disobey a stop-work order. The punishment under this section, is a fine not exceeding N10, 000 (Ten thousand naira) and in the case of a company, a fine not exceeding N50, 000.

Section 72 provides for the preservation and planting of trees for environmental conservation.

The above provisions would be respected in obtaining building approval and permits from relevant authorities.

1.7.2.6 Panel Code

The Nigerian Panel Code makes it an offence punishable with up to 6 month's imprisonment

for any person who:

- ✓ Violates the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carrying on business in the neighbourhood, or passing along a public way; or
- ✓ Does any act which is, and which he knows or has reason to believe to be, likely to spread the infection of any disease dangerous to life, whether human or animal.

The above penal code provisions will also be given regard to in the design of an ESMP for the proposed project.

1.7.2.8 State Legislations: States Environmental Protection Edicts

In accordance with Section 24 of the FMEnv Act, Chapter 131 of the Laws of the Federal Republic of Nigeria, 1990, the State Environmental Protection Edicts are enacted. The edict empowers the State Environmental Protection Agencies to establish such environmental criteria, guidelines/specifications or standards for the protection of the state's air, lands and waters as may be necessary to protect the health and welfare of the people. The functions of SEPAs among others include:

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

Generally, State laws on environment are still in the evolving stages. Specifically, for EA, the States rely on the EIA Act 86 of the Federal Government.

1.7.2.9 National Environmental (Food, Beverage and Tobacco Sector), 2009 (The purpose of these Regulations is to prevent and minimize pollution from all operations and ancillary activities from this sector in the Nigerian Environment).

Sokoto State Ministry of Environment

Sokoto State Ministry of Environment oversees activities involving the environment in Sokoto State. Among its other mandates, the Ministry supervises the Sokoto State Environmental Protection Agency (SEPA). The ministry has the responsibility of maintaining a clean and healthy environment through provision of sanitation and waste management services as well as oversight of spatial development planning.

Sokoto State Environmental Protection Agency (SEPA)

Sokoto Environmental Protection Agency (SEPA) Edict No. 10 of 1995 and Sokoto State Environmental Sanitation Law No. 7 of 2015. SEPA is responsible for the protection and improvement of the environment within the State as well as assists in implementation and enforcement of the National Environmental Regulation and Guidelines within Sokoto State. In carrying out its duties of environmental protection, SEPA is required to collaborate with relevant Federal and State Ministries, Local Government Councils, statutory bodies, research and educational institutions. Although the primary regulatory authority overseeing environmental concerns of the proposed project lies with FMEnv, SEPA plays a role as a key stakeholder in

environmental management of the state through:

- ✓ Protection of environment and biodiversity conservation and sustainable development in Sokoto State;
- ✓ Conduct research on matters relating to environment;
- ✓ Collaborate with federal government through the Federal Ministry of Environment in conducting public investigation on major environmental problems;
- ✓ Monitor the quality of water, air, land and natural resources in the state; and
- ✓ Promote environmental education and awareness.

Other relevant frameworks to this project include:

- Labour Act, CAP L1 LFN 2004, Factories Act, CAP F1 LFN 2004, National Policy on Occupational Safety and Health, 2016, Employees Compensation Act, 2010, Federal Ministry of Agriculture and Rural Development (FMARD), Agriculture Promotion Policy (2016-2020), National Agricultural Land Development Authority Act, 1992.
- The Ministry of Water Resources and the relavant State Ministries of Water resources are regulatory to natural and man-made water bodies in the country. They ensure the production and delivery of safe water for drinking and irrigation activities in the nation
- International Guidelines and Standards (The World Bank Environmental and Social Framework), World Bank Group Environmental, Health and Safety (EHS) Guidelines and African Development Bank (AfDB) Operational Safeguards).
- Since The World Bank Environmental and Social Standards (ESS), the African Development Bank (AfDB) Operational Safeguards (OS) and the IFC Performance Standards (PS) are largely similar, the applicability of each of the standards to the proposed project are summarized in a table 1.1.

Table 1. 1: applicability of the Worldbank, AfDB and IFC standards to the proposed Project

Standard	World Bank ESS	IFC PS	AfDB OS	Cross cutting requirement	Applicability and rationale	Sections of the EIA report that addressed the requirements
Environmental and social assessment	Yes	No	Yes	Nil	Yes, government project for human development	Chapters 5 and 6
Involuntary resettlement, land acquisition and compensation	Yes	Yes	Yes	Nil	Yes, government project for human development	Not applicable
Biodiversity, renewable and ecosystem services	Yes	Yes	Yes	Nil	Yes, government project for human development	Chapters 5 and 6
Pollution prevention and control, hazardous materials and resource efficiency	Yes	Yes	Yes	Nil	Yes, government project for human development	Chapters 5 and 6
Labour conditions, health and safety	No	Yes	Yes	Nil	Yes, government project for human development	Chapters 5 and 6

1.7.2.9 International Treaties and Convention

In addition to the national laws/ regulations supporting the use of EIA as an environmental management tool, Nigeria is also signatory or party to several international conventions and treaties that support the use of standard environmental management tools/ measures for achieving sustainable development. Some of these include:

African Convention on the Conservation of Nature and Natural Resources

This convention was adopted on the 15th of September 1968 in Algiers, Algeria, the African Convention entered into force on the 9th of October 1969. Its objectives are "to encourage individual and joint action for the conservation, utilization and development of soil, water, flora and fauna for the present and future welfare of mankind, from an economic, nutritional, scientific, educational, cultural and aesthetic point of view." It commits signatory parties (the Parties) to adopting "measures necessary to ensure conservation, utilization and development of soil, water, floral and faunal resources in accordance with scientific principles and with due regard to the best interests of the people."

The Parties (Nigeria inclusive) agree to use resources wisely, to manage populations and habitats, to control hunting, capture and fishing, and to prohibit the use of poisons, explosives and automatic weapons in hunting. They also agree to prevent and control water pollution,

establish conservation areas and consider ecological factors in development plans.

United Nations Guiding Principles on the Human Environment

Ever since it was formed, the United Nations (UN) has been concerned about negative environmental trends. Thus, at the UN Conference on Human Environment held in Stockholm in 1972, conservation of biological diversity was identified as a priority. The guiding principles established in that convention are formal declarations that express the basis upon which an environmental policy can be built and which provides a foundation for action. Some of the principles relevant to the proposed project include:

Principle 2

The natural resource of the earth, including the air, water, land, flora and fauna and 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 4

Man has a special responsibility to safeguard and wisely manage the heritage of wildlife and its habitat, which are now gravely imperilled by a combination of adverse factors. Nature conservation, including wildlife, must therefore receive importance in planning for economic development.

World Heritage Convention

In 1972, the United Nations Educational, Scientific and Cultural Organization (UNESCO) recognised the need to identify and permanently protect the world's special areas and adopted the World Heritage Convention. Founded on the principle of international cooperation, the Convention provides for the protection of the world's cultural and natural heritage places. It came into force in 1975 after being initially ratified by 20 countries.

The Ramsar Convention

The convention was developed and adopted by participating nations at a meeting in Ramsar on February 2, 1971 and came into force on December 21, 1975. The Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilization of wetlands, that is, to stem the progressive

encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.

International Labour Organization (ILO) Core Conventions

International Labour Organization (ILO) Core Conventions are as follows:

- ✓ Convention 1973, No. 138 regarding admission of age to employment which is 18years for Hazardous work or 16 under strict conditions, 14 as basic minimum age and 12-14 for light works and
- ✓ Convention 1999 No. 182 regarding worst forms of Child Labour. Under this convention Article 3 below applies;

For the purposes of this convention, the term the worst forms of child labour comprise:

(a) all forms of slavery or practices similar to slavery, such as the sale and trafficking of children, debt bondage and serfdom and forced or compulsory labour, including forced or compulsory recruitment of children for use in armed conflict;

(b) The use, procuring or offering of a child for prostitution, for the production of pornography or for pornographic performances;

(c) The use, procuring or offering of a child for illicit activities, in particular for the production and trafficking of drugs as defined in the relevant international treaties;

(d) Work which, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety or morals of children.

The implication of these conventions for the proposed project is that during recruitment of project personnel, under-aged persons would not be considered. Also, no person shall be forced to carry out any activity relating to the project against his or her wish.

Vienna Convention for the Protection of the Ozone Layer

This convention held in 1985 places general obligations on countries to take appropriate measures to protect human health and the environment against adverse effects resulting from human activities which tend to modify the ozone layer.

United Nations Conference on Environment and Development

The Rio 'Earth Summit' of 1992 emphasized the need for the preservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources, including access to genetic resources and appropriate transfer of relevant technologies, taking into account all rights over those resources and technologies. Nigeria is signatory to these international agreements on the environment. The principles adopted include:

Principle 1

Humans are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 5

All states and people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, to decrease the disparities in standard of living and better meet the needs of the majority of the people of the world.

Principle 17

Environmental Impact Assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

This principle is the one that gave birth to the requirement for the conduct of EIA all over the globe.

Convention on Biological Diversity

This convention is the most important of all the international agreements on biodiversity. Negotiated under the auspices of United Nations Environment Programme (UNEP), the Biodiversity Convention was opened for signature in June 1992 at the 'Earth Summit' held in Rio de Janeiro, Brazil, and entered into force in December 1993. It is the first global agreement to cover all aspects of biological diversity: the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising from the use of genetic resources.

Thus, any biological diversity present on the proposed project site or its surrounding will be protected by the application of this convention.

United Nations Framework Convention on Climate Change

The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys universal membership with 193 countries having ratified.

Under the Convention (entered into force on 21 March 1994), governments:

- gather and share information on greenhouse gas emissions, national policies and best practices;
- launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries;
- cooperate in preparing for adaptation to the impacts of climate change.

This convention is applicable in the implementation of this project in terms of efforts that will be geared towards minimization of greenhouse gas emissions.

The Copenhagen Accord

This Accord reached by some Heads of State, Heads of Government, Ministers and other heads of delegation at the United Nations Climate Change Conference 2009 in Copenhagen, Denmark recommends that deep cuts in global greenhouse gas emission be made. It also underlined the need to pursue various approaches, including opportunities to use markets, to enhance the cost-effectiveness of, and to promote mitigation actions.
This accord is also applicable in terms of need to cut down on greenhouse gas emissions.

The Paris Climate Accord

This is a major international treaty arrived at after the expiration of the Kyoto Protocol in 2012. Nigeria is one of the more than 140 countries that ratified this agreement in Paris, France in December 2015. The central aim of the agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise in this century well below 2 degrees Celsius above pre-industrial levels and to also pursue efforts to limit the temperature

increase even further to 1.5 degrees Celsius. The agreement also aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework are being put in place globally, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

The Paris Agreement requires all Parties to put forward their best efforts through nationally determined contributions (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

1.7.3 The Structure of the Report

In line with the standard national EMP report writing format, this report is presented in seven chapters as indicated below:

Chapter 1 is the Introduction chapter. It provides relevant background information on the project, the Statutory Regulations and project objectives. In addition, it highlights the national environmental assessment process.

Chapter 2 Justifies why the proposed project should be implemented

Chapter 3 describes the proposed project and processes, namely, type, input and output of raw materials and products, project operation and maintenance and decommissioning.

Chapter 4 presents the bio-physical and socio-economic baseline conditions of the proposed project environment.

Chapter 5 identifies and quantifies the potential and associated beneficial and adverse impacts of the proposed project.

Chapter 6 proffers mitigation and ameliorative measures for the adverse potential impacts identified, while also providing enhancement measures for the identified positive impacts.

Chapter 7 presents the Environmental and Social Management Plan that will be adopted throughout the project cycle. It also includes the Monitoring Plan that will ensure the effectiveness of the mitigation measures and the remediation plans.

Chapter 8 presents the conclusions arrived at as a result of conducting the ESIA.

CHAPTER TWO: PROJECT JUSTIFICATION

2.1 NEED FOR THE PROJECT

For Sokoto State to become self-sufficient in food production, it needs to be self-reliant in the production of agricultural products such as beef and milk, which are indispensable in provision of good and balanced diet.

The State has been rated the second largest state in terms of livestock resources in the country (Personal communication). Nigeria by extension is endowed with abundant livestock resources having an estimated 20.2 million heads of cattle, 79.9 million goats, 45.6 million sheep and approximately 1 million donkeys (FAO, 2019). The livestock population in the state has been estimated to be 3,457,993 cattle (24.8% of the Nigerian total). Thus, with over 5million people and 2.66 million hectares of land of which 2.43 million hectares is arable, there is huge potentials for making the state a hub to livestock production in the country. Worthy of mention are bountiful endowments of indigenous cattle species such as Sokoto Red Goat, Sokoto Gudali, White Fulani and Red Bororo known widely for quality leather, milk and premium beef. A study has shown that, Sokoto Gudali and Azawak are more profitable than any other indigenous cattle in view of their better feed conversion.

The system of rearing livestock and cattle in Nigeria and Sokoto is still largely dependent on the traditional pastoralism which accounts for most of the beef and meet production with about 90% of the livestock being raised in the hands of transhumance and nomadic pastoralists. Unfortunately, this system can no longer sustain the needs and demand for animal derived protein and only offer few economic advantages to the livestock owner.

Furthermore, a recurring problem in Nigeria is the farmer-herder clash which has led to colossal loss of lives and properties over the years.

Against the above background, the proposed project could not have come at a better time. It is therefore imperative to implement this project to solve these problems and boost socio-economic activities in the project area and the country at large. The proposed project will thus go a long way in meeting the critical food needs of people of Sokoto State and Nigeria. The project is therefore anticipated to provide jobs for people in the project area and boost socio-economic activities in the country.

The Cattle breeding Programme which includes improved milk and beef production, specialist reference veterinary hospital and a modern pasture production farm, with the financial support from the AfDB, would provide a paradigm shift for a modern livestock keeping through skill

acquisition in supporting the present and future generations of the traditional pastoralists. The proposed project could not have come at a better time. It is, therefore, imperative to implement this project to solve the problems associated with the existing traditional system and boost socio-economic activities in the project area and the country at large. The project is therefore anticipated to provide sustainable jobs for people in the State at large and to boost socio-economic activities in the country.

2.1.2 Benefits of the project

The key benefits associated with the projects are thus as follows:

1. To ensure the availability of livestock and livestock products as sources of proteins for reduced hunger and malnutrition
2. To improve livestock health and health service delivery for optimum productivity,
3. Increase access to livestock nutrition by identifying, testing and delivering superior feed strategies and options especially using locally sourced raw materials,
4. Ensure value addition and encourage private sector participation in livestock agribusiness
5. Encourage youth and women participation in modern livestock production.
6. Overall improvement of the socioeconomic potentials of the Sokoto State citizenry through sustainable job creation.
7. These projects are closely in line with the Africa Sustainable Livestock 2050, the national livestock transformation Plan 2020, the Sokoto State Development Plan (2020-2025). It seeks to sustainably contribute to addressing the challenges of poverty, hunger and inequality while addressing constraints associated with the livestock agribusinesses competitiveness by furthering opportunities for economic diversification, job creation and improved livelihoods in Nigeria.

2.2 PROJECT ALTERNATIVES CONSIDERED

Project alternatives must normally be considered during an ESIA process. Alternatives, in relation to a proposed project, mean different ways of meeting the general purpose and requirements of the project and may include the following types of alternatives:

- ✓ Location alternatives;
- ✓ Type of project development to be undertaken;
- ✓ Design or layout of the project development;
- ✓ Technology to be used for the development; and

- ✓ Operational aspects of the development.

Alternatives to projects such as livestock breeding, modern pasture development and animal health service delivery that may have impacts on the environment and may raise issues of concern are always considered. The reason is to assess the effects of the alternatives on the environment against expected benefits.

For the proposed project, three main alternatives were considered in all, the first is against the proposed project while the remaining are alternatives. The three alternatives considered were as follows:

- ✓ The ‘’No project’’ option
- ✓ Using other locations
- ✓ Project execution as proposed

A panel of experts reviewed these alternatives with the project objectives in focus as follows:

2.2.1 No Project Development Option

It is essential that the “no project option” be considered as a first step in mitigation. This alternative implies that the proposed value chain in modern livestock production will not be carried out and this implies no investments will be made by Sokoto State Government and AfDB in the area of improved livestock production.

This means that the identified benefits presented in the previous section will not come into fruition. This alternative is against the desires of the Sokoto State Government to boost competitiveness, facilitate manufacturing and industrialization through improved livestock production.

2.2.2 Using other Project Locations

The location of a production business is an important factor for its success. For example, its location to some extent determines access to markets, ease of transportation of raw materials among other things. The existing gazetted grazing reserves are the best locations for the project. This is because acquiring other lands in different locations will bring about environmental and socio-economic disruptions on the new environments, apart from their associated costs. The proposed pasture development is centered in Dogon Daji; an area with historic pastoral nomads settlement and climatic conditions to support the initiative.

The choice of using the existing infrastructure for the milk and meat processing is also a better alternative than acquiring new lands and providing similar infrastructure elsewhere. This is

because the existing milk processing centre and the modern abbatoir in Runjin-Sambo area of Sokoto can effectively serve the envisaged purposes they are meant for, while the latter option is associated with much higher project costs and more significant potential environmental and socio-economic impacts that will be detrimental to the objectives of the State Government. Additionally, the Agro-Cargo Terminal Project, being proposed will facilitate the transport of milk and processed meat from Sokoto to local and international markets.

The existing AI/ET centre in Sokoto supported by the proposed zonal centres, is also a better alternative than replicating the construction of similar centres in every LGA of Sokoto State. This is because, to begin with, there is shortage of both financing and manpower to run the new centres in the LGAs, whereas, with the existing centre in Sokoto and procuring of well-equiped vehicles, the AI/ET facilities can be extended to each LGA from the zonal centres when fully established.

2.2.3 Project execution as proposed

Taking this option means that the proposed projects on the value chain of improved livestock development will be implemented. Current challenges facing cattle rearers in Sokoto State, including the farmer/herder clashes and poor cattle feed will be solved. The proposed project will ensure sustainable feed supply, provide sound animal health services and delivery and processed livestock products processing and marketing. Other project benefits include job and wealth creation and associated enhanced socio-economic impacts to be delivered on the project communities through the execution of these projects.

Significant positive environmental impacts will also be made if the project is carried out as proposed due to the numerous benefits accruable to the inhabitants of the project area and those in the extended project's area of influence. For instance, educational and health status of the immediate and extended host communities will improve as a result of enhanced earnings as a result of the execution of the project. The proposed project, thus, has a high tendency for discouraging rural-urban drift in its area of influence, while maintaining peaceful coexistence among the Sokoto State citizenry.

The most important benefits that can be derived from this project include the following:

- ✓ Ensuring sustainable livestock development with utmost track of value chain realization; and
- ✓ Socio-economic, educational, skill acquisition and health status of Sokoto State citizens and beyond will be enhanced as a result of job and wealth creation as well as provision of healthy livestock products arising from the proposed project.

2.3 VALUE OF THE PROJECT

It has been estimated that about eighteen million dollars ($18, 000, 000. 00) will be required for the implementation of the project. Expected financing from the AfDB is 95% while the Sokoto State Government cares for the remaining 5%. The proposed projects cost includes feasibility/technical studies and ESMP/, mobilization and construction activities (infrastructures, earth dams, irrigation facilities etc) as well as installation of processing and associated equipment. The projects intend to employ over five hundred people in both its constructional and operational phases. This would uplift their earning standard to more than $1/day. Employment priority will be given to qualified persons from the host community, followed by those from nearby communities. The project would also contribute an overall net positive economic benefit to the nation and beyond when its overall potentials for boosting socio-economic activities in the country are considered.

2.4 ENVISAGED SUSTAINABILITY

The sustainability of the project is multifaceted. It is based on several components which include socio-economic and technical sustainable frameworks, among others. Social sustainability of the project is hinged on the policy of ensuring cordial relationship with stakeholders and communities by the project contractor and the proponent through consultation throughout the various phases of the project. It has also been planned that local people will be given priority in terms of employment in the construction and operational phases of the project. The economic and technical sustainability is envisaged on the contributions expected from the contributions from the AfDB and the Sokoto State government. Once the projects took up and because of it is people focused, its continuity is ascertained. This is in addition to other variables like good relationships between the stakeholders and the community.

Environmental sustainability of the project is predicated on the fact that the local pastoralist will be carried along through environmental training and support to ensure that the present traditional livestock keeping is done away with for the much-needed paradigm shift towards total sustainable agricultural practices. Modern sustainable livestock farming through appropriate skill acquisition would go a long way in supporting the present and future generations of the nomadic pastoralists and the citizenry at large.

The environmental sustainability of these projects is based on the above premise and on the following specific considerations:

- ✓ Standard engineering designs which will improve the life cycle costs, environmental performance and projects economics;
- ✓ All other works shall follow standard and environmentally sound construction methods so as to keep disruption to the environment at acceptable levels;

- ✓ The use of best available technology and effective waste management shall be ensured to enhance environmental protection;
- ✓ Project management shall be carried out by fully trained and qualified personnel who are conversant with general HSE guidelines;
- ✓ Environmental sustainability of the project is predicated on the fact that not much interference is expected with the physical setting of the project area as a result of the project, because the project sites have been acquired by the state government from existing lands which have already been cleared for farming activities. In addition, adequate Environmental and Social Management Plan, ESMP, will be designed herewith to ensure minimum environmental disruption and mitigation of significant negative environmental impacts.
- ✓ Social sustainability of the project is hinged on the policy of ensuring cordial relationship with stakeholders and communities by the contractor and the proponent through consultation throughout the various phases of the projects. It has also been planned that people from the project host communities will be given priority in terms of employment in the construction phase.

2.5 PROJECT LIFE SPAN

It is expected that the proposed livestock improvement project will remain operational, viable and sustained with periodic maintenance by the proponent (Sokoto State Government) for at least fifty years.

CHAPTER THREE: PROJECT DESCRIPTION

3.1 THE PROJECT

The proposed project is generally centred on revolutionizing the production of cattle and the associated milk and beef products as sustainable means of creating jobs and wealth for the teeming citizens of the state for poverty eradication. The proposed project has five integrated components comprising of improved cattle breeding through artificial insemination and embryo transfer technologies; improved milk production and processing; improved beef production; improved pasture and livestock feed production; and improved veterinary healthcare delivery.

The project will follow a phased approach where AI and ET centers will first be established across the 23-local government as the phase 1. This will be followed by establishment of **model** cattle ranches at Rabah, Dogon Dagi and Silame covering the three senatorial zones of the state, milk collection centers and meat processing plants will be developed during the second stage. In addition, existing grazing reserves would be recovered and rehabilitated.

So far, the Sokoto State Government has secured three thousand hectares (3,000 ha) of land and has installed irrigation equipment to produce pasture and livestock feed which has been identified as one of the major drivers for improved cattle breeding and enhanced beef and milk production. Out of nineteen (19) existing grazing lands, the State Government has completed nine (9) gazetted grazing reserves (estimated to be 14,663.926 ha) and demarcated major cattle routes throughout the state to ensure smooth access to livestock.

Apart from the existing veterinary clinics in all the 23-local governments, effort has been at advanced stage in providing a state-of-the-art specialist veterinary hospital, fully equipped with all the necessary materials and laboratories to ensure healthy livestock in the state. These include:

- ✓ Livestock X-ray machines
- ✓ Ultrasound machines
- ✓ Assorted theatre kits and equipments

The State also has a modern abattoir and dairy plant which would be utilized as infrastructures for achieving a meat and milk industry respectively. In this respect, Sokoto Gudali cattle have been crossed with exotic breed beef cattle (Sokoto Gudali vs Brangus) and likewise with the dairy one (Jersy VS White Fulani; Jersy VS Sokoto Gudali) to improve both meat and milk. It was noted that, apart from the new offerings, farmers have recorded an appreciable milk yield (from average 4ltrs to 15L) and 3 out of the 13 cluster farmers have been into commercial yoghurt production.

The project intends to fund infrastructure development to support the creation of a competitive

enabling business environment; supportive of private sector investments and opening-up access to local and regional markets for livestock and livestock products. For the CSP's second priority area, the project intends to create more inclusive opportunities, especially in the form of job creation for the teeming youth and women who would have decent and gainful employment along the value chains. The project is a key flagship of the Bank Group's 5 key strategic areas of focus, namely: 1) The Feed Africa Strategy - seeking to transforms African agriculture into a competitive and inclusive agribusiness sector that creates wealth, improves lives and secures the environment, 2) Industrialise Africa Strategy, 3) Integrate Africa; 4) Light Africa and 5) Improve the quality of life for the people of Africa. The project's direct area of influence is that part of the project area that may be affected directly by any impact resulting from implementation of the proposed project.

3.2 PROJECT LOCATION

The project components are to be located in Sokoto metropolis and the remaining 23 local government areas. However, based on specific considerations, the following locations are proposed:

Table 3. 1: List of grazing reserves & their locations in sokoto state

	Grazing Reserve	Size	Geo. Location	Surrounding community	Common Vegetation	Source of Water	Doc./Ownership	Est. population	Add. Info.
1.	Masu G/r	1163.6ha	Tambuwal	Masu village	*Pennisetum purpureum*, *Combretum micranthum*	Open Dug well	State Gov't.	-	Gazette
2.	Magunho G/r	1105ha	Tangaza	Magunho village, Gwangwano village	*C. micranthum* *Prosopis africana*	Bore hall; open dug well	State Gov't	-	Gazette
3.	Danbatu G/r	1243ha	Kebbe	Danbatu village, Tungar Isuhu Rara Village	*Guiera senegalensis* *Combretum micranthmu,*	Bore hall	State Gov't.	-	Gazette
4.	Tukuyum G/r	889ha	Rabah	Tukuyum Village, Rara Village	*Andropogon gayanus* *A. nilotica*	Bore hall, Open Dug-well	State Gov't.	-	Gazette
5.	Tullun wanki G/r	4312.540ha	Silame	Jekanadu Village	*Pennisetum purpureum* *A. gayanus*	Bore hall, River, Open Dug well	State Gov't	-	Gazette
6	Tsaraki G/r	3,382ha	Kware	Tsaraki village, mallamawa village	*Combretum micranthum, Prosopis africana*	Bore hall, open dug well	State Gov't.	-	Gazette

7.	Biyonadi G/r	1084.9ha	Wurno	Marnona village	*Guiera senegalensis*, *Digitaria debilis*	Bore hall, open dug well	State Gov't		Gazette
8.	Zaru G/r	285.6ha	Dange – shuni	Dabagin ardo, zaru and Bissalam	*Andropogon gayanus*, *D. debilis*	Bore hall, open dug well	State Gov't		Gazette
9.	Girkau G/r	1198ha	Kebbe	Girkau village	*Piliostigma reticulatum*, *D. debilis*	Bore hall, Open dug well	State Gov't.		Gazette
10.	Dogon-daji	6400ha	Tambuwal	Kardi village, madara village, kwalkwato village	*A. milotica*, *Andropogon gayanus*, *D. debilis*	Bore hall, open dug well	State gov't.	-	Gazette
11.	Birnin wari G/r	4,500ha	Binji	Bunkari village, Birnin wari village	*Pennisetum purpureum*, *A. gayanus*	Bore hall, Open dug well	State Gov't.		Gazette
12	Dantasakko G/r	3905ha	Gwaranyo	Dantasakko village	*P. purpureum*, *G. senegalensis*	Dam, open du well.	State Gov't.		Gazette
13.	Tozai G/r	1000ha	Tangaza	Tozai village	*P. africana*	Open dug well	State Gov't		Gazette

e. The development consists of the construction and equipment of Artificial Insemination (AI)/Embryo Transfer (ET) centre at Runjin Sambo Area, Sokoto on a land of about 1.219 ha size as well as mini-AI/ ET centers across the 23 Local Government Areas of the state. For the AI, semen and embryos would be imported to inseminate the indigenous breeds, in addition, live animals would also be imported to serve as donors.

f. The Sokoto milk production/dairy plant, Sokoto (12°28.065'N, 004°49.196'E) is located in a residential area within Sokoto metropolis.

g. The proposed Sokoto Specialist Veterinary Hospital, Sokoto (Longitude 12°58.603'N, Longitude: 005.16.288'E) is also located along Gusau Road in Kwannawa residential area outskirts of Sokoto town, in Dange-Shuni LGA. It is also adjacent to the Sokoto State University, a proximity that can provide future collaboration activities with the academics of the University on livestock health research and development. At present, the Sokoto State is having a total number of 22 clinics across the LGAs. These include:
Aliyu Jodi, Runjin Sambo, Sokoto South and Hokon Idi vet clinics all in Sokoto metropolis. While Wamako, Wurno, Kware, Illela, Binji, Gwadabawa, Wurno, Binji, Tangaza, Ruwa wuri, Tureta, Bodinga, Kebbe (Kuchi), Goronyo, Isa, Sabon Birni, Yabo and Tambuwal.

h. The proposed modern Pasture farm Estate (Longitude 12°28.309'N, Longitude: 004.49.014'E), is in the rural setting of Dogon-Daji in Tambuwal Local Government Area of Sokoto State. This project occupies a 10-hectare land adjacent to the Dogon-Daji Savanna Forest that spans over 1000 hectares. The Dogon-Daji Forest is famous in supporting pastoral Fulani with a vast vegetated area of savanna forest for livestock feed and settlement. It also offers some natural water bodies that support the dwelling of the pastoralist up to the time of dry season. Pasture will be preserved through Silos making and Feed mills. The pasture planned to be grown include *Brachiaria ruziziensis* (Congo grass), *Brachiaria decumbens* (Signal grass), *Pennisetum pedicellatum* ("Kyasuwa"), *Pennisetum purpureum* (Elephant grass), *Lablab pupureus* (Lablab), *Mucuna pruriens* (Mucuna), *Cajana cajan* (Pigeon pea), *Zea mays* (Corn/Maize) and *Glycine max* (Soybeans). These were selected based on an earlier recommendation of NAPRI/ABU, Zaria. They contained the requisite nutrients for improved livestock productivity.

i. The Sokoto Meat Production and Modern Abattoir (12.58.633'N Longitude: 005.16.244'E), is a project to be located in Sokoto metropolitan area. The good road network inside Sokoto town would offer easy logistics for transport of products.

Figures 3.1-3.4 Show the locations of the proposed project components.

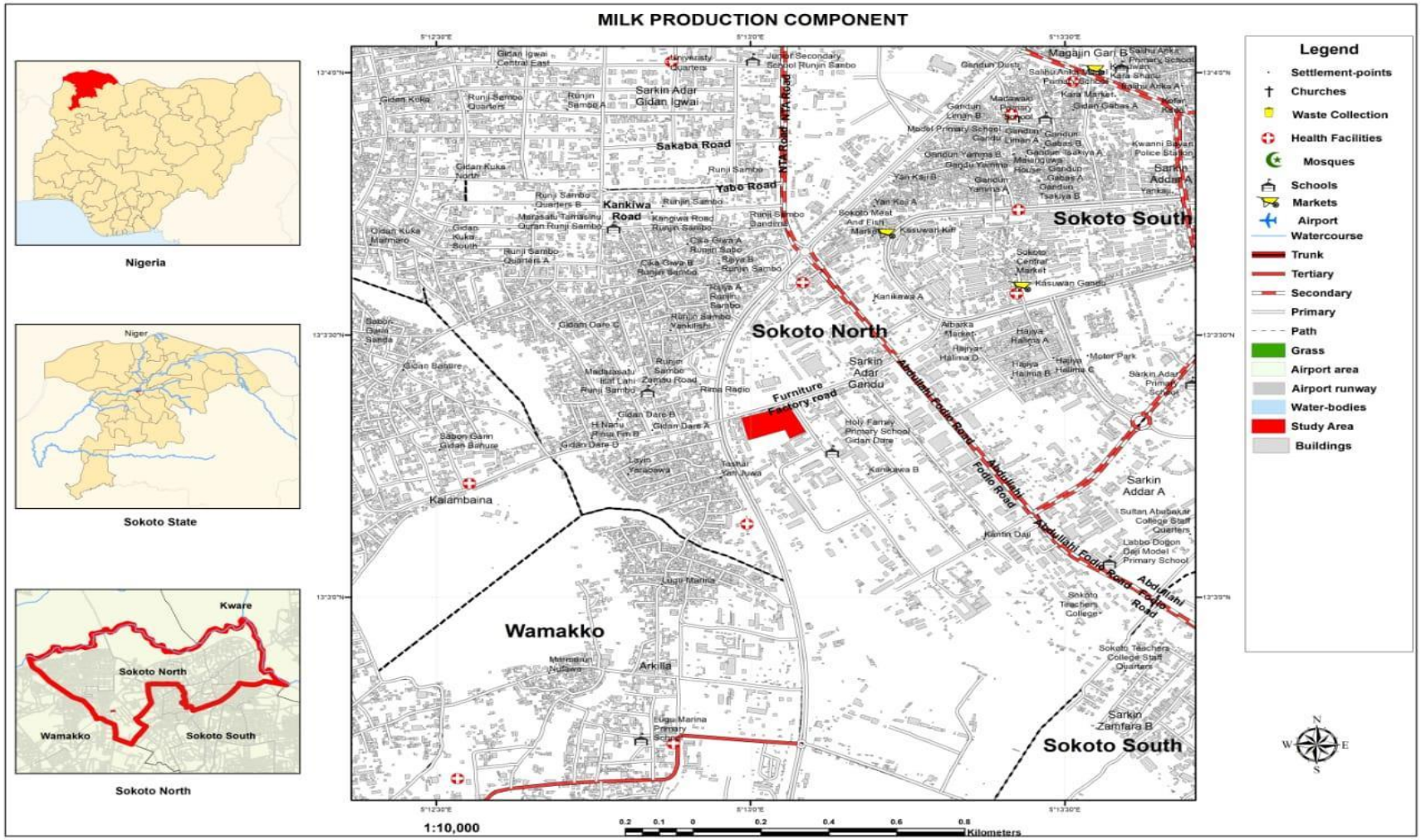


Figure 3. 1: Existing milk production factory

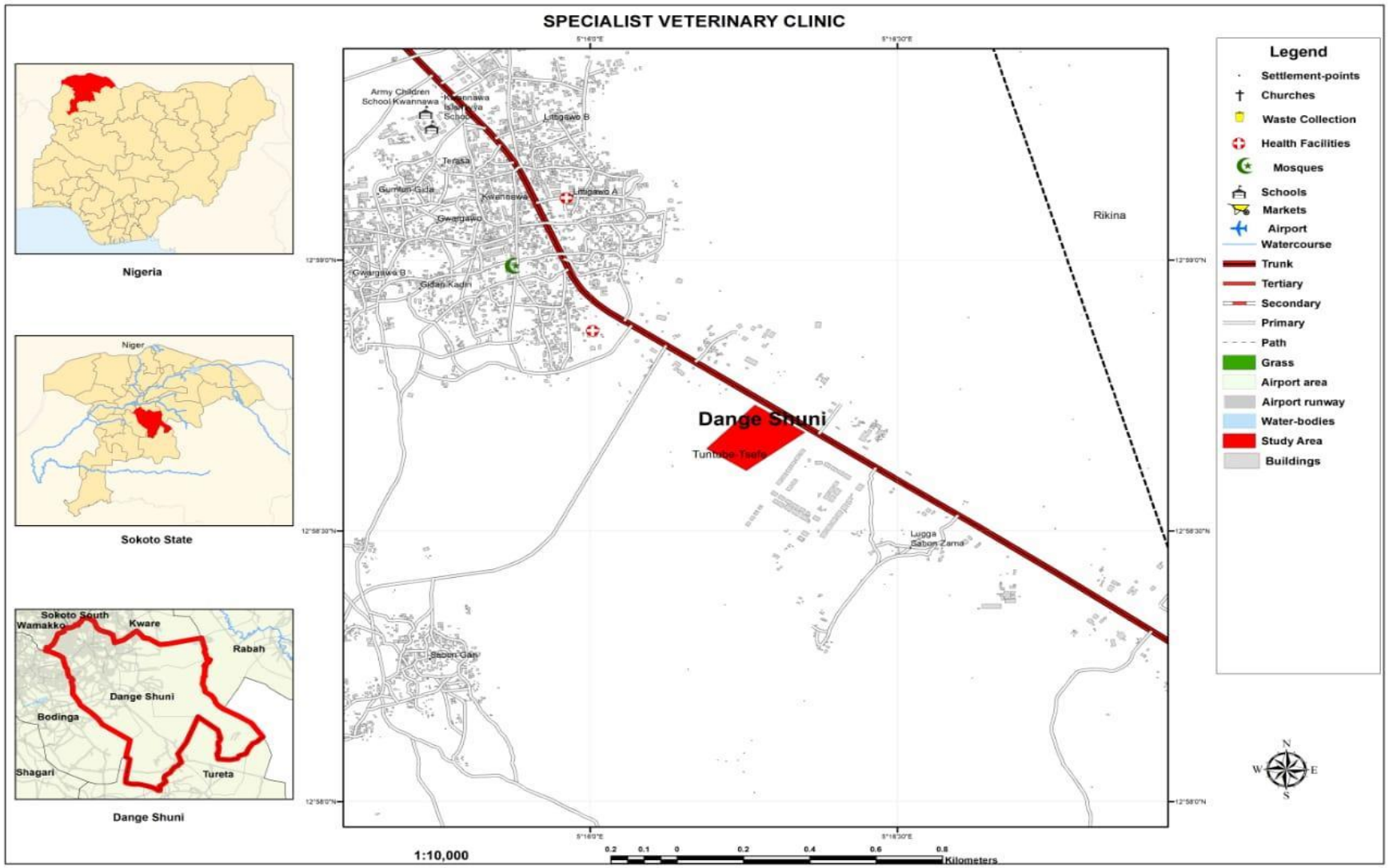


Figure 3. 2: Site for establishment of Specialist Veterinary Hospital

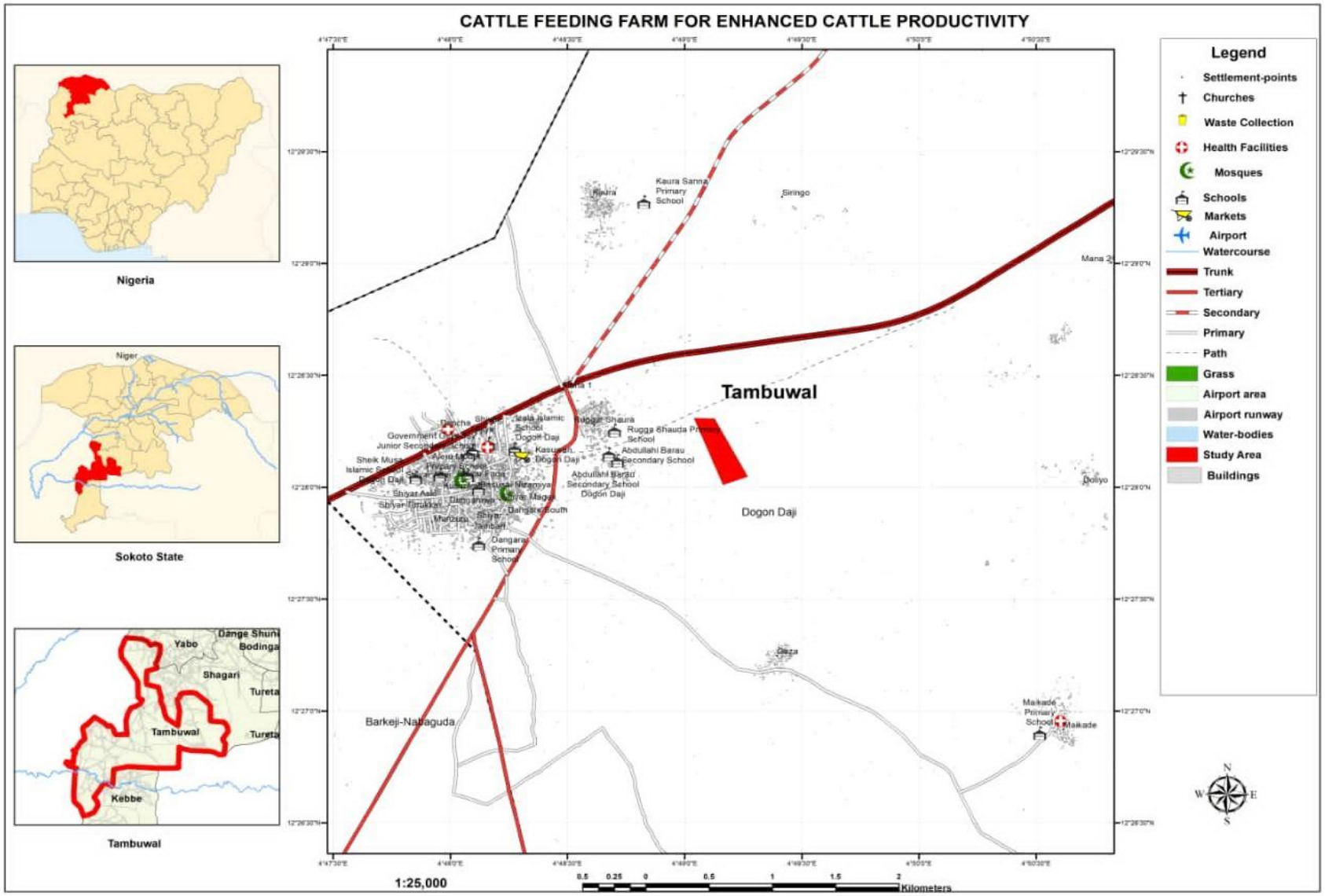


Figure 3. 3: Site for the proposed modern Pasture Farm Estate

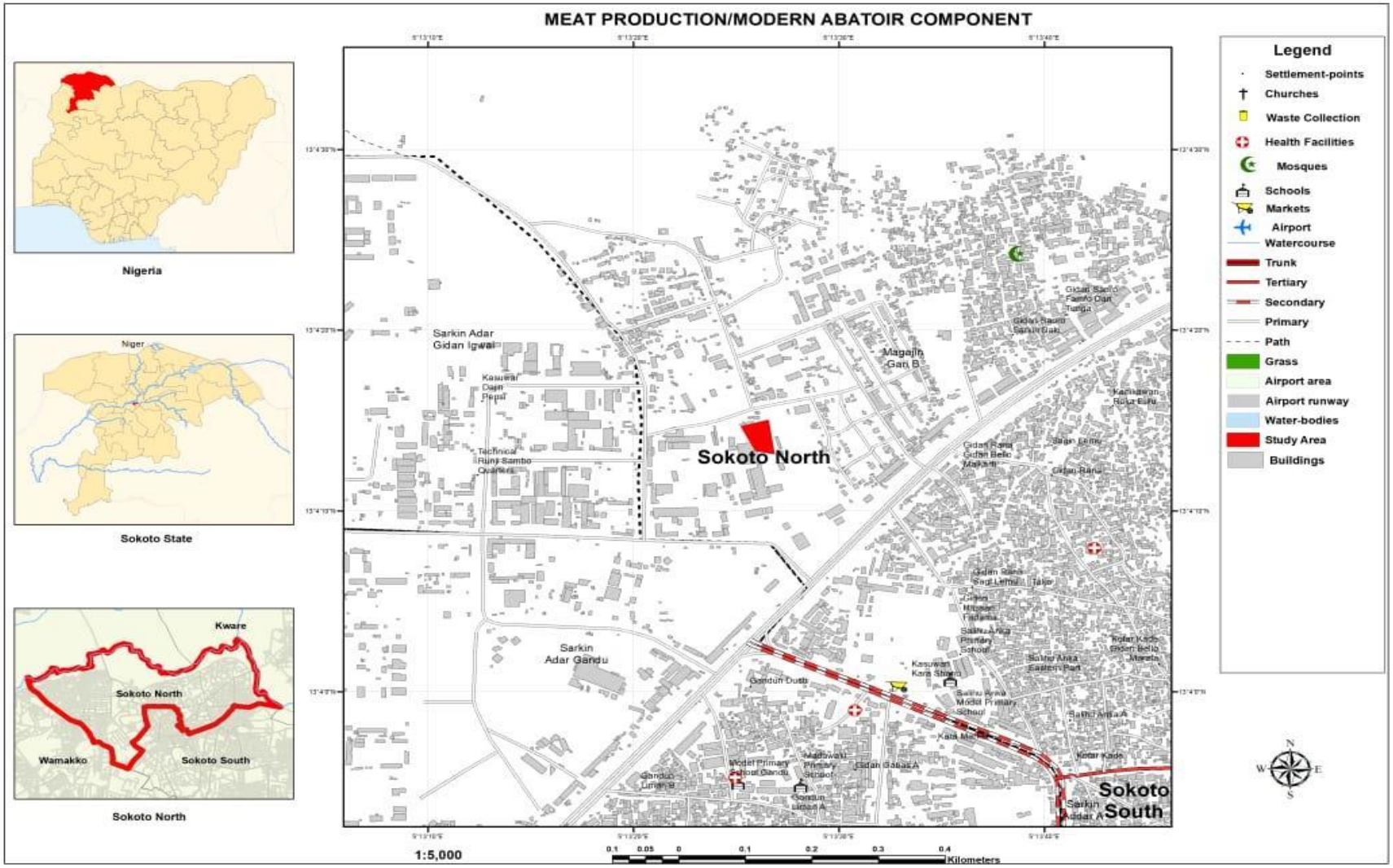


Figure 3. 4: Site for the existing modern abattoir/meat processing factory

3.2.1 The project's Direct Area of Influence

The project's direct area of influence comprises of the above-mentioned locations where the respective components of the project are located.

3.2.2 The project's Actual Area of influence

The project's extended area of influence is the entire Sokoto State, as the project will establish a

This is aimed at ensuring even development of the State by reaching out to the grassroots.

3.3 SCOPE OF WORKS

The proposed project involves the following broad key activities:

A. Upgrading of the AI/ET Centre in Sokoto will involve the following activities.

i. Expansion of the existing building at the centre in Runjin-Sambo as well as constructing mini-AI/ET Centres in the 23 LGAs, which will include the following construction activities.

- Project Design
- Permitting and licensing including this EIA
- Site Preparation
- Civil construction
- Installation of machineries
- Commissioning of the facility
- Demobilization

ii. Procurement of additional AI/ET facilities including mobile AI/ET bans for field activities.

B. The Sokoto milk production/dairy plant

The existing milk production centre will be expanded, and more facilities will be procured to increase its milk processing capacity. The following are the major project activities to be carried out.

- Project Design
- Permitting and licensing including this EIA
- Site Preparation
- Civil construction

- Installation of machineries
- Commissioning of the facility
- Demobilization

C. The proposed Sokoto Specialist Veterinary Hospital

This veterinary hospital will be constructed on an existing farmland in Kwannawa residential area outskirts of Sokoto town, in Dange-Shuni LGA. The following are the major activities for this project:

- Design of the veterinary hospital as well as other permitting and licensing activities, including this EIA
- Preparation of the proposed site for building activities
- Building and civil engineering construction work
- Procurement and installation of equipment
- Commissioning of the facility and
- Demobilization from site

Another component of this sub-project is construction and equipping of a transboundary animal diseases laboratory at the border.

Fig. 3.4a. Architectural design of the Specialist Vet Hospital (Arial view)

Fig. 3.4b. Architectural design of the Specialist Vet Hospital (Front view)

D. The proposed modern Pasture farm Estate

There will be construction of farmhouse estate in the acquired land located in the rural setting of Dogon-Daji in Tambuwal Local Government Area of Sokoto State. This project occupies a 10-hectare land adjacent to the Dogon-Daji Savanna Forest that spans over 1000 hectares. The building construction will be for storage and equipment maintenance workshops facilities as well as residential quarters for the farm employees. Earth dam will be constructed, and water storage and irrigation equipment will also be procured and installed. The following are the major activities for this project:

- Design of the layout and facilities as well as other permitting and licensing activities, including this EIA
- Preparation of the proposed site for building activities
- Building and civil engineering construction work

- Procurement and installation of equipment
- Commissioning of the facility and
- Demobilization from site

E. The Sokoto Meat Production and Modern Abattoir

The existing modern abattoir is within the Sokoto metropolitan area. The abattoir will be rehabilitated and additional equipment for beef processing will be installed. Cold storage facilities will also be constructed and equipped.

3.4 ACTIVITIES WITHIN PROJECT PHASES

3.4.1 Pre-construction Phase

Generally, preconstruction activities for this project include feasibility/technical design, land acquisition and environmental planning as well as permitting and approval processes, including this ESIA study.

3.4.2 Construction Phase

3.4.2.1 Site Preparation

Construction activities will be preceded by recruitment of skilled and non-skilled workforce, establishment of construction yards and site offices for the respective project components. The Construction Phase will begin with surveying and clearing of the proposed lands.

3.4.2.2 Building and Civil Engineering Construction

The building and civil engineering works necessary for the realization of the proposed projects include the following works:

- Construction of mini-AI & ET centers in the 23 local government areas and upgrading of the existing one in Sokoto town.
- Construction of storage system (silos) for feeds and grains as well as residential quarters for employees and construction of an earth dam and water storage infrastructure and at Dogon-Daji
- Construction of the Veterinary Specialist Hospital in Dange-Shuni area of Sokoto town and rehabilitation of the existing veterinary clinics in all the 23 LGAs of Sokoto State as well as construction of transboundary animal diseases laboratory at the border
- Upgrading of the existing milk processing plant

Other components of the building construction work include paving, flooring, tiling, finishing work, painting and corrosion protection of metal structures, cladding, roofing, plumbing, air conditioning as well as all works necessary for the operation of buildings.

Roads

A road network is required for the movement of vehicles in and out of the project sites. The pavement structure will have to be constituted at least by a bilayer pavement structure.

Firefighting plan

The objectives of firefighting plan for the proposed project are:

i. To define the general philosophy for application of Active Fire Protection (AFP) and Passive Fire Protection (PFP);
ii. To define areas where passive fire protection is required;
iii. To establish criteria to be used for deciding which equipment needs to be protected by AFP and/or PFP in the areas where it is required; and
iv. To define type of fire against which they must be protected and required duration of protection.

The fire-fighting plan will be executed according to the above plan. All identified fire-fighting equipment will be procured and installed accordingly.

3.4.2.3 Procurement of equipment and materials

Procurement of all equipment required for the full functioning of the project components will be carried out in parallel with building and civil engineering construction works to minimize delays in ordering transportation and delivery. Procured equipment will be installed as soon as construction and civil works are completed.

3.4.2.4 Capacity Building

This important complimentary component of the project will be carried out along with the construction of physical components of the project to ensure that the capacity of implementing agencies of the State Government is improved. Institutional capacity shall be strengthened to improve the implementing agency's function with regard to the delivery of the various projects. In this regard, necessary tools for the functioning of the agencies as well as training of relevant staff of such agencies will be carried out to ensure the project components can be effectively delivered by the agencies.

3.4.2.5 Public Sensitization

This is a critical component of the proposed project. Through the mass media, the public in Sokoto State and other concerned key stakeholders including Civil Society Organizations will be informed of the lofty goals of the proposed project and the various opportunities available to them through the entire value-chain to be delivered by the proposed project. People will be encouraged to key into the various aspects of the project in various roles so as to benefit from the opportunities presented by the various components of the project.

3.4.3. Operational Phase

Operational phase of the projects will succeed the construction phase and would be characterized by operationalization of the various project components. For example, it is in this phase of the project that AI and ET would be carried out on cattle owned by interested stakeholders. Pasture farm development for both rain fed and irrigation systems would also take place in this project phase. The Veterinary Specialist Hospital would also become operational in this phase. Milk collection and processing at the factory will also take place in this phase of the project as well as meat processing, etc. In this phase of the proposed project, installed equipment would also require routine maintenance.

3.4.3.1 Raw Materials for the Project

The basic raw materials for the improved livestock development programmes include cattle semen and embryo, improved local and exotic pasture seeds, modern hygienic milk collection equipment, silos for storage, drugs and medicine supplies for the veterinary clinics, etc.

3.4.3.2 Estimated Project Workforce

In the construction phase, the proposed projects will directly employ about one hundred skilled professionals as well as about five hundred unskilled employees; in the operational phase, the project will employ about one hundred and twenty (120) skilled professionals and about two hundred (200) unskilled laborers.

However, during employee recruitment, priority will be given to qualified persons from the host community, followed by those from nearby communities. This will be in accordance with a Local Content Plan to be designed by the contractor and vetted by FMEnv and Sokoto State Ministry of Environment. The Local Content Plan will ensure that whenever possible qualified skilled and non-skilled positions are reserved strictly for people from the project host communities and that on-the-job training is made an integral part of the recruitment policy of the contractor.

3.4.4 Decommissioning Phase

The design life of the proposed project will be 50 years, which is dependent on proper maintenance. The project is part of the medium- and long-term plans to meet Sokoto State's livestock production needs for healthy living and economic growth; therefore, it is unlikely that the project would be decommissioned in the near future. It would more likely be upgraded or remodeled if this is found to be desirable considering future population growth. However, should decommissioning be required in the long run, the general good practice guidelines for decommissioning of infrastructure as well as the existing environmental legislation of the time would guide appropriate decommissioning of the project. As planned, at the end of the construction phase the construction area and yard will be rehabilitated according to recommended plans before being put to alternative use.

3.4.5 Project Implementation Schedule

The Gantt chart of figure 3.5 is self-explanatory and briefly summarizes the project scheduling. According to the proposed schedule, preconstruction phase of the proposed project will last for 6 months, i.e., from July 2021 to January 2022, culminating with obtaining all relevant permits include building development permit, environmental permit, etc.

The construction phase, which will include physical building construction activities and developing related infrastructure as well as installation of production equipment and accessories, is expected to begin in February 2022 and lasts for twelve months.

The operational phase of the project during which AI and ET administration, pasture development, milk and meat production/processing, other livestock products like hide and skin processing and export will commence as scheduled in February 2023 and to lasts for at least fifty years.

S/N	Activity	Preconstruction Phase	Construction Phase	Operations Phase
		Duration (timeframe)		
		June 2021-May 2022	June 2022-May 2023	June 2023-July 2073
1.	Preconstruction activities, including site acquisition, building and process designs, permits/approvals including this ESIA			
2.	Construction of buildings and associated structures			
3.	Installation of plant and equipment and test-running			
4.	Demobilization from construction sites			
5.	Operations and periodic maintenance			

Figure 3. 5: Gant chart for the project scheduling

CHAPTER FOUR: DESCRIPTION OF THE PROJECT ENVIRONMENT

4.1 INTRODUCTION

Sokoto has a hot semi-arid climate. It is located in the dry Sudan surrounded by sandy savannah and isolated hills. With an annual average temperature of 28.3 °C (82.9 °F), Sokoto is one of the hottest cities in Nigeria, however the maximum daytime temperatures are generally under 40 °C (104.0 °F) most of the year, and the dryness makes the heat bearable. The warmest months are February to April, where daytime temperatures can exceed 40°C. The highest recorded temperature is 45°C. The rainy season is from June to October, during which showers are a daily occurrence. The showers rarely last long and are a far cry from the regular torrential showers known in many tropical regions. From late October to February, during the 'cold season', the climate is dominated by the harmattan wind blowing Sahara dust over the land. The dust dims the sunlight, thereby lowering temperatures significantly.

The region's lifeline for growing crops is the floodplains of the Sokoto-Rima River system, which are covered with rich alluvial soil. For the rest, the crops cultivated in Sokoto includes millet, guinea corn, beans perhaps being the most abundant, followed by maize, rice, sesame, other cereals and vegetables such as: onions, tomatoes, pepper, garden egg, lettuce, and cabbage. Apart from millet, Sokoto is the major onion producer in Nigeria. In terms of vegetation, Sokoto falls within the savannah zone. This is an open tse-tse fly-free grassland suitable for cultivation of grain crops and animal husbandry. Rain starts late and ends early with mean annual rainfall ranging between 500 mm and 1,300 mm. There are two major seasons in Sokoto, namely wet and dry. The dry season starts from October and lasts up to April in some parts and may extend to May or June in other parts. The wet season on the other hand begins in most parts of the state in May and lasts up to September, or October. The harmattan, a dry, cold and fairly dusty wind is experienced in the state between November and February. Heat is more severe in the state in March and April. But the weather in the state is always cold in the morning and hot in the afternoons, save in peak harmattan period. The topography of the state is dominated by the famous Hausa plain of northern Nigeria. The vast Fadama land of the Sokoto-Rima River

systems dissects the plain and provides the rich alluvial soil fit for a variety of crop cultivation in the state. There are also isolated hills and mountain ranges scattered all over the state.

4.2 CLIMATE AND PHYSICAL BASELINE

The area is characterized by tropical continental climate with a very fragile ecosystem. Temperatures are high throughout the year while rainfall, low and erratic which barely lasts for more than five months in a year.

4.2.1 Rainfall/Relative humidity

Average annual rainfall barely exceeds 629 mm while temperatures could be as high as 39° C or even higher, particularly during the month of April which usually records the highest of temperature. In Sokoto, the wet season is hot, oppressive, and mostly cloudy and the dry season is sweltering and partly cloudy. Over the course of the year, the temperature typically varies from *62°F* to *104°F* and is rarely below *57°F* or above *108°F*.

4.2.2 Geology and hydrogeology of Sokoto State

The Sokoto basin forms the southeastern part of the Iullemedan basin, which is a sedimentary basin covering an area of about 700 km^2 that extends from Mali and the western boundary of the of the Niger Republic through the northern Benin Republic and the northwestern Nigeria into eastern Niger (Obaje, 2009). It consists predominantly of gently undulating plain, occasionally interrupted by low mesas, with an elevation varying from 250 to 400 meters above sea level.

Within Nigeria, Sokoto basin is in the northwestern part, covering surface area of about 111,925 km^2, bounded between longitudes 3.50° N to 7.00° N and latitudes 10.0°N to 14.0° N, predominantly spanning between Sokoto, Kebbi and Zamfara states. The basin is believed to have developed by tectonic epeirogenic movements or stretching and rifting of tectonically stabilized crust during the Paleozoic era (Kogbe, 1981; Wright *et al.*, 1985). The climate of the region is characterized by long dry season (October to November- April/May), with short rainy season (June to September) and harmattan season marked by dry cold dusty wind blowing between months of November to February). During the dry season, temperatures exceed 39° C while annual rainfall ranges from 400 to 700 mm.

The vegetation of the basin falls within the Sudan Savannah agro-ecological zone characterized by sandy soil, loamy soil and some patches of Fadama land. It is made up of various species of grasses and legumes, patches of bushes and sparsely distributed indigenous tree species majority of which are thorny trees (Singh, 1995). The soil cover is mainly lithosols and alluvial along the river areas and tributaries, while the Niger river and Sokoto – Rima River and their tributaries mainly water the area.

4.2.2.1 Geology of the Area

The Sokoto basin is underlsin by crystalline basement rocks and overlying sediments. The

crystalline basement rocks consist of (i) dominant crystalline complex of migmatites and gneises, (ii) N-S trending schist belt, and (iii) older granites. Overlying the basement complex rocks are successions of sediments deposited under different conditions ranging from continental to marine events (Wright *et al.*, 1985; Kogbe, 1989; Obaje 2009).

Sedimentation began with the deposition of the Illo and Gundumi Formations unconformably over the basement complex. The Gundumi Formation consists of gravel with sand intercalations, sandstone and variegated clays, while the Illo Formation consists of interbeded clays and grits (Kogbe 1989; Obaje 1989). Overlying the Gundumi/Illo Formations is the Rima Group consisting of three distinct marine sedimeents, known as the Taloka, Dukamaje and Wurno Formations (Kogbe 1989; Obaje 2009). The Taloka Formation is the oldest Formation in the Rima Group, which consist of multiple layers of sandstone and shakes, with the sandstone containing a lot of water. The Dukaaje Formation overlies the Taloka Formation and is shaley with limestone and mudstone intercalations (Kogbe 1989; Obaje 2009), while the Wurno Formation consist of sandstone containing carbonaceous material making it to have dark appearance (Kogbe, 1989; Obaje, 2009). The Sokoto group, consisting of D age and Kalambaina Formation, overlies the Rima Group. The Dange Formation cosists of clays and shales, while the Kalambaina Formation, which overlies the former, consisits of limestone and shale. The Gwandu Formation, which consists of clay. Limestone and sandstone are the youngest series and overlies the Sokoto Group, It is of Tertiary age attributed to a lacustrine environment (Kogbe, 1989).

4.2.2.2 Hydrogeology of Sokoto Area

The water resources of Sokoto State can be categorized into surface and underground groups. The surface sources emanate from streams and rivers, lakes and ponds. Major rivers of hydrogeological importance in the State are the Sokoto, Rima and Goronyo rivers, as discharges from these rivers recharge the Rima group and to a less extent the Kalambaina limestone. Other lakes of importance are the Kalmalo, Kware and Bodinga lakes. Overflow from these lakes, contribute immensely to the recharge of Rima in the Sokoto area during intense dry season and Dange clays.

Generally, the sedimentary Formations which contain aquifers in the Sokoto basin are, (i) Recent (Alluvium, laterite), (ii) Tertiary (Gwandu Formation, Kalambaina Formation), and (iii) Cretaceous (Wurno Formation, Taloka Formation, Gundumi Formation and Illo Formation) (Oteze, 1989). All the Formations that serve as good aquifers are found in Sokoto state except the Illo Formation.

For better characterization of the hydrogeology of the Sokoto area, it will be described in terms of different geographic zones (Fig. 1), which are classified as (i) Sokoto metropolis, (ii) Southern part of Sokoto State, (iii) Eastern part of Sokoto State, and (iv) Northern part of Sokoto State.

Sokoto Metropolis

The Sokoto metropolis is presently partitioned into Sokoto North, Sokoto South and Wamakko Local Government areas. Information obtained from drilled boreholes in the Sokoto North, which comprises of the northern part of the Sokoto metropolis reveals that the prolific aquifers,

with high yield (≥ 250 Lpm), were found at moderate and high depth values. Prolific aquifers at moderate depth between 60 to 70 meters were found around Bazza, Dutse Assada and Sokoto Television Station areas. The static water level in these areas generally ranges between 18 to 24 meters. Also, such aquifers were found at high depths ranging between 104 to 130 m around Sultan Palace, Filin Idi, Kofar Kware, Mabera Jelani, Dutsin Assada and Bi-water Company. The static water level in these areas ranges from 40 to 45 meters. The aquifers constitute of limestone, of Kalambaina Formation, which is interpreted to be hard and fractures which enables it to store enough underground water.

In the Sokoto south local government, which covers the southern portion of the metropolis, the prolific aquifers are found to be shallow within areas around Civil Service Club, at depth of about 30 meters and static water level of 13.5 meters. Moderate aquifers were found at moderate depths ranging between 52 to 72 meters around Tudun Wada and Yar Akija areas, with static water levels between 27 to 43 meters respectively. Hence, these areas are prolific for groundwater survey. The aquifers constitute of limestone, of Kalambaina Formation, which is interpreted to be hard and fractures which enables it to store enough underground water.

In other parts of the metropolis, which falls within the Wamakko Local Government area, prolific aquifers at shallow, moderate and high depths were found. The shallow aquifers were found at depths ranging between 28 to 43 meters with static water levels ranging between 6 to 17 meters, around Sokoto Guest Inn, Arkilla, Kasarawa, Kontagora Road, Bado Village and Yawuri Secretariat. Such aquifers are not expected to be prolific during the intense dry season. Aquifers at high depths ranging between 96 to 150 meters with static water levels between 45 to 58 meters, were equally found around Bubare, Gwiwa, Bado Quarters, Farfaru and Talata Mafara Road. These aquifers are expected to be prolific throughout the year, especially during intense dry season when water is generally scarce. The aquifers constitute of limestone, of Kalambaina Formation, which is interpreted to be hard and fractures which enables it to store enough underground water.

Southern Part of Sokoto State

This portion of the state contains seven local governments namely, Yabo, Shagari, Bodinga, Dange/Shuni, Tureta, Tambuwal and Kebbe. Information from borehole data shows that prolific aquifers, with high yield ranging from 250 to 400 Lpm and moderate yield ranging between 100 to 250 Lpm were found in all the areas of the local governments.

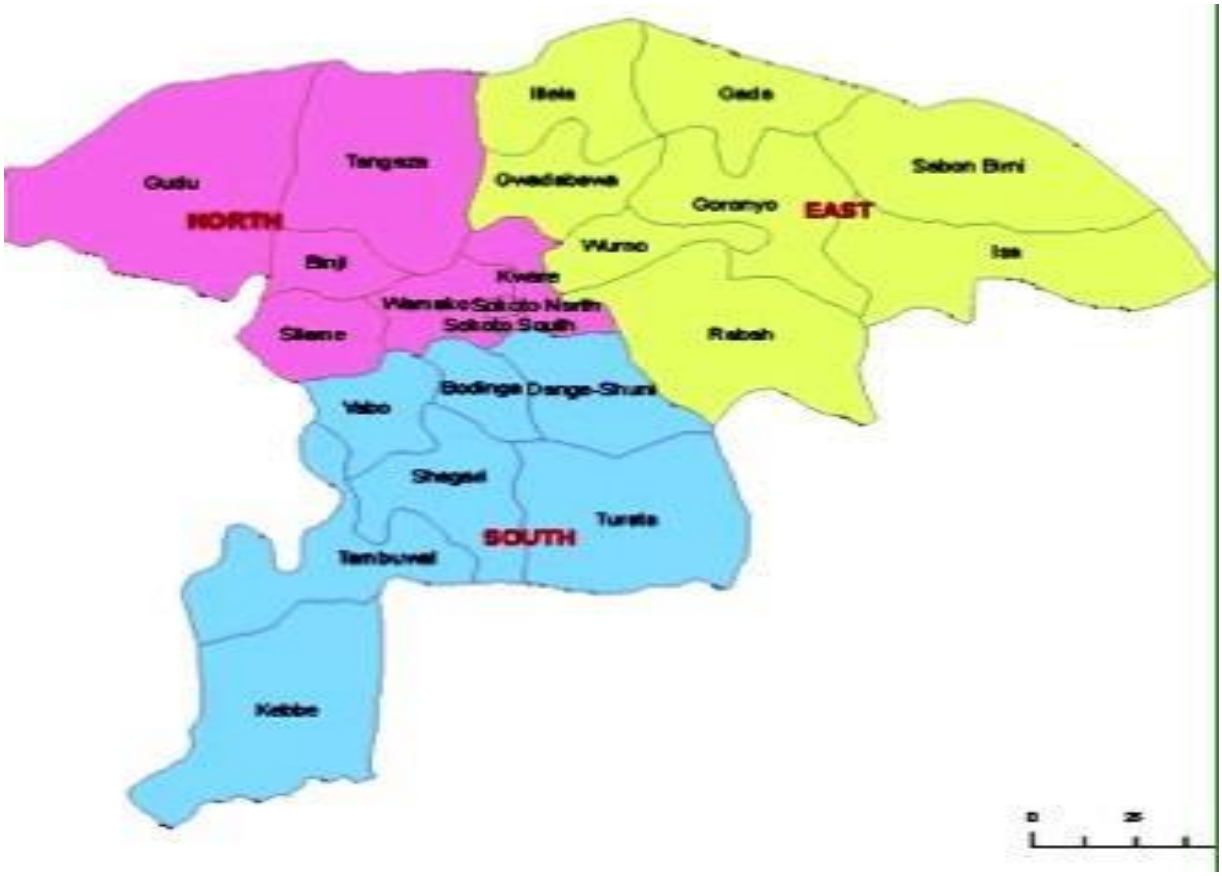


Figure 4. 1: Sokoto State showing different geological zones and local governments

In Tambuwal Local Government, the area has high prolific aquifers at depth ranging from 11.1 to 123.7 meters with static water level ranging from 5 to 80 meters, except few areas where moderate and low prolific aquifers were found. Areas of moderate prolific aquifers were found in Bilom and Iloji areas at depths ranging from 89 to 127 meters. The low prolific areas were found in Saida, Garam, Tungar Makera, Tungar Dorowa, Ruggar Rumbu, Samo, Rakuma, Gwangar Makera and Gesalode. The aquifer in the area consists of clayey sand and limestone, contained in Gwandu and Kalmbaina Formations.

In Shagari Local Government, high prolific aquifers were found ranging from 14.5 to 107.5 meters, with the static water level ranges from 42.9 to 64.2 meters throughout except around Gangumma and Illelar Wanke areas where moderate aquifers at depths ranging between 75 to 105 meters were found. The aquifers constitute fine sand, coarse sand and sand contained in Gwandu and Kalambaina Formations.

In Yabo Local Government, high prolific aquifers were found ranging from 20 to 112.5 meters, with the static water level ranges from 3.6 to 74.6 meters throughout except around Kundumba and Ruggar Kijo where moderate aquifers at depths ranging between 27.5 to 79.5 meters, with static water levels ranging from 6 to 27.5 meters were found. The aquifers constitute fine sand, coarse sand and sand and clay contained in Gwandu and Kalambaina Formations.

In Bodinga Local Government, the high prolific aquifers were found in the predominant part of the area at depths ranging from 11.0 to 122.5 meters, except few areas where aquifers of moderate and low yield were found. The areas of moderate prolific aquifers, which are at depths between 57.5 to 92.5. meters are Tauma, Bagauwan Dan Ajiwe, Zonzoro, Darhela and Tuntube areas. Further, areas of low prolific aquifers are in Tudun Buba, Lukuyawa,Guntun Gida Gidan KokaniDwrko, Kwaciyar Lalle, Badu, Darhela, Gugari, , KabawaKauri Haiya, Kaura Miyo and Kulodo areas at depths ranging between 13.0 to 134.0 meters.

In Dange/Shuni Local Government, Bodinga Local Government, the high prolific aquifers were found in Chofi, Kaluje, Tudun Dandogo, Kwannawa, Dandogo, Shiyar Ajiya, Gumera, Majen Baraya, Dankilo, Batta, Goribau, Juga Runji, Dankilo, Gajara, Shiyar Sarkin Hatsi, Rudu Fako, Rudu Gero, Runda, Marke, Kwanadi, Dabagin Dugui, Dabagin Dugaji, Rikina Gari, Burkitawa, Runjin Kai and Gugiru ateas. areas. Formation logs of drilled boreholes in the areas highlight that the depth to the aquifers in these areas range from 15.5 to 129 meters, while static water level ranges from 6.0 to 70.0 meters. Further, aquifers with moderate yield were found around Dan Burunje, Barganange, Batta, Jibawal, Dabagin Ardu, Yandara, Dali and Tuntube areas at depth between 61 to 96.5 metres and static water level between 20.0 to 60.0 meters. The aquifers constitute fine sand, in some cases with clay intercalations, contained within Gwandu Formation. Aquifers in other portions are non- prolific and not viable for storage of groundwater. The aquifers in the area constitute fine sand often associated with clay intercalations contaimed within Gwandu Formation.

In Tureta Local Government, high prolific aquifers are predominant at depths ranging between 28 to 93.5 meters and static water level between 6 and 75 meters. The aquifers consist of fine and coarse sand with clay intercalations. Apart from these areas low aquifers are present in Dangi and Bangi areas.

Eastern Part of Sokoto State

This portion of the state contains seven local governments namely, Wurno, Gwadabawa, Illela, Gada, Goronyo, Rabah, Isa and Sabon Birni. Information from borehole data shows that prolific aquifers, with high yield ranging from 250 to 400 Lpm and moderate yield ranging between 100 to 250 Lpm were found in all the areas of the local governments.

In Wurno Local Government, the high prolific aquifers were found in Marafawa, Takaru, Buramawa Magaji, Gigim and SADP headquarters. The depth to the aquifers in these areas range from 51 to 77 meters, while the static water level ranges from 12.5 to 57 meters. Aquifers in these areas constitute fine and coarse sand. However, around Runjin Tsamiya, Danbata and Kaurare Akararu areas have moderate yield aquifers at depths ranging from 59 to 104 and static water levels ranging from 36.5 to 55.4 meters were found. Aquifers in these areas constitute fine and coarse sand of Taloka Formation.

In Gwadabawa Local Government, the high prolific aquifers were found in Kangiye and Abdala

areas. The depth to the aquifers in these areas were found to range from 22 to 26 meters, while the static water level ranges from 4.12 to 4.38 meters. Also, aquifers with moderate yield at depths ranging from 83 to 98 meters and static water levels ranging from 31.2 to 59.2 meters were found in Asara Ango and Tungar Zabu areas. Aquifers in these areas constitute fine sand. Apart from these areas, borehole information from other portions of the local government shows low prolific aquifers which do not store sufficient underground water.

In Illela Local Government, the high prolific aquifers were found in Kangiye and Abdala areas. The depth to the aquifers in these areas were found to range from 22 to 26 meters, while the static water level ranges from 4.12 to 4.38 meters. Also, aquifers with moderate yield at depths ranging from 83 to 98 meters and static water levels ranging from 31.2 to 59.2 meters were found in Asara Ango and Tungar Zabu areas. Aquifers in these areas constitute fine sand and limestone. Apart from these areas, borehole information from other portions of the local government shows low prolific aquifers which do not store sufficient underground water.

In Gada Local Government, a high prolific aquifer at a depth of 79 meters and static water level of 34.6 meters was found in Baredi. Also, two aquifers with moderate yield at depths of 81 and 132 meters and static water levels ranging from 47.2 and 47.9 meters were found in Gidan Magaji and Damarke respectively. Aquifers in these areas constitute fine sand. Apart from these areas, borehole information from other portions of the local government shows low prolific aquifers which do not store sufficient underground water.

In Isa Local Government, considerable high prolific aquifers were found in the area. These areas include Janunu, Kwanar Isa, Malamawa,Gidan Katau, Batamawa, Kayaye,Dan Amma, Gidan Kadau, Gomoroji,Tagirke, Tungar Gobirawa, Kagara Bugaje, Ashabanza, Gyangyadi, Yarfakko, Awulkitti, Talokan Fili The depth to the aquifers in these areas range from 20.5 to 76.5 meters, while the static water level ranges from 3.9 to 67.5 meters. Aquifers in these areas which are confined/semi confine, constitute coarse sand and gravel. Apart from these areas, borehole information from other portions of the local government shows low prolific aquifers which do not store sufficient underground water.

In Sabon Birni Local Government, considerable number of high prolific aquifers were found in the area. These areas include Kodamayo, Kwarin Gamba, Tashar Bagaruwa, Dankwa J/Masau, Korar Mota, Takwastawa, Yar Durumba, Shalli, Kalbaba, Adamawa, Gidan Dan Fullo, Zangon Bugaje, Dankaka, Dankaru, and Satiru. The depth to the aquifers in these areas range from 41.0 101.0 meters, while the static water level ranges from 9.5 to 51.9 meters. Aquifers in these areas, which are semi confined, constitute coarse sand and gravel. Further, moderate prolific aquifers were found in Dangari and Gidan Dikko at depths of 90 and 51 meters and static water levels 13.4 and 45.6 meters respectively. The aquifers are semi confined and constitute coarse sand and gravel. The aquifers are contained within Gundumi and Taloka Formations Apart from these areas, borehole information from other portions of the local government shows low prolific aquifers which do not store sufficient underground water.

In Rabah Local Government, considerable high prolific aquifers were found throughout the Local Government, except in Kubutta, Marinawa, Alikiru and Chiris areas where the aquifers are low prolific. The depth to the prolific aquifers, which are confined/semi confined, range from 26 to 91 meters while the static water level ranges from 2.2 to 41.5 meters and constitute sand, coarse/fine sand and sand and gravel, and are contained within Gundumi Formation.

In Goronyo Local Government, the high prolific aquifers were found in Digim, Makafaru, Takaro, Kanifaru, Awalala, Dogon Tabki, Tantarkwai and Kuda Kuda. The depth to the aquifers in these areas range from 12.0 to 114.5 meters, while the static water level ranges from 4.5 to 79.5 meters. The aquifers constitute coarse sand, sand, fine sand and are contained within Kalambaina, Wurno Formations and some of them are semi confined. Further, a moderate prolific aquifer was found in Runjin Tsamiya at 55 meters depth and static water level of 37.5 meters and constitute coarse sand. The aquifers are contained within Taloka and Gundumi Formations. Apart from these areas, borehole information from other portions of the local government shows low prolific aquifers which do not store sufficient underground water.

Northern Part of Sokoto State

This portion of the state contains five local governments namely, Kware, Silame, Binji, Gudu and Tangaza. Information from borehole data shows that prolific aquifers, with high yield ranging from 250 to 400 Lpm and moderate yield ranging between 100 to 250 Lpm were found in all the areas of the local governments.

In Kware Local Government, high prolific aquifers were found in Walakae, Basansan, Geben Damna and Tungar Madugu areas. The depth to these aquifers ranges from 37.2 to 67 meters, while the static water level ranges from 6.1 to 73.5 meters. Also, moderate yield aquifers were found around Gantama'u, Gidan Rairai and Girariwa areas. These aquifers are at depths ranging from 48.5 to 125 meters and static water levels ranging from 23.8 to 79.5 meters. Aquifers in these areas, which are confined and semi confined, constitute limestone, and are contained within Kalambaina Formation.

In Silame Local Government, high prolific aquifers were found in Jakanadu, Gidan Boji, Gaukai, Tamboma, Grahitto, Tungan Bacci and Battare areas. The depth to the aquifers in these areas were found to range from 17.5 to 78 meters, while the static water level ranges from 1.0 to 14.4 meters. Aquifers in these areas constitute coarse sand, fine sand and sand which are contained in the Gwandu Formation. Apart from these areas, borehole information from other portions of the local government shows low prolific aquifers which do not store sufficient underground water.

In Binji Local Government, all the drilled boreholes were found to have high prolific aquifers, except at Dargane, where moderate prolific aquifers were found. This highlights that the area has high potential of groundwater. High prolific boreholes were found at Dalinjan Fulani, Dankuma, Kan Deza, Dargena, Araban Birni, Gidan Almu, Gidan Joga, Sabon Zama, Tungar Kwando and Dam Mali areas. The depth to the aquifers were found to range from 39 to 75 meters, while the static water level ranges from 1.00 to 43.2 meters. At Dargane area, aquifers with moderate yield

were found at depth of around 63 meters and static water levels around 14.4 meters+. The aquifers constitute fine sand, coarse sand and medium sand contained in the Gwandu Formation.

In Gudu Local Government, all the drilled boreholes in the area were found to have high prolific aquifers, which highlights that the area has high potential of groundwater. The depth to the aquifers were found to range from 25 to 92 meters, while the static water level ranges from 9.7 to 56.5 meters. The aquifers constitute fine sand, coarse sand and medium sand contained in the

Gwandu Formation

In Tangaza Local Government, all the drilled boreholes in the area were found to have high prolific aquifers, which highlights that the area has high potential of groundwater. The depth to the aquifers were found to range from 33 to 86 meters, while the static water level ranges from
8.7 to 57.7 meters. The aquifers, which are semi confined, constitute fine sand, coarse sand and medium sand contained within the Gwandu Formation.

4.2.3 Hydrology of the Project Area

The project area is drain by River Sokoto. River Sokoto is a tributary of the River Niger and originates from a place close to Funtua in the south of Katsina State about 300 kilometres away from Sokoto. River Sokoto flows north-west passing through Gusau and eventually enters Sokoto where it is joined by River Rima and further down turns south flowing through Birnin Kebbi Town in Kebbi State before reaching its confluence with the River Niger.

The plains around River Sokoto are widely cultivated using its water for irrigation. The river is also an important means of transport. Flow in streams of the Sokoto Basin is mostly overland runoff. Only few streams are perennial. Near Sokoto Town, the Rima River flows throughout the year sustained by spring discharge from perched ground water in limestone of the Kalambaina Formation.
Figure 4.2 presents the hydrology of Sokoto State.

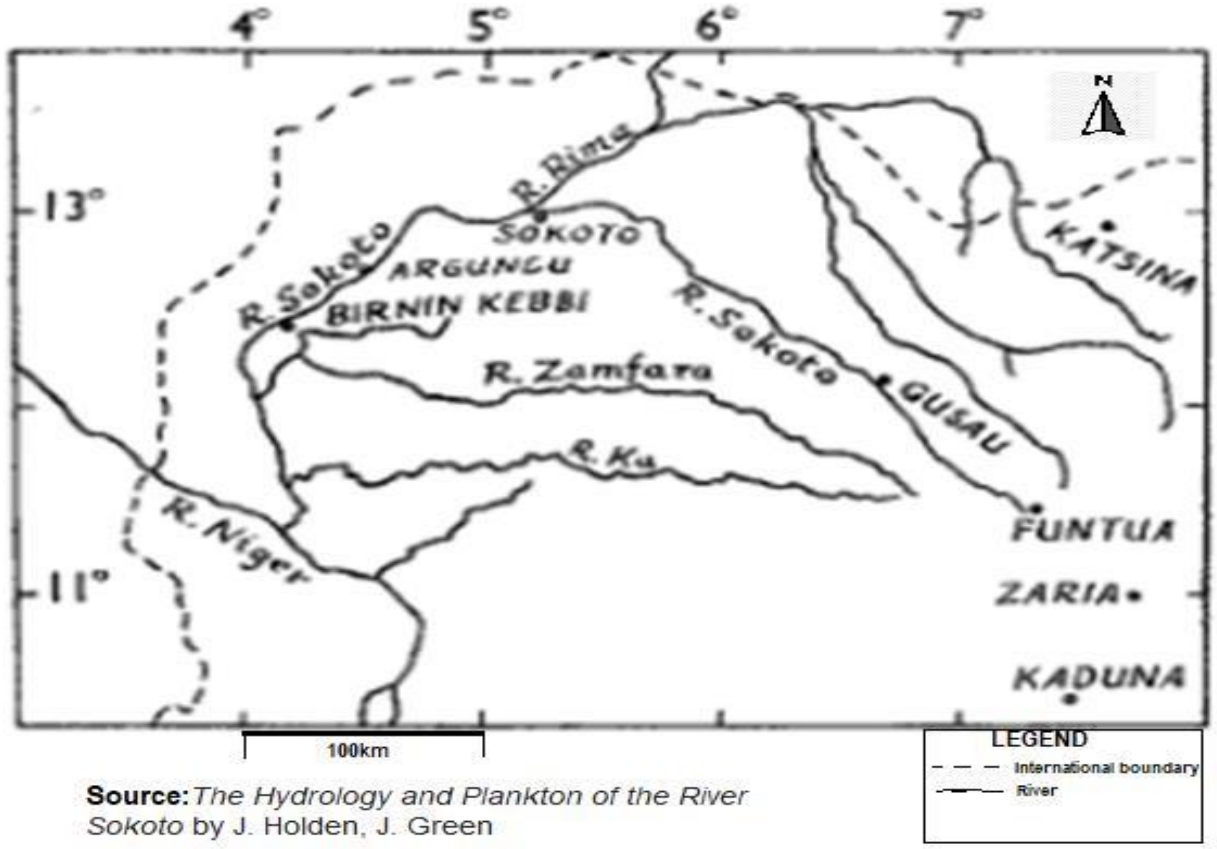


Figure 4. 2: Hydrology of Sokoto State

4.2.4 Field Sampling Techniques

To effectively characterize the bio-physical environment of the study area, a wet season field data gathering exercise was programmed for the study. The data gathering campaign was carried out between 20-25th of September 2021.

4.2.4.1 Sample Handling/Preservation and Transportation

After sampling, each sample was properly labelled, arranged and preserved. The sample label contained the following information:

- Sample Code/I.D
- Name and Location of Site;
- Date and Time of Sampling;
- Name and Signature of Sampler;
- Type of Sample, and

- Type of Preservative used.

4.2.4.2 Chain of Custody Management

All samples collected on site were recorded in a field notebook or field log. Inventory of samples collected and all necessary information including parameters to analyse, type of sample, date of sampling, etc were recorded in the chain of custody form.

4.2.4.3 Quality Assurance/ Quality Control

In order to ensure the integrity of collected samples, the following measures were taken to avoid cross contamination, deterioration and pollution of samples from the point of collection on the site till the collation of the laboratory results.

- We ensured that the samples collected were representative of the materials to be examined by collecting adequate volumes and from points of target as determined;
- Ensured that there was no contamination or cross-contamination of the samples or equipment by keeping all materials in contaminant-free spaces and decontaminating equipment in-between sampling stations with Ninety-five (95) Percent Ethanol;
- Ensured adequate volumes of samples collected for laboratory examinations;
- All samples were collected with the appropriate containers and preservatives;
- All field observations and data were captured and logged in the field logs as timely as required;
- All samples were timely, properly and completely identified/coded;
- All samples were duly preserved in the cool box fitted with frozen ice packs and delivered to the laboratory same day of collection; and
- All samples were properly analyzed in line with required methods and standards.

4.2.5 Analytical Methods and Results

Samples collected from the field were analysed in Giolee laboratory, a FMEnv Accredited laboratory located in Port Harcourt, Rivers State, Nigeria. The methods presented in Table 4.2 were employed in the samples analyses. Also shown on the table are the equipment detection limits for the different parameters analysed.

Table 4. 1: Analytical methods

Parameter	Method	Detection Limit
Parameters for Water Analysis		
Temperature (^{o}C)	APHA 2110B	-
pH	APHA 4500H^{+}B	-
Turbidity (NTU)	APHA 2130B	1.0
Salinity (mg/l)	APHA 2520B	0.01
TSS (mg/l)	APHA 2540D	1
TDS (mg/l)	APHA 2510A	-
Conductivity (µS/cm)	APHA 2510A	-
THC (mg/l)	ASTM D3921	1.0
DO (mg/l)	APHA 4500-O G	-
BOD (mg/l)	APHA 5210A	0.5
COD (mg/l)	APHA 5220D	0.8
Reactive Silica (mg/l)	APHA 4500-SiO_2	0.1
Nitrate (mg/l)	EPA 352.1	0.02
Phosphate (mg/l)	APHA4500-P D	0.002
Ammonium (mg/l)	APHA 4500-NH_3	0.02
Calcium (mg/l)	APHA 3111B/ASTM D3561	0. 1
Magnesium (mg/l)	APHA 3111B/ASTM D3561	0.1
Potassium (mg/l)	APHA 3111B/ASTM D3561	0. 1
Sodium (mg/l)	APHA 3111B/ASTM D3561	0.1
Lead (mg/l)	APHA 3111B	0.20
Total Iron (mg/l)	APHA 3111B	0.05
Copper (mg/l)	APHA 3111B	0.05
Zinc (mg/l)	APHA 3111B	0.05
Manganese (mg/l)	APHA 3111B	0.10
Cadmium (mg/l)	APHA 3111B	0.02
Total Chromium (mg/l)	APHA 3111B	0.10
Mercury (mg/l)	APHA 3112B	0.0002
Arsenic (mg/l)	APHA 3030B/3114B	0.001

Table 4.1 continued

Parameter	Method	Detection Limit
Parameters for Soil Analysis		
pH (H_2O)	ASTM D4972	-
TOC/TOM (mg/kg)	BS 1377	-
Conductivity (mg/kg)	APHA 2510B	10.0
THC (mg/kg)	ASTM D3921	0.02
Nitrate (mg/kg)	EPA 352.1	0.002
Phosphate (mg/kg)	APHA 4500-P D/CAEM	-
PSD (mg/kg)	ASTM D422	0.1
Calcium (mg/kg)	APHA 3111D	0.1
Magnesium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Potassium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Sodium (mg/kg)	APHA 3111B/ASTM D3561	0.05
Zinc (mg/kg)	ASTM D5198/APHA	0.20
Lead (mg/kg)	ASTM D3111B /D5198	0.0002
Mercury (mg/kg)	APHA 3112B/ASTM D	0.001
Arsenic (mg/kg)	APHA 3030F/3114B	0.05
Total Iron (mg/kg)	APHA 3111B/ASTM D5198	0.05
Copper (mg/kg)	APHA 3111B/ASTM D5198	0.02
Cadmium (mg/kg)	APHA 3111D/ASTM D5198	0.10
Total Chromium (mg/kg)	APHA 3111B/ASTM D5198	

The specific objectives of the field sampling were to: Determine the ambient air quality and noise level of the study area;

A total of 5 air/noise samples including controls samples were collected from each station.

Plate 4. 1: Air/noise samples been collected

Sokoto Dairy Plant and Veterinary Hospital Air Quality and Noise Level

The mean concentrations of the air pollutants (CO_2, SO_X, SPM, NH_3, VOC, NO_X, CH_4, H_2S) and noise levels were measured in the study area within a radius of 1.5km (zone of influence) from the center of the project site. Measurements were taken during the study period. Generally, measurements indicated that the ambient air was free from pollution by these measured parameters as at time of study. The qualities of air as tested within the proposed Sokoto dairy plant study area and the Veterinary Hospital study area are presented in Table 4.2**.**

Suspended Particulate Matter

The SPM levels in the Sokoto dairy plant study area ranged from 8.0µg/m^3 to 14.0 µg/m^3 with a mean value of 11.67 µg/m^3 during the sampling period which compared well with the control. The SPM levels in the Veterinary hospital study area ranged from 9.00µg/m^3 to 16.0 µg/m^3 with a mean value of 11.67 µg/m^3 during the sampling period which also compared well with the control. Values were also below the regulatory limit of 250µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Table 4. 2: Air quality characteristics for dairy and vet. hospital sites

Parameter/unit	**Sokoto Dairy Plant**				**Veterinary Hospital**				**Fertilizer Blending Plant Project EIA, 2021**	**FMEnv Limits (Daily Average) ****
	min	**max**	**Mean**	**Control**	**min**	**max**	**mean**	**Control**		
Noise level, d(B) A	43.30	46.20	44.90	40.95	43.60	46.30	44.80	40.75	47.34	**90**
SO_X, µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.89	**26**
NOx, µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NA	**75-113**
SPM µg/m^3	8.00	14.00	11.67	12.00	9.00	16.00	11.67	12.00	50	**250**
NH_3, µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.7	**0.13**
CH_4 µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NA	**0.01**
CO µg/m^3	0.03	0.09	0.07	0.02	0.03	0.09	0.07	0.02	2.13	**11.4**
H_2S, µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.01**
Air Temp (^{o}C)	36.03	37.16	36.41	35.53	34.01	37.04	35.74	35.53	NA	**NA**
Wind Speed (m/s)	0.01	0.04	0.02	0.03	0.01	0.04	0.02	0.03	NA	**NA**
Relative Humidity (%)	37.40	44.80	40.37	43.55	39.30	42.70	41.07	43.55	NA	**NA**

Source: Field work, 2021. NA: Not Applicable

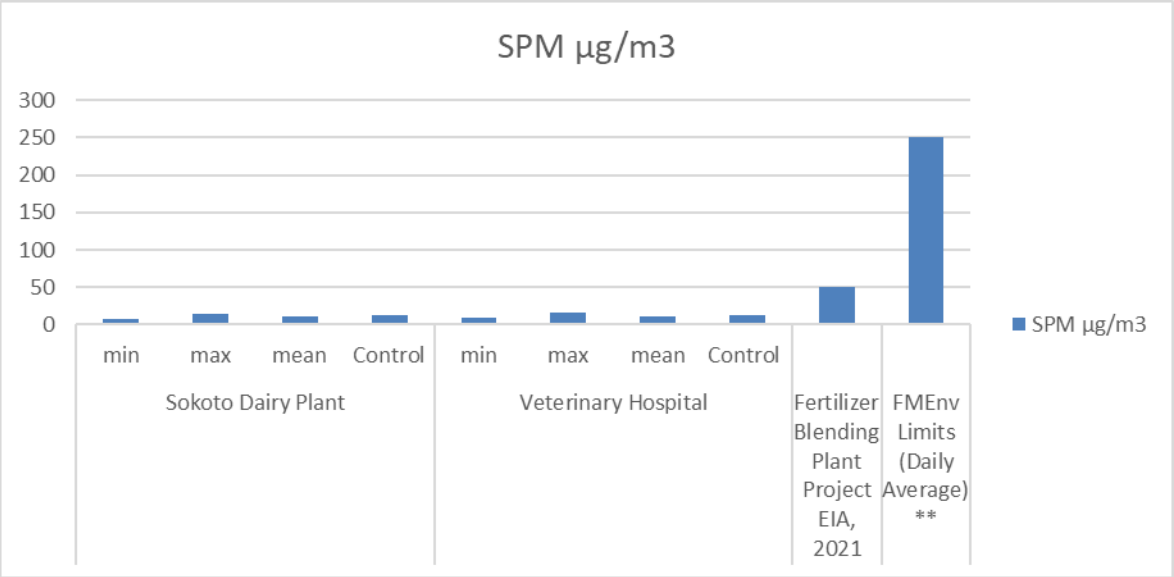


Figure 4. 3: Suspended Particulate Matter in Air. Source: Fieldwork, 2021

Carbon Monoxide

The recorded level of CO ranged from 0.01µg/m^3 to 0.03µg/m^3 with a mean value of 0.09 µg/m^3 during sampling period in the Sokoto dairy plant study area. These obtained values compared well with control readings. In the Veterinary hospital study area the CO level ranged from 0.03µg/m^3 to 0.09µg/m^3 with a mean value of 0.07 µg/m^3 during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 11.4µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Hydrogen Sulphide

H_2S was generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 0.01µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Sulphur Oxides

SO_x were generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 26µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Nitrogen Oxides

NO_x was generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 75µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Methane

Methane gas was generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 0.01µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Ammonia

NH_3 was generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 0.13µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

2.8.3 Noise Level

Noise levels in the Sokoto dairy plant study area ranged from 43.30 d(B) to 46.20 d(B) with a mean value of 44.90 d(B) during the sampling period which compared well with the control. In the Veterinary hospital study area, it ranged from 43.60 d(B) to 46.30 d(B) with a mean value of 44.80 d(B) during the sampling period which compared well with the control. Values were also below the regulatory limit of 90 d(B) and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

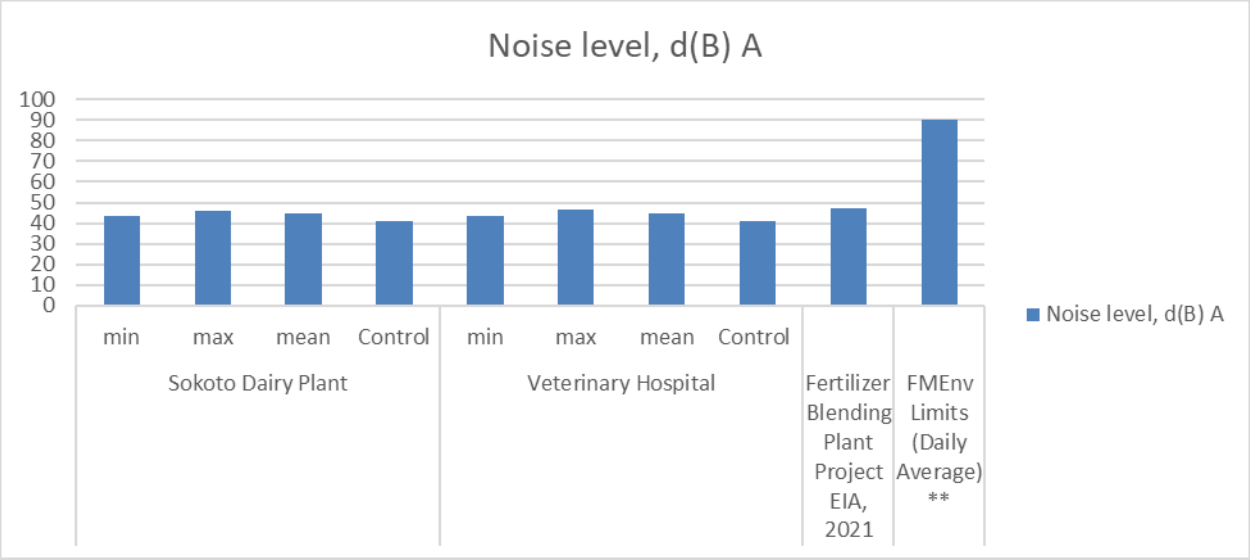


Figure 4. 4: Noise Level. Source: Fieldwork, 2021

<u>Agrofarm Estate, Dogon Daji and Cattle Breeding & Milk Production Air Quality and Noise Level</u>

The mean concentrations of the air pollutants (CO_2, SO_X, SPM, NH_3, VOC, NO_X, CH_4, H_2S) and noise levels were measured in the study area within a radius of 1.5km (zone of influence) from the centre of the project site. Measurements were taken during the study period. Generally,

measurements indicated that the ambient air was free from pollution by these measured parameters as at time of study. The quality of air as tested within the Agro farm estate study area are presented in Table 4.4, while Table **4.** presents the quality of air as tested within the Cattle breeding/Milk production study area.

Table 4. 3: Air quality characteristics for Agro-farm and Cattle breeding and Milk prod sites

Parameter/unit	**Agro Farm Estate**				**Cattle breeding /Milk production**				**Fertilizer Blending Plant Project EIA, 2021**	**FMEnv Limits (Daily Average) ****
	min	**max**	**mean**	**Control**	**min**	**max**	**mean**	**Control**		
Noise level, d(B) A	41.30	44.50	43.29	43.95	42.10	45.50	43.60	40.95	47.34	90
SO_X, µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.89	26
NOx, µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NA	75-113
SPM µg/m^3	8.00	17.00	11.40	12.00	9.00	12.00	10.67	12.00	50	250
NH_3, µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.7	0.13
CH_4 µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NA	0.01
CO µg/m^3	0.01	0.07	0.02	0.02	0.02	0.08	0.06	0.02	2.13	11.4
H_2S, µg/m^3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Air Temp (^{o}C)	33.14	36.04	34.75	35.53	35.01	36.04	35.41	35.53	NA	NA
Wind Speed (m/s)	0.01	0.07	0.03	0.03	0.01	0.04	0.02	0.03	NA	NA
Relative Humidity (%)	32.10	47.90	42.43	43.70	38.30	42.80	40.10	43.55	NA	NA

Source: Field work, 2021. NA: Not Applicable

Suspended Particulate Matter

The SPM levels in the Agro farm estate study area ranged from 8.0µg/m^3 to 17.0 µg/m^3 with a mean value of 11.40 µg/m^3 during the sampling period which compared well with the control. The SPM levels in the Cattle breeding/Milk production study area ranged from 9.00µg/m^3 to 12.0 µg/m^3 with a mean value of 10.67 µg/m^3 during the sampling period which also compared well with the control. Values were also below the regulatory limit of 250µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

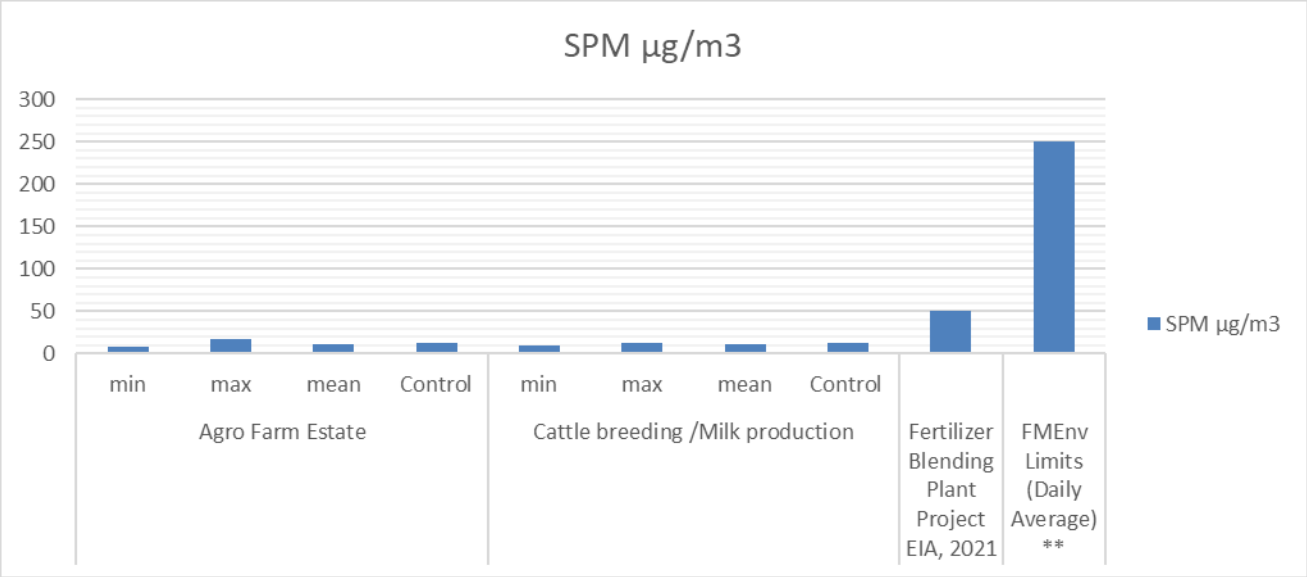


Figure 4. 5: Suspended Particulate Matter in Air

Source: Fieldwork, 2021

Carbon Monoxide

The recorded level of CO ranged from 0.01µg/m^3 to 0.07µg/m^3 with a mean value of 0.02 µg/m3 during sampling period in the Agro farm estate study area. These obtained values compared well with control readings. In the Cattle breeding/Milk production study area the CO level ranged from 0.02µg/m^3 to 0.08µg/m^3 with a mean value of 0.06 µg/m^3 during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 11.4µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Hydrogen Sulphide

H_2S was generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 0.01µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Sulphur Oxides

SO_x was generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 26µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Nitrogen Oxides

NO_x was generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the

regulatory limit of 75µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Methane

Methane gas was generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 0.01µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Ammonia

NH_3 was generally below detectable level of <0.01µg/m^3 in the study areas during the sampling period. These obtained values compared well with control readings. Values were also below the regulatory limit of 0.13µg/m^3 and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Noise Level

Noise levels in the Agro farm estate study area ranged from 41.30 d(B) to 44.50 d(B) with a mean value of 43.29 d(B) during the sampling period which compared well with the control. In the Cattle breeding/Milk production study area it ranged from 42.1 d(B) to 45.50 d(B) with a mean value of 43.60 d(B) during the sampling period which compared well with the control. Values were also below the regulatory limit of 90 d(B) and compared well with readings from a previous study (Fertilizer Blending Plant Project EIA, 2021).

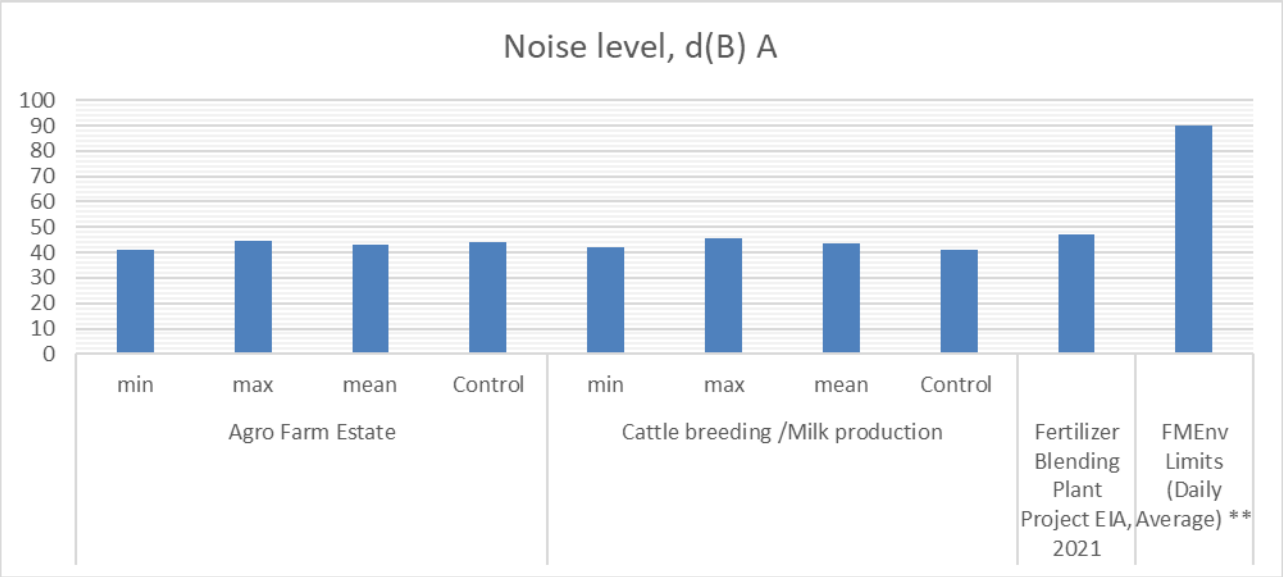


Figure 4. 6: Noise Level

Source: Fieldwork, 2021

4.2.4.5 Methodology for Soil studies

Soil samples were collected with hand auger at two depth intervals (0-15cm and 15-30cm). These samples were preserved in plastic bags and stored in coolers and transported to Giolee Laboratory for Analysis within 24 hours. On the **Ground Water Quality,** the concentrations of the groundwater parameters were measured in the study area within a radius of 1.5km (zone of influence) from the center of the project sites.

4.2.4.6 Soil Physico-Chemical Characteristics for the sites Dairy Plant and Vet. Hospital

Soil samples of the proposed project sites for Sokoto dairy plant and veterinary hospital were collected from geo-referenced stations on the project sites. At each station, soil samples were collected from two depth levels: 0 – 15cm, and 15 – 30cm. Result from analyses is summarized in Table 4.4.

Plate 4. 2: Soil sampling on cattle breeding site

pH

Soil pH or soil reaction is an indication of the acidity or alkalinity of soil and is measured in pH units. Soil pH is defined as the negative logarithm of the hydrogen ion concentration. The pH scale goes from 0 to 14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases, the soil pH decreases thus becoming more acidic. From pH 7 to 0 the soil is increasingly more acidic and from pH 7 to 14 the soil is increasingly more alkaline or

basic.

pH of the soil sampled were generally varying from basic to acidic. At the proposed Sokoto dairy plant study area, it ranged from 1.14 to 8.14 with a mean value of 6.42 at the top soil and between 7.11 and 7.21 with a mean value of 7.15 at sub soil. At the proposed Veterinary hospital study area it ranged from 1.34 to 8.25 with a mean of 6.94 at the top soil and between 7.11 and 8.34 with a mean value of 7.40. All obtained values compared well with values from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Total Organic Carbon

The principal factors responsible for high organic matter in soil include vegetative cover and decay of plant residue. These factors are significantly absent in the proposed project areas. Hence, return of organic matter to the soil is poor. Total organic carbon content in the entire soils was generally low. The result indicates that at the proposed Sokoto dairy plant study area, the soil had a mean total organic content of 0.30% and 0.85% in top and sub soil respectively. Meanwhile at the proposed Veterinary hospital study area, TOC had a mean value of 1.43% and 1.48% respectively in top and sub soil.

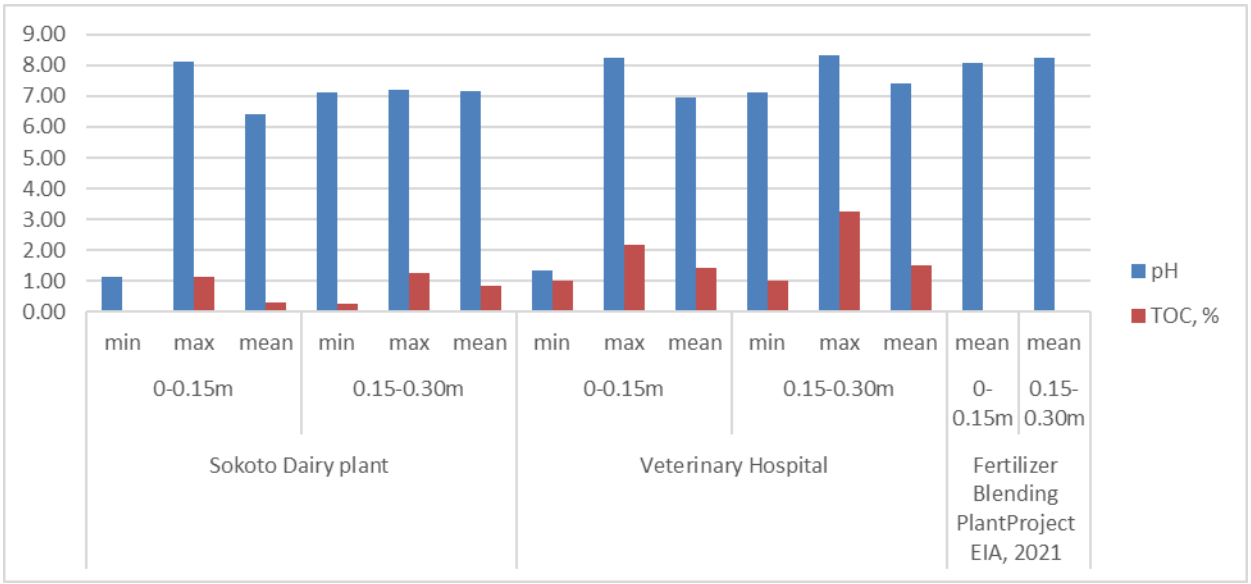


Figure 4. 7: pH and Total Organic Carbon in Soil. Source: Fieldwork, 2021

Total Hydrocarbon Content (THC)

Hydrocarbons are a common and natural occurrence in the environment and varying concentrations in soils are not unusual. Microbes in the soils and water have a natural ability to breakdown many of these compounds and any hydrocarbon which is exposed to the air will also have an affinity to

volatilize. As well, reactions including photochemistry and the various transformations of the hydrocarbon through these reactions can enhance the hydrocarbon decomposition. Industrial processes and man induced activities often result in the increased loading of hydrocarbons in soil. The natural abilities of the soil to decompose the hydrocarbons become overwhelmed.

The THC analysed from the soil samples during the study were below equipment detection limit of <0.01mg/kg in all stations. These values were lower than the natural background concentration of 50mg/kg for standard soils (SIEP, 1995).

PSD

The textural composition of soil samples collected from the area was dominantly sand with an admixture of silt and clay. Mean particle size of 68.10% sand, 15.48% silt and 16.02% clay were recorded for top soil and 62.80% sand, 11.04% silt and 26.16% clay for sub soil for the proposed Sokoto dairy plant study area. On the other hand, mean particle size of 72.33% sand, 14.04% silt and 13.34% clay were recorded for top soil and 63.57% sand, 12.06% silt and 24.23% clay for sub soil at the proposed Veterinary hospital study area. These findings did not corroborate the previous study as the soil was silty (Fertilizer Blending Plant Project EIA, 2021).

Anions Concentration of the Soils

Sulphate: At the proposed Sokoto dairy plant study area, sulphate values were low with values ranging from 1.02 to 1.82mg/kg and from 0.21 to 1.82mg/kg respectively for top and sub soil. At the proposed Veterinary hospital study area, sulphate concentration ranged from 0.21 to 1.82mg/kg and 0.14 to 1.23mg/kg respectively for top and sub soil. Values were lower than those obtained from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Ammonia: At the proposed Sokoto dairy plant study area, ammonia values were low with values ranging from 0.01 to 0.12mg/kg and from 0.06 to 0.18mg/kg respectively for top and sub soil. At the proposed Veterinary hospital study area, ammonia concentration ranged from 0.01 to 0.12mg/kg and 0.02 to 0.18mg/kg respectively for top and sub soil

respectively.

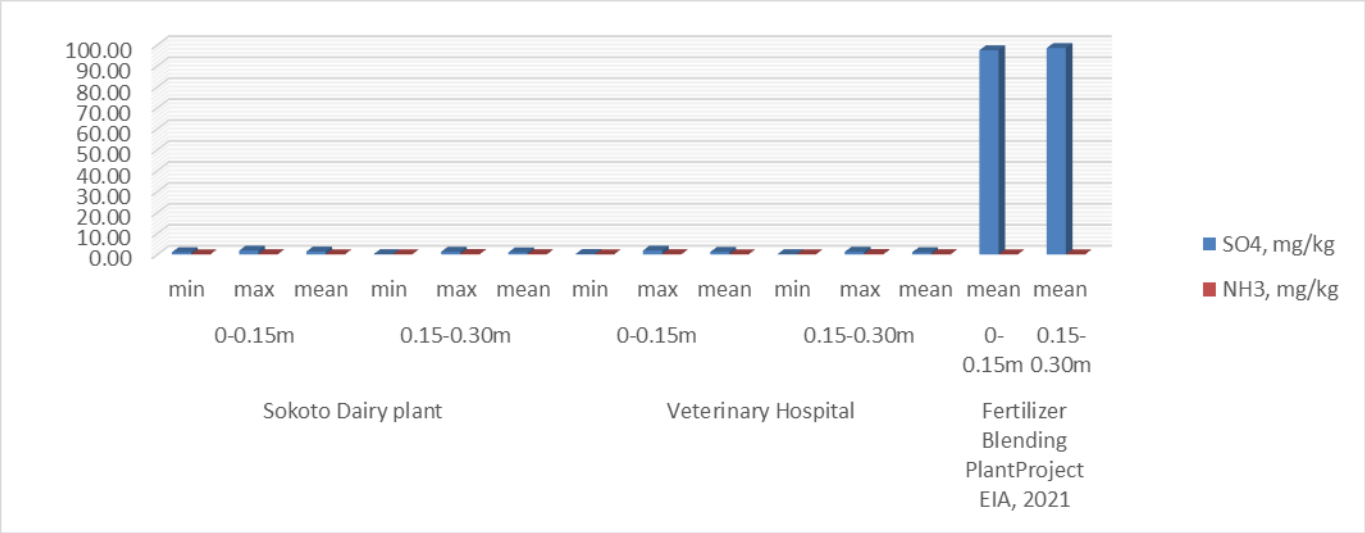


Figure 4. 8: Sulphate and Ammonia in Soil

Source: Fieldwork, 2021

Table 4. 4: Physico-Chemical and Microbiology of soil samples for Dairy and Vet Hospital

Parameters	**Veterinary Hospital**						**Veterinary Hospital**						**Fertil Plant**
	0-0.15m			**0.15-0.30m**			**0-0.15m**			**0.15-0.30m**			**0-0.15**
	Min	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Mean**
pH	1.14	8.14	6.42	7.11	7.21	7.15	1.34	8.25	6.94	7.11	8.34	7.40	8.10
TOC, %	0.02	1.14	0.30	0.25	1.25	0.85	1.01	2.15	1.43	1.02	3.25	1.48	NA
THC, mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NA
SO_4, mg/kg	1.022	1.82	1.36	0.14	1.23	0.95	0.21	1.82	1.18	0.14	1.23	1.01	97.5
NH_3, mg/kg	0.01	0.12	0.05	0.06	0.18	0.12	0.01	0.12	0.04	0.02	0.18	0.09	NA
% Sand	63.00	71.50	68.10	48.30	75.00	62.80	63.00	93.40	72.33	48.30	75.00	63.57	10.36
% Silt	10.20	19.00	15.48	5.10	18.00	11.04	5.00	19.00	14.04	5.10	19.00	12.06	53.89
% Clay	9.50	25.80	16.02	10.80	46.60	26.16	1.60	25.80	13.34	10.80	46.60	24.23	35.73
Calcium, mg/kg	12.92	14.12	13.40	11.31	16.41	13.67	11.15	15.61	13.39	11.31	16.41	13.66	3.65
Magnesium, mg/kg	9.60	27.60	17.58	9.15	21.10	13.92	9.60	27.60	17.65	9.15	21.60	16.06	5.73
Sodium, mg/kg	9.23	14.26	12.24	8.33	15.48	11.31	9.23	24.56	14.46	8.33	18.57	12.34	NA
Potassium, mg/kg	10.15	28.53	17.89	9.41	18.11	12.56	10.15	28.53	17.26	9.41	28.53	14.83	NA
Copper,	0.0	1.9	1.1	0.1	2.2	1.2	0.0	1.9	1.1	0.1	2.2	1.3	1.1
mg/kg	1	1	2	4	3	6	3	1	9	4	6	9	1
Lead, mg/kg	0.17	1.46	1.00	1.12	1.34	1.22	0.17	1.75	1.19	1.12	1.56	1.26	0.018
Iron, mg/kg	11.03	23.14	17.89	12.19	22.16	19.15	18.17	24.9	20.86	18.2	27.7	21.8	6.59
Nickel, mg/kg	2.22	11.69	8.10	2.17	8.58	6.56	6.14	224.0	39.36	2.17	8.58	6.64	0.015

Table 4.4 continued

Parameters	**Veterinary Hospital**						**Veterinary Hospital**						**Fertil Blend Proje 2021**
	0-0.15m			**0.15-0.30m**			**0-0.15m**			**0.15-0.30m**			**0-0.15m**
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Mean
Chromium, mg/kg	0.01	0.09	0.07	0.07	0.09	0.08	0.01	0.17	0.09	0.02	0.18	0.08	NA
Cadmium, mg/kg	0.01	0.07	0.04	0.01	0.07	0.03	0.01	0.07	0.04	0.01	0.07	0.04	0.15
Zinc, mg/kg	0.35	1.79	1.00	0.11	1.80	0.74	1.00	1.79	1.33	0.12	3.16	1.41	2.62
HUB, CFU/gx10^4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nil
HUf, CFU/gx10^3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nil
THB, CFU/gx10^4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nil
THB, CFU/gx10^3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nil
E Coli	0.00	2.04	0.85	0.00	4.03	1.23	0.00	2.04	0.95	0.00	1.06	0.74	Nil

Exchangeable Bases

The exchangeable bases of the soil measured were Na, K, Ca and Mg. In the proposed Sokoto dairy plant study area, Potassium dominated the exchange site with mean values of 17.89mg/kg and 12.56mg/kg respectively in the top and sub soil. While magnesium dominated in the proposed Veterinary hospital study area with mean values of 17.65mg/kg and 16.06mg/kg respectively in the top and sub soil. Two factors which mainly contribute to Exchange Capacity in soil are organic matter content and clay composition. In the assessment these two parameters were relatively and inherently low which will give rise to generally low CEC of the soils.

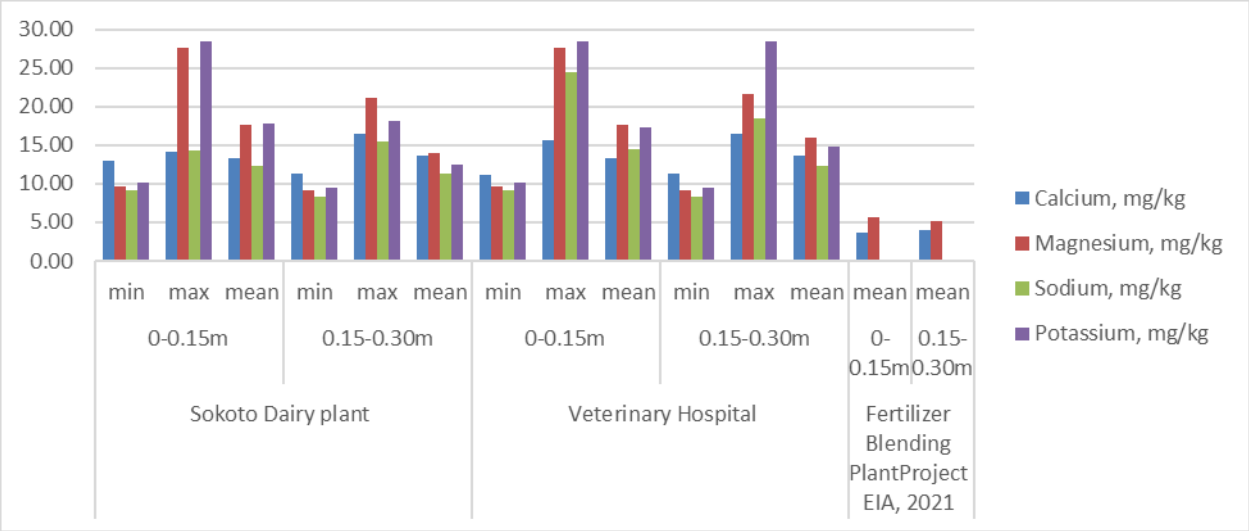


Figure 4. 9: Soil Exchangeable Bases for dairy plant and vet. hospital

Source: Fieldwork, 2021

Heavy Metals

Human activities have dramatically changed the composition and organization of soils. Industrial and urban wastes, agricultural application and also mining activities resulted in an increased concentration of heavy metals in soils. Soils normally contain low background levels of heavy metals. Excessive levels of heavy metals can be hazardous to man, animals and plants. Heavy metals of greatest concern are iron (Fe), copper (Cu), lead (Pb), nickel (Ni), Zinc (Zn), Chromium (Cr) and Cadmium (Cd). Ecological soil investigation involved sampling of soil (0-15cm and 15-30cm depth) at the designated stations within the study area.

At the proposed construction of the proposed Sokoto dairy plant study area, values obtained were between 0.01-1.91mg/kg (top soil) and 0.14-2.23mg/kg (sub soil) for Cu; 0.17-1.46mg/kg (top soil) and 1.12-1.34mg/kg (sub soil) for Pb; 11.03-23.14mg/kg (top soil) and 12.19-22.16mg/kg

(sub soil) for Fe; 2.22-11.69mg/kg (top soil) and 2.17-8.58mg/kg (sub soil) for Ni; 0.01-0.09mg/kg (topsoil) and 0.07-0.09mg/kg (subsoil) for Cr; 0.01-0.07mg/kg (top soil) and 0.01-0.07mg/kg (sub soil) for Cd; and 0.35-1.79mg/kg (top soil) and 0.11-1.80mg/kg (sub soil) for Zn.

At the proposed Veterinary hospital study area, values obtained were between 0.03-1.91mg/kg (top soil) and 0.14-2.26mg/kg (sub soil) for Cu; 0.17-1.75mg/kg (top soil) and 1.12-1.56mg/kg (sub soil) for Pb; 18.17-24.88mg/kg (top soil) and 18.19-27.72mg/kg (sub soil) for Fe; 6.14-224.00mg/kg (top soil) and 2.17-8.58mg/kg (sub soil) for Ni; 0.01-0.17mg/kg (topsoil) and 0.02-0.18mg/kg (subsoil) for Cr; 0.01-0.07mg/kg (top soil) and 0.01-0.07mg/kg (sub soil) for Cd; and 1.00-1.79mg/kg (top soil) and 0.12-3.16mg/kg (sub soil) for Zn.

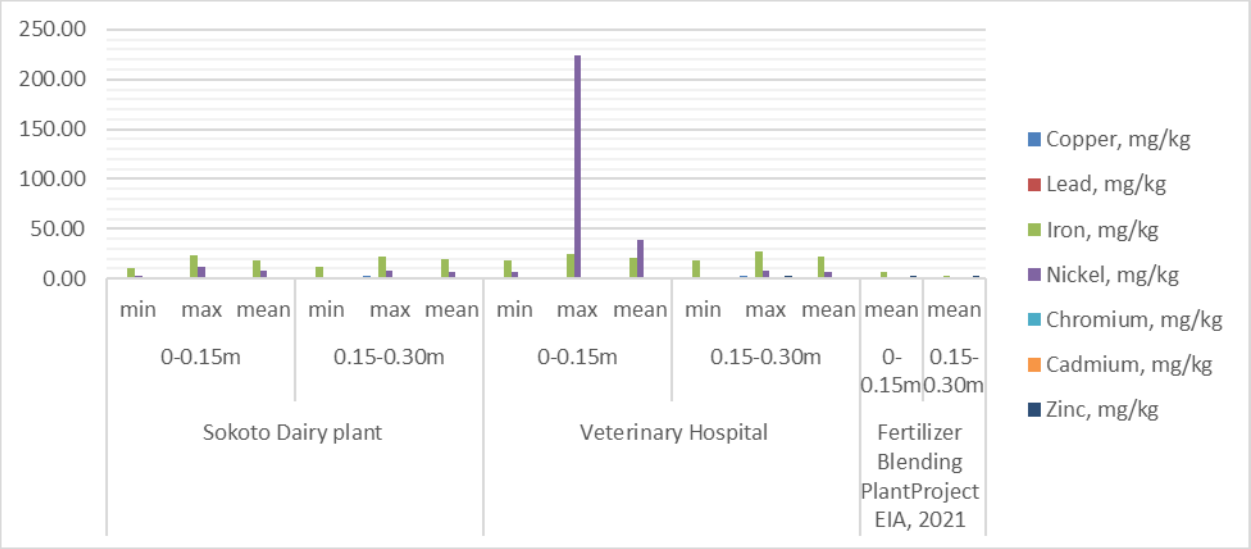


Figure 4. 10: 1Heavy Metals in Soil. Source

Fieldwork, 2021

Soil Microbiological Characteristics

The two groups of microorganisms studied are fungi and bacteria, which are the most important organic matter decomposers in the soil. Bacteria and fungi (microbes) counts provide information on the level of on-going biochemical activities in the soil. Microbial counts under normal circumstances increases with an increase in soil organic matter. About 1g of fertile soil should contain 1 x 10^6 to 1 x 10^8cfu/g bacteria and fungi (Odu *et al.*, 1985). These organisms were not present in the samples collected. However, E Coli in the samples had mean values of 0.85 and 1.23 respectively at the top and sub soil samples for the proposed Sokoto dairy plant study area. On the other hand, mean values of 0.95 and 0.74 respectively were obtained at the top and sub soil samples for the proposed Veterinary hospital study area.

Agrofarm Estate and Cattle Breeding & Milk Production Soil Physico-Chemical Characteristics

Soil samples were collected for the proposed construction of the Agrofarm Estate and Cattle Breeding & Milk Production. Samples were collected within a radius of 1.5km (zone of influence) from the centre of the project sites. At each station, soil samples were collected from two depth levels: 0 – 15cm, and 15 – 30cm. Result from the analyses is summarized in **Table 4.5**.

pH

Soil pH or soil reaction is an indication of the acidity or alkalinity of soil and is measured in pH units. Soil pH is defined as the negative logarithm of the hydrogen ion concentration. The pH scale goes from 0 to 14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases, the soil pH decreases thus becoming more acidic. From pH 7 to 0 the soil is increasingly more acidic and from pH 7 to 14 the soil is increasingly more alkaline or basic.

pH of the soil sampled were generally varying from basic to acidic. At the proposed Agrofarm Estate study area, it ranged from 7.10 to 8.08 with a mean value of 7.24 at the top soil and between 7.01 and 7.41 with a mean value of 7.14 at sub soil. At the proposed Cattle Breeding & Milk Production study area it ranged from 1.34 to 8.29 with a mean of 6.85 at the top soil and between 7.27 and 8.44 with a mean value of 8.08. All obtained values compared well with values from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Total Organic Carbon

The principal factors responsible for high organic matter in soil include vegetative cover and decay of plant residue. These factors are significantly absent in the proposed project areas. Hence, return of organic matter to the soil is poor. Total organic carbon content in the entire soils was generally low. The result, see (**Table 4.**). Indicates that at the proposed Agro farm Estate study area, the soil had a mean total organic content of 0.18% and 0.78% in top and sub soil respectively. Meanwhile at the proposed Cattle Breeding & Milk Production study area, TOC had a mean value of 0.77% and 0.92% respectively in top and sub soil.

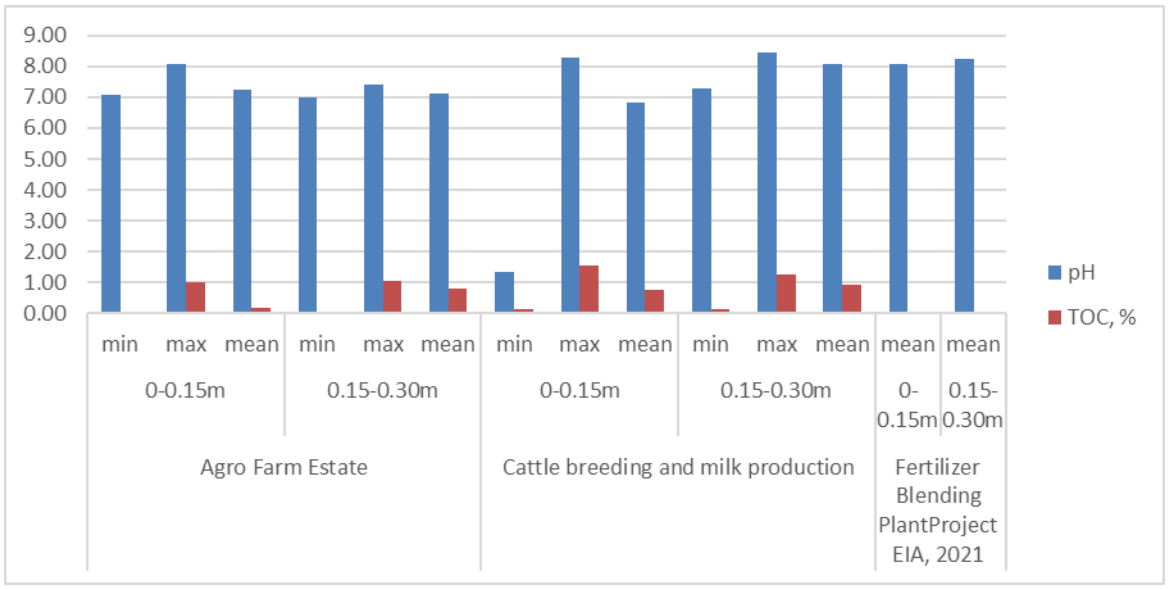


Figure 4. 11: pH and Total Organic Carbon in Soil in agro-farm and cattle breeding &milk prod

Source: Fieldwork, 2021

Total Hydrocarbon Content (THC)

Hydrocarbons are a common and natural occurrence in the environment and varying concentrations in soils are not unusual. Microbes in the soils and water have a natural ability to breakdown many of these compounds and any hydrocarbon which is exposed to the air will also have an affinity to volatilize. As well, reactions including photochemistry and the various transformations of the hydrocarbon through these reactions can enhance the hydrocarbon decomposition. Industrial processes and man induced activities often result in the increased loading of hydrocarbons in soil. The natural abilities of the soil to decompose the hydrocarbons become overwhelmed.

The THC analysed from the soil samples during the study were below equipment detection limit of <0.01mg/kg in all stations. These values were below the natural background concentration of 50mg/kg for standard soils (SIEP, 1995).

PSD

Particle-size distributions (PSDs) of soils are often used to estimate other soil properties, such as soil moisture characteristics and hydraulic conductivities. Prediction of hydraulic properties from soil texture requires an accurate characterization of PSDs. The textural composition of soil samples collected from the area was dominantly sand with an admixture of silt and clay. Mean particle size of 64.59% sand, 21.81% silt and 13.59% clay were recorded for top soil and 75.31% sand, 8.89% silt and 15.80% clay for sub soil at the proposed Agro farm Estate study area. On the other hand, mean particle size of 74.36% sand, 13.82% silt and 11.62% clay were recorded for top soil and 65.10% sand, 12.26% silt and 22.44% clay for sub soil at the proposed Cattle Breeding

& Milk Production study area. These findings did not corroborate the previous study as the soil was silty (Fertilizer Blending Plant Project EIA, 2021).

Anions Concentration of the Soils

Sulphate: At the proposed Agro farm Estate study area, sulphate values were low with values ranging from 0.18 to 3.44mg/kg and from 0.12 to 1.94mg/kg respectively for top and sub soil. At the proposed Cattle Breeding & Milk Production study area, sulphate concentration ranged from 0.21 to 1.82mg/kg and 0.14 to 123mg/kg respectively for top and sub soil. Values were lower than those obtained from a previous study (Fertilizer Blending Plant Project EIA, 2021).

Ammonia: At the proposed Agro farm Estate study area, ammonia values were low with values ranging from 0.01 to 0.06mg/kg and from 0.02 to 0.09mg/kg respectively for top and sub soil. At the proposed Cattle Breeding & Milk Production study area, ammonia concentration ranged from 0.01 to 0.06mg/kg and 0.02 to 0.09mg/kg respectively for top and sub soil.

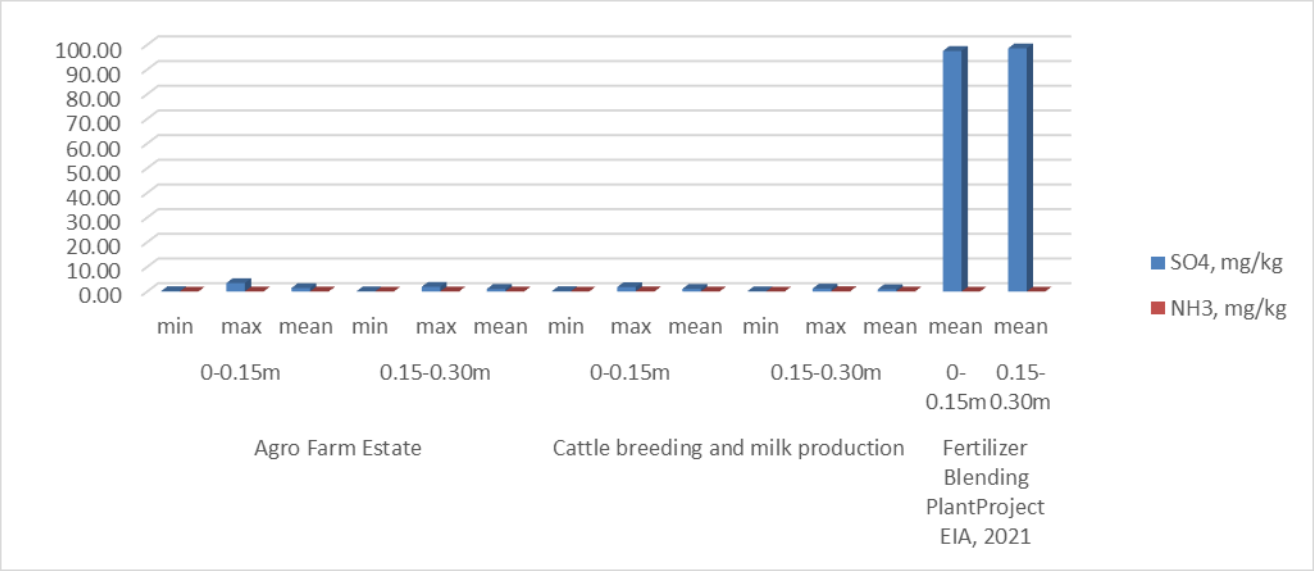


Figure 4. 12: Sulphate and Ammonia in Soil.

Source **Fieldwork, 2021**

Table 4. 5: Physico-Chemical and Microbiology of Soil for Cattle breeding/milk production

Parameters	Agro-farm Estate		Cattle breeding and milk production		Fertilizer Blending Project EIA, 2021		FMEnv. Standard
	0-0.15m	0.15-0.30m	0-0.15m	0.15-0.30m	0-0.15m	0.15-0.30	

													m	
	min	**max**	**mean**	**min**	**max**	**mean**	**min**	**max**	**mean**	**Min**	**max**	**mean**	**mean**	**mean**	
pH	7.10	8.08	7.24	7.01	7.41	7.14	1.34	8.29	6.85	7.27	8.44	8.08	8.1	8.25	
TOC, %	0.00	1.02	0.18	0.00	1.03	0.78	0.14	1.52	0.77	0.11	1.25	0.92	NA	NA	NA
THC, mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NA	NA	NA
SO4, mg/kg	0.18	3.44	1.42	0.12	1.94	1.08	0.21	1.82	1.08	0.14	1.23	0.95	97.55	98.55	500
NH3, mg/kg	0.01	0.06	0.04	0.02	0.09	0.06	0.01	0.12	0.04	0.02	0.16	0.08	NA	NA	NA
% Sand	29.80	93.40	64.59	48.30	98.20	75.31	63.00	93.40	74.36	48.30	75.00	65.10	10.36	14.195	NA
% Silt	5.00	44.30	21.81	0.20	19.00	8.89	5.00	19.00	13.82	5.10	19.00	12.26	53.89	44.77	NA
% Clay	1.60	27.90	13.59	1.60	46.60	15.80	1.60	25.80	11.62	10.80	46.60	22.44	35.73	41.11	NA
Calcium, mg/kg	2.13	6.68	3.81	1.98	7.14	3.47	4.15	8.61	6.34	3.12	8.41	4.93	3.65	3.91	NA
Magnesium, mg/kg	1.12	5.69	2.91	1.12	6.83	2.59	4.23	5.42	4.80	4.15	7.23	4.98	5.73	5.17	NA
Sodium, mg/kg	10.26	21.63	15.43	10.37	25.88	15.94	6.48	9.23	7.95	3.33	98.57	25.16	NA	NA	NA

Potassium, mg/kg	8.02	14.09	9.98	7.50	16.09	10.58	7.02	10.15	8.43	5.41	9.48	7.60	NA	NA	NA
Copper, mg/kg	0.58	4.79	1.70	1.01	4.56	1.70	0.02	1.18	0.90	0.11	1.15	0.75	1.11	1.17	NA
Lead, mg/kg	0.56	1.88	1.41	0.44	2.19	1.32	0.10	1.75	1.01	1.02	1.16	1.09	0.018	0.27	<1
Iron, mg/kg	18.26	30.09	21.61	18.20	31.71	22.75	18.17	24.08	20.08	20.06	27.72	22.81	6.59	2.31	NA
Nickel, mg/kg	5.24	11.70	9.19	5.01	16.96	8.64	6.04	224.00	51.43	2.11	8.01	5.67	0.015	0.02	NA
Chromium, mg/kg	0.07	0.19	0.14	0.07	0.19	0.15	0.01	0.17	0.09	0.02	0.18	0.09	NA	NA	NA
Cadmium, mg/kg	0.05	0.07	0.06	0.04	0.07	0.05	0.02	0.07	0.03	0.01	0.07	0.03	0.15	0.05	NA
Zinc, mg/kg	0.23	9.20	6.59	3.17	9.47	5.00	1.00	1.49	1.23	0.13	1.53	0.98	2.62	2.67	NA
HUB, CFU/gx104	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nil	Nil	NA
HUf, CFU/gx103	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nil	Nil	NA
THB, CFU/gx104	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nil	Nil	NA
THB,	0.0	0.0	0.0	0.	0.0	0.0	0.	0.0	0.0	0.0	0.0	0.0	Nil	Nil	NA

CFU/gx103	0	0	0	00	0	0	00	0	0	0	0	0			
E Coli	0.00	4.03	1.06	0.00	1.02	0.34	0.00	2.04	0.86	0.00	1.06	0.63	Nil	Nil	NA

Source: Fieldwork, 2021

NA means Not Applicable;

Exchangeable Bases

The exchangeable bases of the soil measured were Na, K, Ca and Mg. In the proposed Agro farm Estate_study area, sodium dominated the exchange site with a concentration of 15.43mg/kg and 15.94mg/kg in the top and sub soils respectively. While in the proposed Cattle Breeding & Milk Production study area sodium dominated with mean values of 7.95mg/kg and 25.16mg/kg respectively in top and sub soils. Two factors which mainly contribute to Exchange Capacity in soil are organic matter content and clay composition. In the assessment these two parameters were relatively and inherently low which will give rise to generally low CEC of the soils.

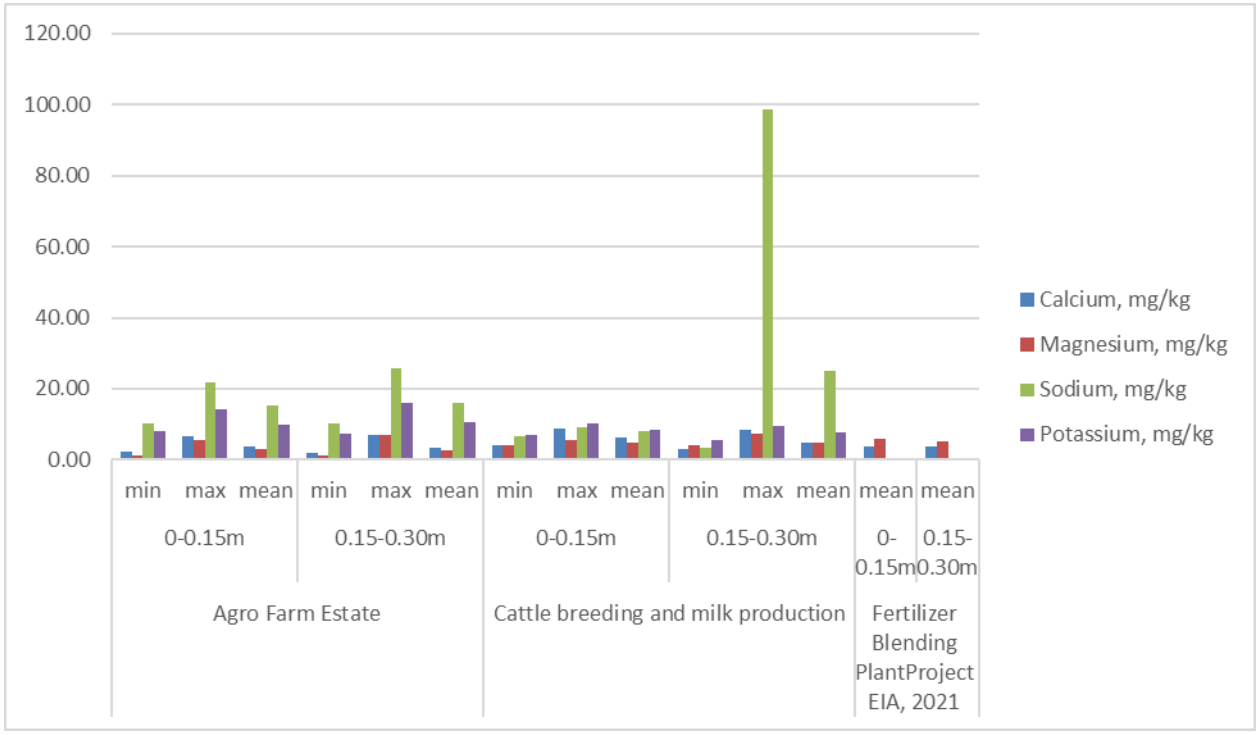


Figure 4. 13: Exchangeable Bases for soil of agro-farm, cattle breeding and milk prod

Source: Fieldwork, 2021

Heavy Metals

Human activities have dramatically changed the composition and organization of soils. Industrial and urban wastes, agricultural application and also mining activities resulted in an increased concentration of heavy metals in soils. Soils normally contain low background levels of heavy metals. Excessive levels of heavy metals can be hazardous to man, animals and plants. Heavy metals of greatest concern are iron (Fe), copper (Cu), lead (Pb), nickel (Ni), Zinc (Zn), Chromium (Cr) and Cadmium (Cd). Ecological soil investigation involved sampling of soil (0-15cm and 15-30cm depth) at the designated stations within the study area.

At the proposed Agro farm Estate study area, values obtained were between 0.58-4.79mg/kg (top soil) and 1.01-4.56mg/kg (sub soil) for Cu; 0.56-1.88mg/kg (top soil) and 0.44-2.19mg/kg (sub soil) for Pb; 18.26-30.09mg/kg (top soil) and 18.20-31.71mg/kg (sub soil) for Fe; 5.24-11.70mg/kg (top soil) and 5.01-16.96mg/kg (sub soil) for Ni; 0.07-0.19mg/kg (topsoil) and 0.07-0.19mg/kg (subsoil) for Cr; 0.05-0.07mg/kg (top soil) and 0.04-0.07mg/kg (sub soil) for Cd; and 0.23-9.20mg/kg (top soil) and 3.17-9.47mg/kg (sub soil) for Zn.

At the proposed Cattle Breeding & Milk Production study area, values obtained were 0.02-1.18mg/kg (top soil) and 0.11-1.15mg/kg (sub soil) for Cu; 0.10-1.75mg/kg (top soil) and 1.02-1.16mg/kg (sub soil) for Pb; 18.17-24.08mg/kg (top soil) and 20.06-27.72mg/kg (sub soil) for Fe; 6.04-224.00mg/kg (top soil) and 2.11-8.01mg/kg (sub soil) for Ni; 0.01-0.17mg/kg (topsoil) and 0.02-0.18mg/kg (subsoil) for Cr; 0.02-0.07mg/kg (top soil) and 0.01-0.07mg/kg (sub soil) for Cd; and 1.00-1.49mg/kg (top soil) and 0.13-1.53mg/kg (sub soil) for Zn.

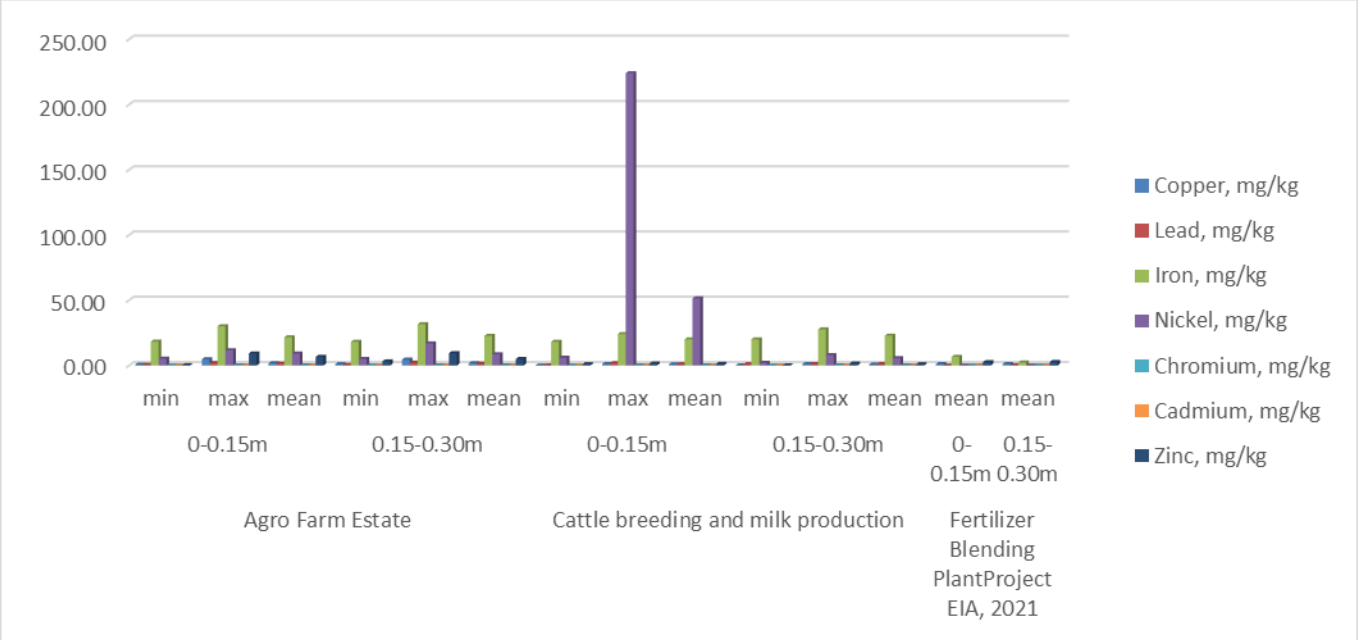


Figure 4. 14 : Heavy Metals in Soil of sites for agro-farm, cattle breeding and milk pro

Source: Fieldwork, 2021

Soil Microbiological Characteristics

The two groups of microorganisms studied are fungi and bacteria, which are the most important organic matter decomposers in the soil. Bacteria and fungi (microbes) counts provide information on the level of on-going biochemical activities in the soil. Microbial counts under normal circumstances increases with an increase in soil organic matter. About 1g of fertile soil should contain 1 x 10^6 to 1 x 10^8cfu/g bacteria and fungi (Odu *et al.,* 1985). These organisms were not present in the samples collected. However, E Coli in the samples had mean values of 1.06 and 0.34 respectively at the top and sub soil samples for the proposed Agro-farm Estate study area. On the other hand, mean values of 0.86 and 0.63 respectively were obtained at the top and sub soil samples for the proposed Cattle Breeding & Milk Production study area.

4.2.4.7 Ground Water Quality

The concentrations of the groundwater parameters were measured in-situ for samples from the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro-Farm Estate, while other parameters were determined in the laboratory.
Result from analyses is summarized in Table 4.7.

Table 4. 6: Physico-Chemical and Microbiology of Groundwater Samples

Parameters	Cattle Breeding /Milk Production	Veterinary Hospital	Sokoto Dairy Plant	Agro Farm Estate	Fertilizer Blending Plant Project EIA, 2021	FM Env. Standard
pH	7.50	7.85	7.70	8.10	7.70	6-9
TEMP (^{0}c)	27.18	28.60	28.10	28.16	28.55	<40
COND (µs/cm)	185.00	166.00	192.02	83.00	252.00	1000
TDS (mg/l)	142.00	131.00	147.04	143.04	84.00	2000
DO (mg/l)	4.17	4.55	4.05	5.12	8.29	2-8
TSS mg/l	0.41	0.33	0.27	0.41	0.006	30

Turbidity, NTU	5.14	5.23	5.03	6.10	0.65	5
BOD (mg/l)	0.45	0.56	0.58	0.45	21.2	7.5
COD (mg/l)	1.16	1.16	1.16	1.16	106.45	30
Petroleum Hydrocarbons						
THC (mg/l)	<0.001	<0.001	<0.001	<0.001	NA	NA
Nutrient						
Nitrate (mg/l)	2.17	3.20	4.15	5.17	4.63	<1
Sulphate (mg/l)	45.01	25.00	41.70	65.01	11.75	500
Ammonium (mg/l)	<0.01	<0.01	<0.01	<0.01	0.005	10
Phophate (mg/l)	1.41	1.27	1.35	1.41	0.112	5
Heavy Metals						
Nickel (mg/l)	<0.001	<0.001	<0.001	<0.001	0.05	<1
Iron (mg/l)	1.02	0.02	1.09	1.02	0.82	1.5
Lead (mg/l)	<0.001	<0.001	<0.001	<0.001	0.006	<1
Copper (mg/l)	<0.001	<0.001	<0.001	<0.001	0.171	<1
Chromium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<1
Zinc (mg/l)	<0.001	<0.001	<0.001	<0.001	1.562	3
Cadmium (mg/l)	<0.001	<0.001	<0.001	<0.001	0.046	<1

Barium (mg/l)	<0.001	<0.001	<0.001	<0.001	NA	NA
Cobalt (mg/l)	<0.001	<0.001	<0.001	<0.001	NA	NA
Arsenic (mg/l)	<0.001	<0.001	<0.001	<0.001	NA	NA
Mercury (mg/l)	<0.001	<0.001	<0.001	<0.001	NA	NA
Cations						
Potassium (mg/l)	0.003	0.01	0.006	0.003	NA	NA
Sodium (mg/l)	0.215	0.253	0.233	0.215	NA	NA
Magnesium (mg/l)	0.012	0.01	0.01	0.012	119.84	NA
Calcium (mg/l)	0.022	0.028	0.017	0.022	308.16	NA
Microbiology						
Coliforms	7	6	4	3	6.6	<1
E. coli	0	0	0	0	NA	absent
Faecalstreptacocci	**Absent**	**Absent**	**Absent**	**Absent**	NA	absent
Straphylococcciaureus	**Absent**	**absent**	**absent**	**Absent**	NA	absent

Source: Field work, 2021

NA means Not Applicable

Physico-Chemical Characteristics

pH values were 7.50, 7.85, 7.70 and 8.10 for the underground water samples collected for the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area. These values are mostly tending towards alkalinity and are below the stipulated limits by FMEnv. Conductivity and TDS values respectively were 185.00µS/cm and 142.00mg/l, 166.00µS/cm and 131.00mg/l, 192.02µS/cm and 147.04mg/l; and 83.00µS/cm and 143.00mg/l respectively for the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area. These values complied well with stipulated limits by FMEnv. The values recorded for Total Suspended Solids were respectively 0.41mg/l, 0.33mg/l, 0.27mg/l and 0.41mg/l while those recorded for turbidity were respectively 5.41NTU, 5.23NTU, 5.03NTU and 6.10NTU in the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area underground water samples collected which complied well with stipulated limits by FMEnv. Obtained values were also within the range of those obtained from a previous study (Fertilizer Blending Plant EIA, 2021).

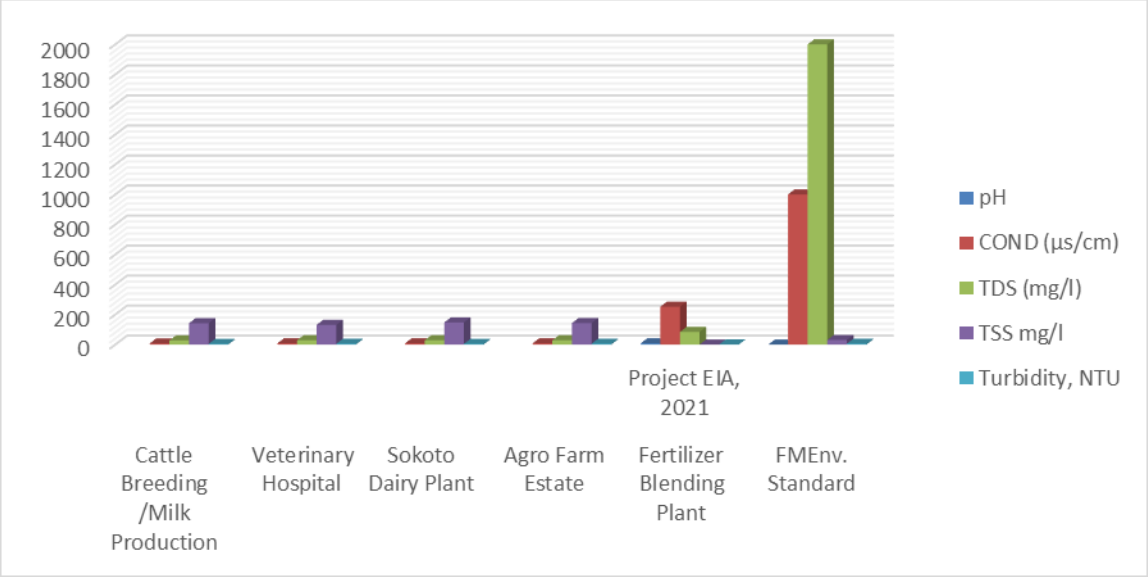


Figure 4. 15: Physico-chemical parameters of groundwater

Source: Fieldwork, 2021

DO, BOD and COD

The Dissolved Oxygen values obtained in samples collected for the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area were 4.17mg/l, 4.55mg/l, 4.05mg/l and 5.12mg/l respectively. The Biological OxygenDemend values obtained in samples collected for the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area were 0.45mg/l,

0.56mg/l, 0.58mg/l and 0.45mg/l respectively. The Chemical Oxygen Demend values obtained in samples collected for the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area were 1.16mg/l in all the samples. These values complied well with stipulated limits by FMEnv and were lower than range of values obtained from a previous study (Fertilizer Blending Plant EIA, 2021).

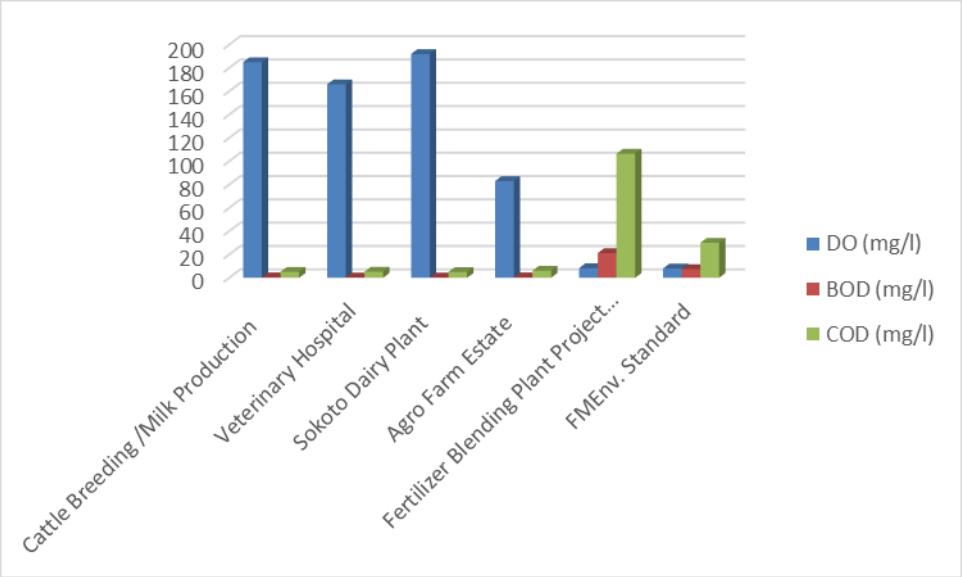


Figure 4. 16: DO, BOD and COD Levels in Ground water. Source: Fieldwork, 2021

Total Hydrocarbon Content (THC)

The THC analysed from the ground water samples in the facility areas were below equipment detection limit of <0.001mg/l in all stations. Obtained values compliedwith the range of those obtained from a previous study (Fertilizer Blending Plant EIA, 2021).

Nutrients

The concentration of sulphate accounted for the larger part of the nutrient content with values of 45.01mg/l, 25.00mg/l, 41.70mg/l and 65.01mg/L for the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area respectively. The order of nutrient concentration present in the samples for the facilities are Sulphate> Nitrate>Phosphate> Ammonium.

Cations

From the Table 4.7 the concentration of sodium accounted for the larger part of the cations content with values of 0.215mg/l, 0.253mg/l, 0.233mg/l and 0.215mg/L for the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area respectively. The order of cations concentration present in the samples for the facilities are Sodium>Calcium>Magnesium>Potassium.

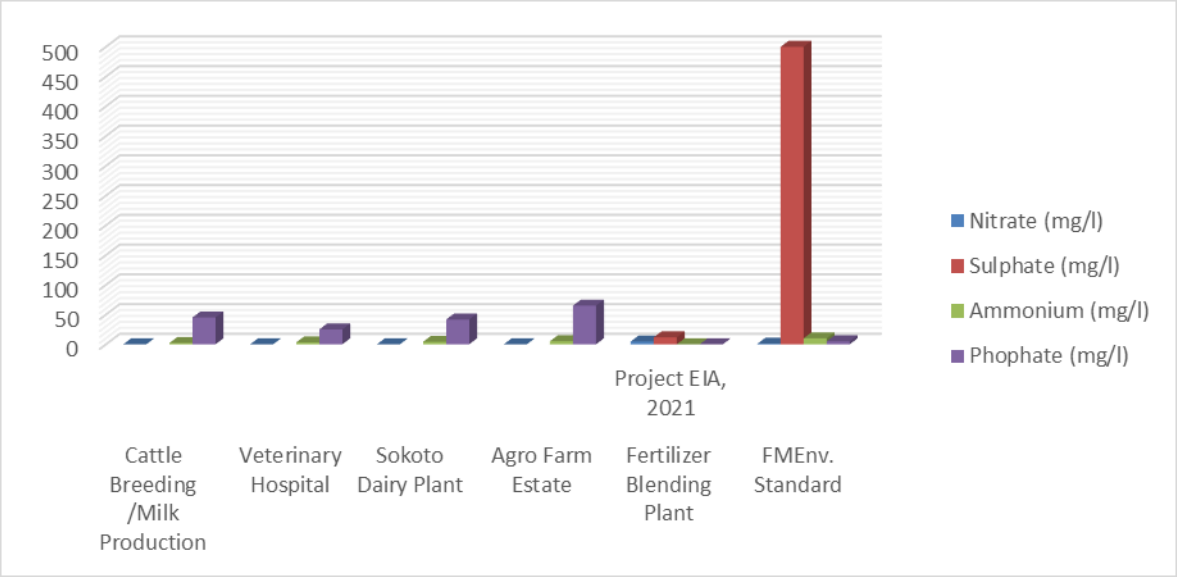


Figure 4. 17: Nutrients Levels in Groundwater

Source: Fieldwork, 2021

Heavy Metals

The heavy metal concentrations of the groundwater, displayed in Figure 4.18, were generally low and mostly below the detection limit of the atomic absorption spectrophotometer used for the analysis except for Iron which was detected at a concentration of 1.02mg/l, 1.02mg/l, 1.09mg/l and 1.02mg/l in samples collected for the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area respectively. In all, the heavy metals results were below FMEnv limits for heavy metals and were also below values obtained from a previous study.

Ground Water Microbiology

The results of microbial counts in underground water samples collected in the project area are presented in Table 4.7 where values were all below equipment detection limit except for coliforms count where a count of 7, 6, 4 and 3 were obtained in the proposed Cattle Breeding /Milk Production, Veterinary Hospital, Sokoto Dairy Plant and Agro Farm Estate study area respectively.

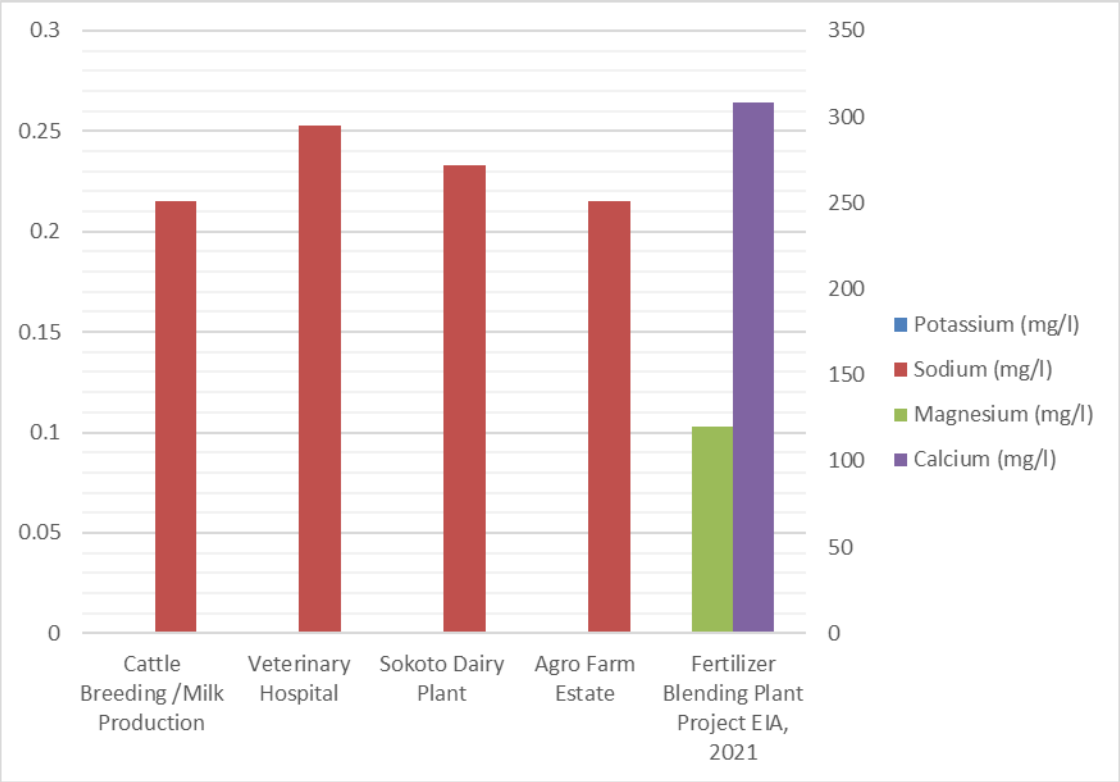


Figure 4. 18: Cations Levels in Groundwater

Source: Fieldwork, 2021

4.3 BIOLOGICAL BASELINE

4.3.1 Ecology of Sokoto

Sokoto State is situated in the North-western part of Nigeria. It is located between latitudes 11° 30" to 13 ° 50" N and longitudes 4° 00'' to 6° 00''E. The state shares common boundaries with the republic of Niger to the North and West, Zamfara State to the East and Kebbi State to the South. The area is characterized by tropical continental climate with a very fragile ecosystem. Temperatures are high throughout the year while rainfall, low and erratic which barely lasts for more than five months in a year. Average annual rainfall barely exceeds 629 mm while temperatures could be as high as 39° C or even higher, particularly during the month of April which usually records the highest of temperature. The area is also characterized by Sudan Savannah type of vegetation dominated by short grasses interspaced by short woody trees and shrubs. Grasses looks green during the rainy season, but eventually withered and die during the dry season (Adamu, 2007). Ecosystem services provided by plants include protection of soil loss against wind and water erosion, humus accumulation, nitrogen fixation, and nutrient supply from deeper layers. Moreover, plants stabilise regional and global climate, provides for pollution control and act as carbon sink (Botkin and Keller, 1998; Alonso *et al.*, 2001; Adamu, 2007). Vegetation

patches also yield utilitarian products/services such as fuel-wood, nuts vegetable, gum, spices, dyes, medicinal products, fodder for grazing and browsing by wildlife and livestock. They also serve as avenues for recreation while crown of trees and shrubs offer shade (in hot weather) (GFA, 2001; Adamu, 2007). Hence, these environmental and utilitarian services underscore the importance of vegetation patches not only in Sokoto metropolis but in all cities and towns in Nigeria. The dryland ecosystem of Sokoto state, in the North-western part of Nigeria has been witnessing gradual loss of vegetation cover in the recent decades caused by natural and human induced drivers of ecosystem change. This negative trend poses great challenges to both the physical environment and the people of the area, particularly due to the fragile nature of the ecosystems in the region and the peoples' over dependence on it for their livelihoods.

4.3.2 Flora and Fauna

A comprehensive ecological study was undertaken to determine the specie distribution, habitat characterization, pathology, uses of both plant and animal species identified within and around the proposed project area to enhance conservation and establish the baseline data of the existing flora and fauna.

Information/ data obtained from the field study revealed that the proposed project area or ecosystem is a highly disturbed Sahel Savanna ecosystem which had been impacted by human activities for a long time. Farming, hunting and social activities and minimal infrastructural development had occurred in the past. Slash and burn deforestation for the purpose of farming was observed while numerous trees had been fell for fuel wood and other various domestic and commercial uses within and around the proposed project location.

4.3.3 Methodology

The vegetation study of the proposed Project area and adjacent environment were made by taking separate sample quadrants (25m x 25m for herbs and shrubs and 4m x 4m for grasses and undergrowth) were measured in the sampling locations, which were selected using stratified random sampling procedures, considering plant species diversity, density and dominance. Homogenous habitats were identified and sampled. The vegetation of the proposed Project location was characterized in terms of types, density, and profile of the vegetation, economic benefits, regional characteristics, and distribution of ecological zones, environmental sensitivity, and reserve areas. Plant specimens were randomly collected from proposed project location and the communities. The plants were tagged, pressed, and labelled. Initial identification of the plant samples was done using Flora of West Tropical Africa (Hutchinson and Dalziel, 1954, 1958) and Nigerian Trees (Keay et al., 1960, 1964). The scientific names of the identified plants were recorded in the table below. Locals were engaged for the local nomenclature of all identified plant species and their local use.

Data were collected along the established quadrant by using the Line Intercept Methods of Cook and Bonham (1977) at pre-selected points. Each study location (plot) covered an area of 10m x 10m along the direction of transect for assessments. The procedure for the Line Intercept Method

consists of recording the plants bisected by the line sometimes referred to as horizontal linear distance for each plant under the line. The total linear measurements for the total intercepts along the line represent the percentage ground covers which were converted to percent species composition as intercepts were recorded by species. However, unidentified plant species and species whose identification were doubted, were collected, given sample location coded numbers and pressed for identification in a herbarium.

Methods used in collecting the baseline samples

Flora (Vegetation): Transects, Informal interviews, Questionnaires, and direct observations.

Fauna (Wildlife): Direct observations and informal interviews

Coordinate location of sampling quadrant

- ***Wildlife***

The wildlife species documented in the Project area include some members of the invertebrate, reptiles, birds and mammals. Major threats to wildlife in the area include uncontrolled poaching and clearance of land for pasture.

- ***Invertebrates***

The invertebrates documented in the area include gastropoda such millipedes (*Pochybolus* sp), dragon flies and butterflies were observed visiting flowers for pollination

- ***Reptiles***

The published works of Nigerian reptiles include works of Child (1974), Dunger (1973), and Grandison (1968). The reptiles documented in the study area include snakes, African Chameleon (Chameleo senegalensis), Rainbow Lizard (Agama agama), Brooks Gecko (Hemidactilus brooki) etc.

- **Birds**

  The avifauna of the project area represents the diverse habitat types in the region as birds inhabit vegetation areas that are most suitable for their feeding and nesting habits. Seed and insect eating birds such as barn swallow, doves, pied crows, common thrush, etc, Tuber-eating birds such as partridge (bush fowl) were observed in farmlands and less dense vegetation areas.

- **Mammals**

The mammals documented in the area are mostly rats, rabbit and African giant rat.

Plate 4. 3: Interacting with a farmer at one of the sites

Table 4. 7: Plant Species at the Dogon Daji Pasture Development Site

Location: Plants from Dogon Daji, Sokoto Transect 25m x 25m Latitude: 12.23.242'N Longitude: 004.49.014'E Date: 23rd September, 2021 Time: 10:30am						
S/N	Scientific Name	Plant Common Name	Abundance/population/CS	Family Name	Economic potential	Plant Habit
1	*Acacia senegal*	Gum Arabic	High/unknown/LC	Fabaceae	Gum Arabic	Tree
2	*Azadirachta indica*	Neem tree	Low/stable/LC	Meliaceae	Insecticidal	Tree
3	*Hyptis suaveolens*	Tea bush	High/na	Lamiaceae	Tea substitute	Shrub
4	*Andropogon gayanus*	Gamba grass	High/na	Poaceae	Thatch	Grass
5	*Securinega virosa*	Carry me seed	High/na	Euphorbiaceae	Diabetes	Shrub
6	*Ziziphus abbysinica*	Jujube	High/na	Rhamnaceae	Medicine	Shrub
7	*Adansonia digitata*	Baobab tree	Low/na	Bombacaceae	Kidney	Tree
8	*Zea mays*	Maize	High/LC	Poaceae	Crop	Grass
9	*Vitellaria paradoxum*	Shea butter	High/na	Sapotaceae	Pasteur (oil)	Tree
10	*Acacia nilotica*	Fodder tree	High/Unknown/LC	Fabceae	Fodder	Tree
11	*Sorghum*	Guinea	High/stable/LC	Poaceae	Crop	Grass

	bicolor	corn				
12	*Diospyros mespiliformis*	Ebony tree	High/na	Ebenaceae	Source of wood	Tree
13	*Urena lobata*	Caesar weed	High/na	Malvaceae	Fibre	Shrub
14	*Senna occidentalis*	Coffea senna	Low/NT	Fabaceae	Anti rabbies	Shrub
15	*Balanites aegyptiaca*	Desert date	High/LC	Balanitaceae	Fruit plant	Tree
16	*Calotropis procera*	Soddom apple	Low/na	Asclepiadaceae		Shrub
17	*Guiera senegalensis*		High/LC	Combretaceae	Medicinal	Tree

Table 4. 8: Birds Species at Dogon Daji Pasture Development Site

Location: Birds from Dogon Daji, Sokoto Latitude: 12.23.242'N Longitude: 004.49.014'E Date: 23rd September, 2021 Time: 10:30am					
S/N	Birds Scientific Name	Birds Common Name	Family Name	Conservation Status (Borrow & Demey, 2013)	Population Estimate
1.	*Elamus coeruleus*	Black shoulder kite	Acciptridae	M/P/R* c	4
2.	*Falco tinnunculus*	Common Kestrel	Falconidae	R/P/V* f/c LC	5
3.	*Polyboroides typus*	African harrier hawk	Acciptridae	R c LC	2
4.	*Milvus migrans*	Yellow billed kite	Acciptridae	M/P/R* c LC	20
5.	*Circus macrourus*	Pallid Harrier	Acciptridae	Pu/s NT	8
6.	*Francolinus bicalcalaratua*	Double Spurred francolin	Phasianidae	R c	10
7.	*Actophilornis Africana*	African Jacana	Jacanaidae	R c	48

8.	*Bubulcus ibis*	Cattle Egret	Ardeidae	R/M+ c LC	85
9.	*Egretta garzetta*	Little Egret	Ardeidae	R+/M/Pc LC	310
10.	*Ardea cineria*	Grey Heron	Ardeidae	R/P+ c/f LC	6
11.	*Ardea purpurea*	Purple Heron	Ardeidae	R/P/V* u/c LC	7
12.	*Ardea melaoncephala*	Black headed Heron	Ardeidae	R/M u/c	7
13.	*Ardea ralliodes*	Squacc o Heron	Ardeidae	R/P/V*f	17
14.	*Columbida guinea*	Speckled pigeon	Columbidae	R c	100

Table 4. 9: Plant Species at the Cattle breeding and Milk production site, Sokoto

Location: Plant Species at the Cattle Breeding and Milk Production site, Sokoto Transect 25m x 25m
Latitude: 12°.28.282'N Longitude: 04°.49.099'E Date: 23rd September, 2021 Time: 1:30am

S/N	Scientific Name	Plant Common Name	Abundance/population/CS	Family Name	Economic potential	Plant Habit
1	*Balanites aegyptiaca*	Desert date	High/LC	Balanitaceae	Fruit plant	Tree
2	*Azadirachta indica*	Neem tree	Low/stable/LC	Meliaceae	Insecticidal	Tree
3	*Acacia nilotica*	Fodder tree	High/Unknown/LC	Fabceae	Fodder	Tree
4	*Andropogon gayanus*	Gamba grass	High/na	Poaceae	Thatch	Grass
5	*Vitellaria paradoxum*	Shea butter	High/na	Sapotaceae	Pasteur (oil)	Tree
6	*Ziziphus abbysinica*	Jujube	High/na	Rhamnaceae	Medicine	Shrub
7	*Adansonia digitata*	Baobab tree	Low/na	Bombacaceae	Kidney	Tree

Table 4. 10: Birds Species at the Cattle breeding and Milk production site, Sokoto

Location: Birds Species at the Cattle breeding and Milk production site, Sokoto Latitude: 12°.28.282'N Longitude: 04°.49.099'E Date: 23rd September, 2021 Time: 1:30am					
S/N	Birds Scientific Name	Birds Common Name	Family Name	Conservation Status (Borrow & Demey, 2013)	Population Estimate
1.	*Elamus coeruleus*	Black shoulder kite	Acciptridae	M/P/R* c	7
2.	*Falco tinnunculus*	Common Kestrel	Falconidae	R/P/V* f/c LC	2
3.	*Polyboroides typus*	African harrier hawk	Acciptridae	R c LC	1
4.	*Milvus migrans*	Yellow billed kite	Acciptridae	M/P/R* c LC	10
5.	*Circus macrourus*	Pallid Harrier	Acciptridae	Pu/s NT	5
6.	*Francolinus bicalcalaratua*	Double Spurred francolin	Phasianidae	R c	5
7.	*Actophilornis Africana*	African Jacana	Jacanaidae	R c	20
8.	*Bubulcus ibis*	Cattle Egret	Ardeidae	R/M+ c LC	11
9.	*Egretta garzetta*	Little Egret	Ardeidae	R+/M/Pc LC	30

Plate 4. 4: *Ziziphus abbysinica* visited by pollinating insects

Table 4. 11: Plant species at the proposed site for the Specialist Veterinary Hospital

Location: Plant species at the proposed Specialist Vet Reference Hospital, Gusau Road, Sokoto Transect 25m x 25m Latitude: 12°.58.682'N Longitude: 005°.11.'E Date: 24th September, 2021 Time: 1:30pm						
S/N	Scientific Name	Plant Common Name	Abundance/population/CS	Family Name	Economic potential	Plant Habit
1	*Acacia senegal*	Gum Arabic	High/unknown/LC	Fabaceae	Gum Arabic	Tree
2	*Azadirachta indica*	Neem tree	Low/stable/LC	Meliaceae	Insecticidal	Tree
3	*Adansonia digitata*	Baobab tree	Low/na	Bombacaceae	Kidney	Tree
4	*Andropogon gayanus*	Gamba grass	High/na	Poaceae	Thatch	Grass
5	*Securinega virosa*	Carry me seed	High/na	Euphorbiaceae	Diabetes	Shrub
6	*Ziziphus abbysinica*	Jujube	High/na	Rhamnaceae	Medicine	Shrub
7	*Balanites aegyptiaca*	Desert date	High/LC	Balanitaceae	Fruit plant	Tree
8	*Fhaiderbia albida*	Apple ring acacia	High/unknown/LC	Fabaceae	Fodder	Tree
9	*Vitellaria paradoxum*	Shea butter	High/na	Sapotaceae	Pasteur (oil)	Tree
10	*Acacia nilotica*	Fodder tree	High/Unknown/LC	Fabceae	Fodder	Tree
11	*Hyphaene thebiaca*	Dum palm	Low/na	Palmae	Source of timber	Tree
12	*Diospyros mespiliformis*	Ebony tree	High/na	Ebenaceae	Source of wood	Tree

Table 4. 12: Birds Species at the proposed Specialist Vet Reference Hospital, Gusau Road, Sokoto

Location: Birds Species at the proposed Specialist Veterinary Reference Hospital Latitude: 12°.28.282'N Longitude: 04°.49.099'E Date: 24th September 2021 Time: 1:30am					
S/N	Birds Scientific Name	Birds Common Name	Family Name	Conservation Status (Borrow & Demey, 2013)	Population Estimate
1.	*Elamus coeruleus*	Black shoulder kite	Acciptridae	M/P/R* c	7
2.	*Falco tinnunculus*	Common Kestrel	Falconidae	R/P/V* f/c LC	2
3.	*Polyboroides typus*	African harrier hawk	Acciptridae	R c LC	1
4.	*Milvus migrans*	Yellow billed kite	Acciptridae	M/P/R* c LC	10
5.	*Circus macrourus*	Pallid Harrier	Acciptridae	Pu/s NT	5
6.	*Francolinus bicalcalaratua*	Double Spurred francolin	Phasianidae	R c	5
7.	*Actophilornis Africana*	African Jacana	Jacanaidae	R c	20
8.	*Bubulcus ibis*	Cattle Egret	Ardeidae	R/M+ c LC	11
9.	*Egretta garzetta*	Little Egret	Ardeidae	R+/M/Pc LC	30

Conservation status key:

Status

R Resident

M Intra-African migrant

P Palearctic migrant (including few species of Nearctic origin)

V Vagrant

* Cape Verde only

+ also Cape Verde

Abundance categories

c	common
f	fairly common (=frequent; the category ‘not uncommon ‘in *BOWA* 2001)
u	uncommon
s	scarce
r	rare
l	local (e.g., ‘lc’ = locally common)
*	Indicates abundance in Cape Verde only (if very different from elsewhere)

Threat categories

CR	Critically endangered
EN	Endangered
VU	Vulnerable
NT	Near Threatened
DD	Data Deficient
LC	Least concern

4.4 SOCIO-ECONOMIC STUDIES

The baseline socio-economic studies covered Rabah, Dogon-Daji and Silame LGAs of Sokoto State as well as Sokoto town.

4.4.1 Population

The total population of Wamakko, Silame and Rabah LGAs added to that of Dogon-Daji District is 253924 (based on the 2006 Census). Table 4.12 presents the estimated 2006 population in the four LGAs.

Table 4. 13: Population of surveyed districts in the project area

S/No.	LGA/District	2006 LGA Population	2006 District Population (assumed to be 10%)
1.	Wamakko	179,619	179,62
2.	Rabah	149,165	14917
3.	Silame	104,378	10438
4.	Dogon-Daji (District)	3,831	3831
Total Population		**433543**	**43698**

The current population was obtained by projecting the 2006 population figure, using a conservative 3% average population growth rate, as follows:

Using the Geometric Method:

A basic equation for getting a projection of a given population is Nt=P e (r * t); where "Nt" represents the number of people at a future time;

"P" is the population at the beginning time;

"e" is the base of the natural logarithms (2.71828);

"r" is the rate of increase (natural increase divided by 100); and

"t" represents the time period involved.

$Nt = P\ e^{(r * t)} = 43698\ X\ 2.71828^{(0.025*14)} = 43698\ X\ 1.4191 = 62, 012$

This population belongs to the four districts.

Thus, assuming an average family size of 9, an approximate number of households in the project area is 62012/9 = 6890

Now to determine the sample size for the questionnaire to be administered in these districts, we use Glenn's Formula, which is:

$n=N/(1+Ne^2)$.

Where n = sample size, N = Population and e = Margin of error

Assuming the margin of error is 10%
n will therefore be = $6890/(1+6890x0.1^2) = 6890/ (69.9) \simeq 99$

This means that 99 copies of the socio-economic questionnaire should be administered across the 4 districts.

Assuming 10% of administered copies of the questionnaire would not be returned, the copies of the questionnaire to be administered should be increased to 109 to ensure that at least 100 are returned.

The spacial boundary selected for the socio-economic studies comprised of four districts. These districts are: Wamakko, Dogon-Daji, Silame and Rabah.

The methodology applied consisted of randomly (using a table of random numbers) selecting one hundred and nine (109) households from the four districts, for administration of the questionnaires. For each household, one copy of the questionnaire was administered to the head of the household and where he was absent, his wife or eldest child responded to the questionnaire. Some copies of the questionnaires were instantly retrieved, while others were retrieved later. Overall, 90 copies were retrieved. The retrieved copies of the administered questionnaire were then analyzed, and some key conclusions arrived at.

On the other hand, 12 FGDs were conducted targeting the youth, the elderly and women household heads within the four districts.

The Key Informants for the study included traditional rulers such as Ward Heads and residents of the towns. Four KIIs were conducted with each of the two groups (traditional leaders, and residents of the towns).

4.4.2 Ethnic Composition

The socio-economic survey revealed a community of people wholly comprising of Hausa and Fulani ethnic groups.

The Table below presents the ethnic composition of the respondents in the three districts surveyed. The table reveals that the Hausa ethnic group has the highest population in the four towns surveyed, with the composition of 90% in Wamakko and the least percentage in Dogon-Daji.

Table 4. 14: Ethnic composition of respondents

District	**Tribe**	**No of Respondents**	**% Composition**
Rabbah	Hausa	18	90
	Fulani	2	10
		20	100
Silame	Hausa	16	80
	Fulani	4	20
		20	100
Dogon-Daji	Hausa	15	75
	Fulani	5	25
		20	100
Sokoto	Hausa	25	83.3
	Fulani	5	16.7
Total		**30**	**100**

4.4.3 Religious Affiliation of Respondents

The entire respondent heads of households in the four surveyed towns are Muslims.

4.4.4 Age Profile of respondents

Table 4.15 presents the distribution of the ages of respondents in the four surveyed districts of the project area.

Table 4. 15: Age group distribution of respondents

District	Age group	No of respondents	% Composition
Rabbah	21-30	2	10
	31-40	6	30
	41-50	4	20
	51-60	5	25
	61 +	3	15
Totals			100
Silame	21-30	3	15
	31-40	5	25
	41-50	4	20
	51-60	3	10
	61 +	5	25
Totals			100
Dogon-Daji	21-30	1	5
	31-40	3	15
	41-50	6	30
	41-60	7	35
	61 +	3	15
Totals			100
Sokoto	21-30	2	0
	31-40	6	20
	41-50	8	30
	41-60	8	30
	60 +	6	20
Totals		30	100

Source: Field survey, September 2021

The age distribution of respondents in the area shows a predominance of the working-age population (21 to 60 years), comprising people within the age brackets of 21-30, 31-40, 41-50

and 51-60, which cumulatively make up 85% in Wamakko, 75% in Silame, 85% in Dogon-Daji and 80% in Sokoto towns.

4.4.5 Gender Distribution

Table 4.16 presents the gender ratio of the respondent household heads in the four towns.Out of twenty household heads surveyed in Wamakko, 90% (18) are male-headed; while the remaining three (10) are headed by women. Out of twenty households heads in Silame, 95% (19) are male-headed; while 5% (1) are female-headed. In Dogon-Daji and Sokoto towns male headed households are 100% and 86.7% respectively, while the remaining percentages comprise the female-headed households.

Table 4. 16: Gender distribution of respondents

Town	**Gender of respondents**	**No of respondents**	**Percentage (%)**
Wamakko	Male	18	90
	Female	2	7.5
	Total	20	100
Silame	Male	19	95
	Female	1	5
Total		20	100
Dogon-Daji	Male	20	100
	Female	0	0
Total		20	100
Sokoto	Male	26	86.7
	Female	4	13.3
Total		30	

4.4.6 Number of dependents of household heads

Table 4.17 below presents the range of dependents supported by household heads in the four surveyed towns in the project area. For example, in Wamakko 20% of household heads have dependents in the 1-4 persons range, 40% in the 6-10 dependents range, while 11-20 and 21+ dependent ranges comprise 25% and 15% of the respondent population, respectively.

Table 4. 17: Number of dependents of respondents

District	**No of dependents**	**No of respondents**	**% Composition**
Rabbah	1-5	4	20
	6-10	8	40
	11-20	5	25
	21+	3	15
Totals		20	100
Silame	1-5	5	25
	6-10	7	35
	11-20	4	20
	21+	4	20
		20	100
Totals			
Dogon-Daji	1-5	3	15
	6-10	6	30
	11-20	6	30
	21+	5	25
Totals			100
Sokoto	1-5	9	30
	6-10	8	26.7
	11-20	7	23.3
	21+	6	20
Totals		30	

4.4.7 Educational backgrounds of household heads

Table 4.18 below present the educational background of respondent household heads in the four towns surveyed in the project area. For example, in Wamakko 20% of respondents have only Islamic/primary education, while 30% of the population has primary education only. Those with secondary school education only constitute 30%, while respondents with tertiary education and those with postgraduate level of education constitute 10% each.

Table 4. 18: Educational qualifications of respondents

District	**No of dependents**	**No of respondents**	% Composition
Rabbah	Islamic/Quranic education	4	20
	Primary level	6	30
	Secondary level	6	30
	Tertiary level	2	10
	Postgraduate level	2	10
Totals			100
Silame	Islamic/Quranic education	5	25
	Primary level	7	35
	Secondary level	4	20
	Tertiary level	2	10
	Postgraduate	2	10
Totals		20	100
Dogon-Daji	Islamic/Quranic education	2	10
	Primary level	6	30
	Secondary level	5	25
	Tertiary level	4	20
	Postgraduate	3	15
Totals		20	100

Sokoto	Islamic/Quranic education	2	6.7
	Primary level	8	26.7
	Secondary level	8	26.7
	Tertiary level	7	23.3
	Postgraduate	5	16.6
Totals		30	100

Wamakko LGA, being a major LGA has many public and private educational institutions.

The following plates display a public primary and secondary school in Wamakko town.

Plate 4. 5: Government Day Secondary School Wamakko

4.4.8 Occupation

People in the project area are predominantly peasant farmers. Other occupations engaged in by the people include trading, mechanical artisanship, hawking, masonry, civil service, etc. the major streets of the four towns are characterized by petty trading which involves sale of food stuffs, consumables, clothing etc.

Table 4.18 below presents the occupational distribution of household heads in the project area

and shows that farming is the occupation practiced by the largest number of household heads in all the towns surveyed, except for Sokoto, where trading has the highest percentage. Analysis of the occupational survey also reveal that many people engage in farming as a supplementary occupation and that many others also practice some of the other professions.

Table 4. 19: Occupational distribution of respondents

District	**Main occupation**	**No of respondents**	**% Composition**
Rabbah	Farming	6	30
	Civil service	2	10
	Trading	5	25
	Artisanship	2	10
	Private employee	2	10
	Others	3	15
Totals		20	100
Silame	Farming	5	25
	Civil service	3	15
	Trading	4	20
	Artisanship	3	15
	Private employee	2	10
	Others	3	15
Totals		20	100
Dogon-Daji	Farming	7	35
	Civil service	2	10
	Trading	4	20
	Artisanship	3	15
	Private employee	1	5
	Others	3	15
Totals		20	100
Sokoto	Farming	8	26.7
	Civil service	5	16.6

	Trading	9	30
	Artisanship	3	10
	Private employee	2	6.7
	Others	3	10
Totals		30	100

Plate 4. 6: Road-side restaurants in Sokoto

Plate 4. 7: Trading activities along a street in Sokoto

4.4.9 Income distribution

Table 4.20 presents the average monthly income distribution of respondent household heads. The monthly income distribution in the project area shows that in Rabbah, Silame and Sokoto the largest proportion of household heads have an average monthly income in the 41000-70000 bracket, while in Dogon-Daji the highest proportion of household heads belong to the N10000-N40000 income group.

Table 4. 20: Monthly income distribution of respondents

District	Monthly income (in Naira)	No of respondents	% Composition
Rabbah	10000-40000	3	15
	41000-70000	6	30
	71000-100000	3	15
	110000-140000	5	25
	>140000	3	15
		20	100

Silame	10000-40000	3	15
	41000-70000	6	30
	71000-100000	4	20
	110000-140000	4	20
	>140000	3	15
Totals		20	100
Dogon-Daji	10000-40000	6	30
	41000-70000	5	25
	71000-100000	3	15
	110000-140000	4	20
	>140000	2	10
Total		20	100
Sokoto	10000-40000	6	20
	41000-70000	9	30.0
	71000-100000	7	23.3
	110000-140000	5	16.7
	>140000	3	10
Totals		30	

4.4.10 Type of residential accommodation

Housing types in the project area are both modern and traditional. Along major streets, houses made of cement and concrete blocks predominate, while in other smaller settlements in the outskirts and neighbouring villages, houses are mostly made of mud. Some of these houses were built of mud and rendered with cement/concrete. The shapes of the houses are rectangular with rectangular doors of about 2 meters high and 1 meter in width. The doors are wooden. The heights of the houses are normally 3 to 4 meters and most roofs were made of zinc.

Plate 4. 8:A street in Kalambaina town

Types of accommodation used by households in the project area are basically categorized, for simplicity and for the sake of this study, into modern and traditional types. Table 4.20 below presents the distribution of housing type in the four towns surveyed for this study. For example, the table shows that, in Wamakko town, 60% of households are modern, while 40% are traditional

Table 4. 21: Type of residential accommodation of respondents

Town	**Type of accommodation**	**No of respondents**	**Percentage (%)**
Wamakko	Modern	12	60
	Traditional	8	40
	Total	20	100
Silame	Modern	14	70
	Traditional	6	30

Total		20	100
Dogon-Daji	Modern	13	65
	Traditional	7	35
Total		20	100
Sokoto	Modern	25	83.3
	Traditional	5	16.7
Total		30	100

4.4.11 Means of Solid waste disposal

Broadly, residents in the towns surveyed dispose their solid waste in two ways; open dumping and incineration/composting. Open dumping in this sense refers to indiscriminate disposal of waste outside the households in illegal/informal refuse dumps, while incineration and composting refers to the situation in which a household segregates its waste into two broad categories of biodegradable and nonbiodegradable and burns the nonbiodegradable while "composting" the biodegradable and subsequently transporting to the farms for use as manure.

Table 4.22 presents the distribution of waste disposal methods in the four towns surveyed in the project area. It reveals that in Wamakko town 40% of households openly dump their waste, while 60 incinerate and compost their waste.

Table 4. 22: Method of waste disposal by respondents

Town	**Waste disposal method**	**No of respondents**	**Percentage (%)**
Wamakko	Open dumping	8	40
	Incineration and farm	12	60
	compost		
	Total	20	100
Silame	Open dumping	9	45
	Incineration and farm compost	11	55
Total		20	100
Dogon-Daji	Open dumping	10	50
	Incineration and farm compost	10	50
Total		20	100
Sokoto	Open dumping	26	86.7
	Incineration and farm compost	4	13.3
Total		30	100

4.4.12 Toilet system used by households

Toilet systems in the area are mainly water closet (WC) system and pit latrines. The modern houses are invariably characterized by the use of WCs, while the traditional houses use pit latrines.

Table 4.23 present the distribution of type of toilet system used by households according to the survey carried out in the four towns in the project area. The table reveals that in Wamakko, 60% of respondents use pit latrines, while the remaining 40% use water closet toilet system. In Silame 70% of households use pit latrines, while 30% use water closet system. In Dogon-Daji, 60% of households use pit latrine, while 40% use water closet. The survey revealed that in Sokoto, 53.3% use pit latrine toilets, while the remaining 46.7% use water closet toilet system.

Table 4. 23 : Types of toilet system used by respondents

Town	**Toilet system used**	**No of respondents**	**Percentage (%)**
Wamakko	Pit latrine	12	60
	Water closet	8	40
Total		20	100
Silame	Pit latrine	14	70
	Water closet	6	30
Total		20	100
Dogon-Daji	Pit latrine	12	60
	Water closet	8	40
Total		20	100
Sokoto	Pit latrine	16	53.3

	Water closet	14	46.7
Total		30	100

4.4.13 Cattle ownership by some farmers

Table 4.24 below presents the distribution of farmers who own cattle among the household heads surveyed. The result show that most of the farmers keep cattle in a form of integrated farming system. For example, the table shows that in Wamakko town 66.75 of the farmers keep cattle while 80%,71.4% and 37.5% keep cattle in Silame, Dogon-Daji and Sokoto respectively.

Table 4. 24: Distribution of farmers who rear cattle

Town	**No of farmers**	**Farmers who own cattle**	**Percentage (%)**
Wamakko	6	4	66.7
Silame	5	4	80.0
Dogon-Daji	7	5	71.4
Sokoto	8	3	37.5

4.4.14 Cattle holding size of farmers

Table 4.25 below presents the distribution of cattle holding sizes of farmers who keep cattle in the four towns surveyed in the project area. The table shows that 1-20 holding size range constitutes the highest number of farmers. About 44% of the cattle owning farmers have cattle numbering from 1 to 20, while the 61-80 and 80+ cattle holding size ranges each constitute 6.25% of the cattle-owners population.

Table 4. 25: Cattle holding sizes of respondents

S/No.	Holding size	No. of respondents	Percentage (%)
1.	1-20	7	43.80
2.	21-40	5	31.30
3.	41-60	2	12.50
4.	61-80	1	6.25
5.	80+	1	6.25

4.4.15 Estimated daily cattle milk yield

Table 4.20 expresses the distribution of daily cattle milk yield as estimated by the cattle owners. According to the estimates, 37.5% of the cattle owners obtain the highest daily milk yield of 4.1-4.5 litres. The lowest daily milk yield of 3.1-3.5 litres is obtained by 18.7% of the cattle owners.

Table 4. 26: Estimated Daily Milk Yield

S/No.	Estimated Daily Milk Yield (Litres)	No. of respondents	Percentage (%)
1.	3.1-3.5	3	18.7
2.	3.6-4.0	7	43.8
3.	4.1-4.5	6	37.5
	Total	16	100

4.4.16 Social Infrastructure

The quality of life may be indicated by the availability of basic social infrastructure in an area. Social infrastructure includes water supply, electricity supply, good road network, storm water drainage, transportation, security, telecommunication, and proximity of social services such as hospital and recreational facilities, etc.

4.4.16.1 Water Supply

Sokoto and Wamakko towns are supplied with pipe-borne water. Boreholes are also available in the project area, provided by the three tiers of Government. Other sources of water in the project area include wells and surface water in rivers (in the rainy season). Many households in the project area, especially those in remote parts, use water from wells.

Plate 4. 9: A Motorized borehole in Sokoto

4.4.16.2 Electricity

Electricity in Wamakko LGA is provided by Kaduna Electricity Distribution Company (KEDCO). However, as in other parts of the country, several reasons have combined to impede a constant supply of in the project area, which led many people to be using private electricity generating sets.

4.4.16.3 Telecommunication electricity

Private telecommunication companies that provide telecommunication services, in form of mobile phone (GSM) and digital data services (Internet) in the project area include MTN, 9Mobile, Airtel and Glo.

4.4.16.4 Transport

Apart from walking, other means of transportation in the project area includes motor vehicles, tricycles, motorcycles, bicycles, animals, such as donkeys and camels, as well as animal-driven carts, especially in the rural areas.

Plate 4. 10: A camel being used for the conveyance of agricultural produce

4.4.16.5 Road network

The project area is characterized by a fairly good road network. However, the tarred road network is more prominent in the town centres, while the rural areas mainly comprise of earth roads.

Plate 4. 11: Typical roads in Wamakko town

4.4.17 Security

Currently, the major security threats in the project area are banditry and kidnapping as well as armed robbery. Insecurity in the project area is so serious that hardly a day passes without a report of bandits' attack, cattle rustling or kidnapping being reported. Farmlands in the rural areas have practically been abandoned by their owners, with most villages sacked and many villagers killed or abducted.

4.4.18 Communal land disputes/litigations

Communal land disputes and land litigations are rare in the project area. This is partly because of the existence of clear land tenure systems and the system of land inheritance under Sharia adopted by adherents of Islamic religion in the area. Under the system, when a landowner dies his/her heirs both male and female are entitled to their shares in a given ratio, as specified by the Sharia law.

4.4.19 Social vices/menace in the project area

To a limited extent, social vices like drug abuse and prostitution take place in the project area, albeit secretly because of the Sharia legal system being practiced. People in the area normally frown at such vices, which mainly take place in hidden or isolated areas.

4.4.20 Lifestyles and Values

Sokoto State has banned the sale and drinking of alcoholic beverages in the State, in line with the Sharia law practices. Accordingly, alcoholic drinks are not sold legally in the project area. However, a small number of youths in the area abuse drugs and misuse some medicines such as cough syrups as intoxicants.

The commonest physical exercise/recreational activity is football game, which normally take place at the playgrounds of public and private schools.

4.4.21 Markets/heritage sites

The major markets in Sokoto include Hajiya Halima central market, while in Wamakko is the township market that opens daily. However, Wednesdays and Sundays are designated market days in Kanwuri, Rugga area and Kaura Kimba area both in Wamakko. These markets attract more traders from neighbouring communities and therefore witness high volumes of transactions.

4.4.22 Community Perception and Needs

Following public consultations and meetings with community members in the four towns,

community stakeholders raised several issues and concerns which significantly bordered on employment and economic opportunities. The meetings conducted at all locations show that the project host communities firmly support the implementation of the proposed project. At each Key Informant Interview (KII) or FGD, residents of the town expressed their desire to be given job opportunities during the construction and operational phases of the project. The communities also expressed the view that since unemployment rate is high in the area, the Project Contractor should give the first opportunities for employment to members of their communities.

The communities are enthusiastic about the proposed project development and consider it a step in the right direction in terms of realizing the agricultural potentials of the area as well as the potentials for job and wealth creation through value addition to agricultural products, especially the potential milk and meat industries that may develop as a result of implementation of the project. Overall, they believe that the project will bring about a significant positive impact on the socio-economy of the area.

Major needs of the communities include improved electricity supply as well as improved healthcare and educational systems that can cope with the rapidly increasing population in the towns especially from the refugees displaced by the armed banditry. Other needs of the community include improvement of the road network and drainage systems in the area.

In terms of the proposed project, the most significant need of the people is provision of employment opportunities to the local people in both the constructional and operational phases of the project.

4.4.23 Land Use Pattern

Major land use observed in the project area is agricultural, followed by residential, institutional, and commercial and to a much lesser extent recreational. Agricultural land use in the project area is in form of farming/orchards and rearing of animals. People in the project area are predominantly farmers. Institutional land use is mostly in form of schools and administrative and office accommodation.

The present land use surrounding the proposed sites is a mixture of agricultural and residential uses.

Plate 4. 12: Agricultural land use on the outskirts of Kalambaina town

4.4.24 land ownership structure

Land ownership in the area include private, family, community, and institutional ownerships. Private and family ownerships mainly involve residential and business buildings as well as land parcels owned by individuals and families in the project area. On the other hand, community ownership is for lands and properties commonly used by members of the community, such as cemeteries, markets, motor parks, town squares, etc. Institutional ownership of land in the area is for lands and properties belonging to Local, State and Federal Governments.

4.4.25 Housing and Settlement Pattern

The four towns enjoy a predominantly linear settlement pattern with single houses arranged linearly along streets in the residential districts. However, the villages nearby have dispersed and nucleated settlement patterns. Residential densities range between low to high. However, the high-density areas predominate in the towns.

Plate 4. 12: A light density residential area at the outskirts of Sokoto

Plate 4. 13: A typical road in Kalambaina District

4.4.26 Waste Management

Most people in the project area dispose of their domestic waste by open dumping. Sometimes they openly burn such waste after gathering it over a long period of time. The residue of the burnt refuse is later moved to farms as manure.

Plate 4. 14: Refuse dump site in Kalambaina District

Sewage from some houses are sometimes allowed to flow along the streets. However, SEPA is seriously enforcing environmental compliance with environmental laws.

4.5 HEALTH ENVIRONMENT

Health baseline data acquisition was carried out to establish a data base for subsequent monitoring and evaluation of potential impacts that may result from the project.

4.5.1 Health Services

The survey carried out in the project area shows that there is a four-wheel approach in the treatment of ailments by respondents. Respondents make use of government hospitals, private clinics, off-the-shelf self-medication. They also resort to consulting herbal and traditional alternative health practitioners, including traditional birth attendants and traditional orthopedic practitioners. Numerous public and private medical facilities are available in the project area. These include an orthopedic hospital in Wamakko town, numerous Primary Health Care clinics, dispensaries. There is also a rural ambulance service in Wamakko LGA that caters for the

residents of the rural areas in the LGA. The plates that follow show some of the available health care infrastructure in the LGA.

Plate 4. 15: Entrance gate of Orthopaedic hospital in Wamakko town

Plate 4. 16: A local dispensary in Sokoto town

4.5.2 Common Ailments

It was established through administered questionnaires and Focused Group Discussions that the commonest ailments include malaria, typhoid fever, ulcers, cardiovascular diseases and diabetes. It was also established that certain ailments are be seasonal, environmental and/or occupational. Measles, heat rash and cough were said to be rampant in the hot season. Rheumatism is a major ailment in old adults. Typhoid fever, diarrhea and dysentery in children that take place occasionally may be linked to unhygienic living environment and polluted water.

4.6 TRADITIONAL ADMINISTRATION

4.6.1 Emirate System of Governance

The emirate system of traditional local administration was practiced in all the predominantly Muslim States of Northern Nigeria. Prior to the colonial invasion, the Emir appointed officials to assist in making his governing task easier. Such a decision by the Emir showed that even with the outright centralisation of power in the emirate system, there was still some delegation of power similar to a democratic system of government. Each official in the Emir's cabinet had a unique role to play. For example: the ***Waziri*** was the Prime Minister and was the closest to the Emir; ***Galadima*** oversaw the capital and oversaw matters that pertained to the capital of the emirate; ***Madawaki*** was the commander of the army.

When an external conflict arose, the Emir summoned the Madawaki through the Waziri. While the Madawaki led the army, ***Dogari*** oversaw the police and the ***Maaji*** managed the Treasury department.

Other title holders of the traditional emirate include the three ***Sarkins*** of the emirate who were also quite close to the Emir. ***Sarkin Fada*** saw to the welfare and running of the Palace.
The ***Sarkin Pawa*** was the head of the butchers in the emirate. ***Sarkin Ruwa,*** oversaw fishing activities in the emirate. Each one of these officials were sought out when it came to running the activities of the emirate; however, the Emir still had served as the preeminent voice of authority and had the power to relinquish any officer of his position.

The Emirate system due to its landmass and population was further subdivided into districts. These districts were supervised by officials known as ***Hakimis***. The Hakimis were responsible for the collection of taxes and had the power to appoint village heads (***Dagachis***) who made the collection of taxes easier. The emirates also had ***Alkali*** courts, led by Alkali judges. These judges ruled based on the precepts of Sharia law and delivered judgment on issues such as marriage, murder, debt to mention a few. Court cases that were of greater consequence to the emirate were heard in the Emir's palace with the Emir as the judge.

The British employed to great success the Emirate system for its Indirect Rule and because of the centralised power structure of the Emirate, the British Indirect Rule approach quickly prospered.

The project area is within the Sultanate of Sokoto. The Sultan is the head of the Sultanate who has historically been the head of the entire emirates of the Northern Nigeria and also the leader of all Muslims in the country. The three districts in the project area, namely, Wamakko, Arkilla and Kalambaina, are all headed by Hakimis (District Heads) who are appointed by the Sultan.

In a typical emirate, the Mai Anguwa is the closest to the residents and all disputes and misunderstandings are first reported to him for settlement. The Mai Anguwa reports to the Dagachi (Village Head) or Magaji, who in turn is answerable to the Hakimi (District Head). The District Head reports to the Emir. In terms of information/instructions from the emir to the people, the hierarchy trickles down from the emir to the people in the communities. The traditional hierarchy is schematically depicted in Figure 4.32 below.

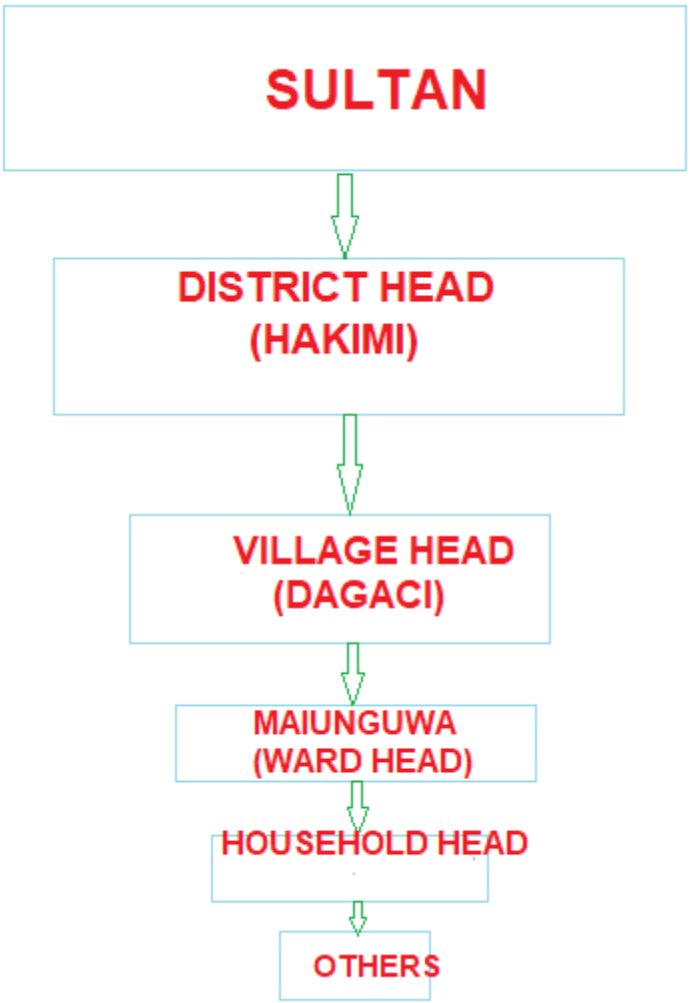


Figure 4. 21: Traditional leadership hierarchy in the project area

4.7 PUBLIC CONSULTATION

Consultations were carried out with the project affected communities and relevant institutional stakeholders. Consultations were carried to ensure broad community support and to ensure informed consultation and community participation. The consultation process was carried out in conjunction with dissemination of relevant environmental and social information to concerned stakeholders.

4.7.1 Consultation Process

Consultation is defined as the process of exchanging information about the environmental and socio-economic implications of a proposed project, which is being subjected to an EIA process, with Project Affected Persons, designated bodies, organizations or persons with environmental responsibilities or interests. The purpose of the consultation exercise conducted for this project was to provide an opportunity for stakeholders to offer valuable inputs, which will assist the project team and other agencies of the Federal Government of Nigeria and Sokoto State in making decisions and recommendations throughout the project phases. It is essential for the project stakeholders to have the opportunities to participate in and provide input early on and throughout the impact assessment process. With timely and meaningful input, concerns can be identified, considered, and appropriately addressed before final decisions are made.

Stakeholders' consultation is a major requirement in the Nigerian EIA process. Through this process, stakeholders and the public have an opportunity to contribute to the overall project design by raising concerns and making recommendations. In addition, consultation brings about commitment of project stakeholders by creating the needed sense of ownership and being valued by the project proponents.

4.7.2 Objectives of Consultation

The main objectives of consultations carried out for this EIA were to:

- ✓ Inform stakeholders about the proposed project and its potential benefits as well as discuss environmental and social issues associated with the project and solicit for their views and concerns;
- ✓ Collect relevant information for the project design;
- ✓ To identify and mitigate impacts before the project gets underway;
- ✓ To avoid conflicts by addressing issues of concern early and continuously in the life of the project; and
- ✓ To ensure that any fears or apprehension about the nature, scale and impacts of the project have been fully addressed.

4.7.3 Stakeholders Consulted

The proposed project has a wide range of stakeholders representing various and sometimes differing views on the relationships between the project, economic development, and environmental protection. The primary stakeholders consulted were:

- ✓ Sokoto State Ministry of Environment;
- ✓ Sokoto Environmental Protection Agency;
- ✓ The Traditional Councils in the four towns surveyed; and
- ✓ All affected communities in the four towns.

Stakeholder consultation for the proposed project took several forms which include, institutional consultations, questionnaire administration, personal interviews, FGDs.

Stakeholders were consulted directly through visitations and Focused Group Discussions. Some of the stakeholders consulted are shown in the plates below.

Plate 4. 17: MD SEPA flanked by members of the EIA team, September 2021

Plate 4. 20: End of an FGD with Ardon Sarkin Musulmi

Plate 4. 18: A KII session with an elderly community member

Plate 4. 19: An interaction with community stakeholders in a village near Dogon Daji

Plate 4. 20: Animals being fed before milking at Sidi Akibu farm

The Secretary of Wamakko LGA, who represented the LGA Chairman who was somewhere else

on official engagement. The LGA Secretary expressed the optimism of the LGA Council on the prospects of the proposed project on the socio-economic development of Wamakko LGA. He called on the project proponent to be wary of false indigeneship claims by people they may be dealing with.

4.7.4 Brief Outcomes from community consultations

Communities in the four towns were consulted via FGDs and personal interviews. Throughout the consultation process, the project background, design concepts and its social and environmental consequences were briefly presented to ensure that the stakeholders understand the issues at hand and their context for better commitment.

Highlights of the consultation process in the project communities include the following:

- ✓ Attendance at all the consultation meetings were appreciable and cut across the different strata of the communities;
- ✓ The team was well received at all the visited communities;
- ✓ The communities emphasized the need for the State Government to ensure that a competent company is considered for the construction work to ensure timely completion and avoid abandonment of the project midway through;
- ✓ Community stakeholders also want the proponent to compel the construction company to consider their youths for employment during the constructional phase of the project;
- ✓ Community stakeholders also want the proponent to consider some of their youths for employment in the operational phase of the project; and
- ✓ Community leaders assured the EIA team that they would continue to give moral support to government in the implementation of the project.

4.7.5 Summary of Responses and concerns

The outcome of the consultation with the various stakeholders and beneficiaries of the project is summarized in forms of expressed appreciations and concerns in as follows.

4.7.5.1 Appreciations

The following positive impacts that would potentially be made by the proposed project were appreciated by the communities:

- ✓ Boosting of agricultural productivity in the area;

- ✓ Creation of wealth in the project area;
- ✓ Reduction of crime in the project area as a result of youth employment;
- ✓ Creation of employment in the constructional phase of the project; and
- ✓ Provision of jobs, in the operational phase of the project, to especially youth in the local communities.

4.7.5.2 Concerns/Observation

The objectives of the project were made known to the stakeholders. A major concern expressed by communities in the project area is that of youth employment in both the construction and operations phases of the project.

4.7.6 Future Consultations

Further consultations would be carried out throughout the project cycle time so as to realize the overall objectives of the consultation process. Submission of the EIA report is not the end of the EIA process. Key stakeholders would continuously be engaged throughout the project life cycle in several capacities including, but not limited to:

- ✓ Disclosure of the draft EIA report as stipulated by law;
- ✓ Dialogue with authorities and regulators involved in inspection and monitoring;
- ✓ Technical collaboration on design modification where desirable (as appropriate); and
- ✓ Interacting with communities during the operational phase to get feedback on the effectiveness of mitigation and enhancement measures.

CHAPTER FIVE: ASSOCIATED AND POTENTIAL IMPACTS OF THE PROPOSED PROJECT

5.1: INTRODUCTION

All major development projects have environmental and/or socio-economic impacts. If the objectives of such projects must be realized, the associated and potential environmental, socio-economic and health impacts of the projects must be identified, evaluated and adequately mitigated. In general, these impacts are the resultant changes in environmental parameters, in space and time, compared with what would have happened had the project not been undertaken. The parameters may be related to any of the environmental characteristics such as air quality, water quality, noise levels or local occupational employment. There are direct and indirect impacts which may sometimes correlate with short – run and long run impacts. For some impacts however, the distinction between short run and long run impact may relate to the distribution between the construction and operational stages of the project. Although the greatest concern about impacts is their negative aspect, some impacts are positive and should therefore be enhanced. However, whether positive or negative, impacts can vary considerably in magnitude, extent and in significance.

5.2 IMPACTS ASSESSMENT METHODOLOGY

This section identifies relevant issues associated with the proposed project and defines the nature of the potential impacts.

Analysis of impacts identifies the following:

- ✓ Types of impact;
- ✓ Predicts the magnitude of impact;
- ✓ Probability of occurrence of impact;
- ✓ Extent of the impact; and
- ✓ Determines the overall significance of the impact.

5.3 ENVIRONMENTAL AND SOCIAL IMPACTS

Potential impacts were assessed using the methodology described below.

Firstly, relevant issues were described as they relate to particular project activities and those aspects of the activities that are likely to result in impacts. The nature of the impacts was then described, after which the significance of the impacts was determined.

The following definitions are applicable to the assessment process:

- ✓ An **activity** is a distinct process or task undertaken by an organization for which a responsibility can be assigned. Activities also include facilities or pieces of infrastructure that are possessed by an organization.

- ✓ An **environmental aspect** is an element of activities of organizations or their products and services which can interact with the natural or human environment. The interaction of an aspect with the environment may result in an impact.

- ✓ **Environmental and social impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to adverse air quality. Receptors can comprise of, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as aquifers and flora.

Impacts on the environment can lead to changes in existing conditions; the impacts can be direct, indirect or cumulative.
Direct impacts refer to changes in environmental components that result from direct cause-effect consequences of interactions between the environment and project activities. Indirect impacts result from cause-effect consequences of interactions between the environment and direct impacts. Cumulative impacts refer to the accumulation of changes to the environment caused by the project and other ongoing or planned human activities.

5.4 DESCRIPTION OF ASPECTS AND IMPACTS

The findings of the environmental investigations form the basis for prediction of impacts. Once a potential impact has been determined during the scoping process, it is necessary to identify which project activity will cause the impact, its probability of occurrence as well as its magnitude and extent (spatial and temporal). This information is important for evaluating the significance of the impact, and for defining mitigation and monitoring strategies.
The aspects and impacts identified will therefore be described according to the definitions below:

5.4.1 Extent

The extent for each aspect, receptor and impact will be defined. The geographical coverage (spatial scope) description will take account of the following factors:

- ✓ The physical extent/distribution of the aspect, receptor and proposed impact; and

- ✓ The nature of the baseline environment within the area of impact.

For example, the impacts of noise are likely to be more confined to a smaller geographical area than the impacts of atmospheric emissions, which may be experienced a long distance away. The significance of impacts also varies spatially. Many will be significant only within the immediate

vicinity of the site or within the surrounding community, whilst others may be significant at a local (project) or regional (district) level.
The **extent** of the impact will be rated as shown in Table 5.1 below.

Table 5. 1: Rating for extent of impacts

S/No	Extent	Scale of magnitude
	Localized (At localized scale i.e. along the road corridor or 500m on either side of the ROW in extent)	1
	Study area (The proposed ROW and 2km on either side of it)	2
	Regional (Covers the region where the road passes)	3
	National (At country level)	4
	International (Beyond Nigeria)	5

5.4.2 Duration

Duration refers to the time span over which a positive or negative change caused by the aspect may be experienced by the environment.
The assessment method will rate time periods for impact duration in table 5.2 below.

Table 5. 2: Impact duration rating

S/No	Duration of impact	Rating
	Very short (0 – 1 Years)	1
	Short term (1 – 5 Years)	2
	Medium term (5 – 15 years)	3
	Long term (>15 years)	4
	Permanent	5

5.4.3 Magnitude

The **magnitude** of an environmental or social impact is determined by the degree of change to the baseline condition, and includes consideration of the following factors:

- ✓ The reversibility of the impact;
- ✓ The sensitivity of the environmental receptor;
- ✓ The impact duration, its permanency and whether it increases or decreases with time; Whether the aspect is controversial or would set a precedent; and
- ✓ The threat to environmental and health standards and objectives.

Magnitude of impacts was rated according to the scale in Table 5.3 below.

Table 5. 3: Impact magnitude rating

S/No	Impact Magnitude	Rating
1.	Small (will have no effect on the physical, biological or social environment)	0
2.	Minor (will cause a minimal impact on physical, biological or social environment)	2
3.	Low (will cause a slight impact on the physical, biological or social environment)	4
4.	Moderate (will result in a physical, biological or social environment component or process continuing but in a modified way)	6
5.	High (physical, biological or social environment or component or process is altered to the extent that they temporarily cease to exist or operate)	8
6.	Very high (results in complete destruction of physical, biological or social environment components and permanent cessation of the processes)	10

5.4.4 Probability of impact

The **probability** or **frequency** of impact means how often an aspect may impact either positively or negatively on the environment. In other words, the probability of an impact expresses the likelihood of an impact occurrence.

The probability rating used for the assessment is summarized in Table 5.4 below.

Table 5. 4: Impact probability rating

S/No	Impact probability	Rating
	Highly improbable (<20% chance of occurring)	1
	Improbable (20 – 40% chance of occurring)	2
	Probable (>40% - 70% chance of occurring)	3
	Highly probable (>70% - 90% chance of occurring)	4
	Definite (>90% - 100% chance of occurring)	5

5.5 ASSESSING THE SIGNIFICANCE OF IMPACTS

The purpose of impact assessment is to assign overall relative significance to predict impacts associated with a proposed project, and to determine the methods to be used in avoiding, mitigating or managing anticipated impacts. For this study the information presented above was summarized in a tabular form and significance was assigned based on reasonable deductions. Significance was determined before and after application of appropriate mitigation measures.

A "significant impact" for the purposes of this study is: "An impact which, either in isolation or in combination with others, could in the opinion of the specialist, have an influence on the decision-making process, including the specification of mitigation measures."

5.6 DETERMINATION OF SIGNIFICANCE OF IMPACTS

Environmental significance rating is an attempt to evaluate the importance of a particular impact, the likelihood and consequence of which has already been assessed by the relevant specialist. The description and assessment of the aspects and impacts undertaken is presented in a consolidated table with the significance of the impacts assigned using the process and matrix (Table 5.5) below.

The sum of the first three characteristics (extent, duration and magnitude) provides a total score for the **Consequence** of each impact. The last characteristic determines the **Probability** of the potential impact. The product of **Consequence** and **Probability** represents the **Significance** of the impact.

Table 5. 5: Significance Assessment Matrix

		CONSEQUENCE (Extent + Duration + Magnitude)																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Probability	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
	3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
	5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

In order to evaluate impacts and mitigation thresholds, the ratings in Table 5.6 were used.

Table 5. 6: Impact and mitigation ratings

S/No.	Rating	Range	Interpretation
1.	Low	<30	Whenever impact would not have a direct influence on the decision to go ahead with the project as proposed
2.	Medium	30-60	Whenever impact could influence the decision to go ahead with the proposed project in the area unless it is effectively mitigated
3.	High	>60	Whenever the impact would definitely have an influence on the decision process to develop in the area

5.7 POTENTIAL IMPACTS ASSOCIATED WITH THE PROJECT

The proposed project is expected to generate both positive and negative impacts on the physical and socio-economic environments of the project area. The project will require construction

works over an area of about ten Hectares (10Ha) for the veterinary specialist clinic, about one hectare each for both the milk and meat processing projects and over one thousand hectares for the pasture and livestock feed project component.

Construction work will involve excavation for foundation footings, building construction for administration and project units, as well as road pavement construction. Similarly, maintenance and repair activities in the operational phase will involve carrying out periodic building and equipment maintenance.

The sources of impact are grouped by project phases as follows:

- ✓ Pre-construction;
- ✓ Construction;
- ✓ Operation; and
- ✓ Decommissioning

Table 5.7 explains these sources of impacts.

Table 5. 7: Sources of environmental and socio-economic impacts

S/No.	Source of Impact	Description of Impact
1.	**Preconstruction Phase**	
	Displacement of farming activities from the grazing reserve site and the site for establishment of the veterinary specialist hospital	Temporary loss of means of livelihood by farmers using the proposed sites and reduction in supply of agricultural crops hitherto produced from the farms in the site
2.	**Construction Phase**	
	Site preparation	Noise impacts and traffic accident hazards from construction equipment carrying out site preparation activities
	Transportation and traffic	Impacts from transportation of materials, equipment and workers to and from the site, including fueling and maintenance of vehicles and machinery
	Construction activities	HSE hazards as a result of construction of earth dams, irrigation facilities, silos, feed mills, building and civil structures and assembling of process equipment

Table 5.7 continued

S/No.	Source of Impact	Description of Impact
	Management of wastes and hazardous materials	Management of waste, pollutants, hazardous substances and other materials
	Procurement of materials, goods and services	Economic impacts in terms of trading and procurement opportunities
	Presence of workers	Presence of workers which could lead to potential abuse of local population, including gender based-violence and potential increase in STDs
3.	**Operational Phase**	
	Operating of dairy farms, pasture farms, earth dams, silos and Abattoirs' processing operations	Pollution and HSE impacts resulting from operations
	Equipment maintenance operations	HSE and other socio-economic impacts arising from presence of maintenance workers
	Waste and hazardous materials management	Solid waste generation and disposal

5.8 ENVIRONMENTAL AND SOCIAL COMPONENTS

Environmental and social components are the elements of the physical, biological and socio-economic environment that are likely to be affected by one or more sources of impact. The components identified for this project are listed in Table 5.8. The study focused only on these components.

5.8.1 Positive impacts

The proposed grazing reserves project will yield benefits to both the formal and informal economy of the project area and the entire country. For example, residents of the project area could be temporarily employed during the construction phase for unskilled and semi-skilled work. The stakeholders consulted had observed that they expect their youth to be employed in the operational phase of the project. Community stakeholders also expect their women to be engaged to provide catering services to construction workers.

Additionally, it is expected that as a result of the influx of workers in the construction phase, there will be a demand for temporary housing and lodging services which is identified as a benefit to the project communities.

Establishment of the grazing reserves, milk and meat processing factories as well as the AI/ET centres and the veterinary specialist clinic will significantly contribute to provision of improved cattle breeds and the associated improved supply of beef, milk and hides in this part of the country which is expected to, apart from solving the problems associated with inadequacy of the existing supply, go a long way in providing new business opportunities for supporting industries such as food, beverages, transportation, banking and insurance.

Table 5. 8: Environmental and social components

S/No.	Component		Description
1.	**Physical Environment**	Soil	Physical and chemical characteristics of the soil in the project area, including vulnerability to erosion
		Water	Physical and chemical characteristics of surface and groundwater
		Air quality	Physical and chemical characteristics of the air
		Noise	Noise, vibrations
2.	**Biological Environment**	Terrestrial flora	Terrestrial plant communities
		Terrestrial fauna	All terrestrial and semi-aquatic animal species and their habitats
3.	**Socio-economic Environment**	Employment and economic development	Local and regional economic development and employment
		Land use	Land uses: agricultural, livestock rearing, etc.
		Infrastructure	Electricity supply, water supply local road network, etc.
		Cultural and archeological heritage	Religious, cultural or historical sites and structures
		Public health and safety	Population well-being and health, including Sexually Transmitted Infections (STIs)

5.8.2 Negative impacts

The main impacts on the socio-economic environment are the temporary loss of farmlands by the users of the land parcels that have been acquired for the establishment of the grazing reserve and the specialist veterinary hospital.

Other impacts may occur during construction and maintenance works but will be of temporary nature. These may include traffic accidents, noise, degradation of water quality and soil contamination by poor waste management or accidental spill of hydrocarbons. However, negative impacts that may occur during the construction phase will be localized and of a short-term duration. There may also be negative impacts in the operational phase of the project, which may include HSE hazards, air, soil and water pollution problems.

5.8.3 Identification of potential environmental and social impacts

Identification of the potential environmental and social impacts was carried out using an "environmental matrix", in which one axis identifies the project's sources of impacts while the

other axis identifies the biophysical and socio-economic components of the project. Table 5.9 presents these interactions and will be the basis for the impact evaluation.

Table 5. 9: Impact identification matrix

	ENVIRONMENTAL COMPONENT											
		Physical Environment					Biological Environment	Social Environment				
SOURCES OF IMPACT BY PHASE		Soil	Surface water	Groundwater	Air quality	Noise	Terrestrial ecology	Employment and economic development	Land use	Infrastructure	Community health and safety	Workers health and safety
	PRE-CONSTRUCTION PHASE											
	Displacement of farming activities							**N**	**N**			
	CONSTRUCTION PHASE											
	Site preparation				**N**	**N**		**P**			**N**	**N**
	Transportation and traffic				**N**	**N**		**N/P**		**N**	**N**	**N**
	Construction activities	**N**			**N**	**N**		**P**			**N**	**N**
	Management of wastes and hazardous materials	**N**	**N**	**N**							**N**	**N**

Table 5.9, continued

		ENVIRONMENTAL COMPONENT										
		Physical environment					Biological environment	Social environment				
SOURCES OF IMPACT BY PHASE		Soil	Surface Water	Groundwater	Air quality	Noise	Terrestrial ecology	Employment and economic development	Land use	Infrastructure	Community health and safety	Workers health and safety
	Procurement of materials, goods and services							**P**				
	Presence of workers							**N/P**			**N**	**N**
	Operational Phase											
	Operating the grazing reserves, milk and meat processing plants and the veterinary hospital	**N /P**	**N**	**N**	**N**	**N**		**P**		**P**		**N**
	Transportation and traffic	**N**			**N**	**N**					**N**	
	Maintenance of reserves		**N**	**N**	**N**	**N**					**N**	**N**
	Waste management	**N**	**N**	**N**				**N/P**			**N**	**N**
	Presence of maintenance workers										**N**	**N**

Key: N = Negative impact; P = Positive impact; and N/P = Negative and positive impacts

5.9 ASSESSMENT OF IMPACTS

5.9.1 Potential Impacts in the Pre-construction Phase

5.9.1.1 Potential positive impacts on project communities

A positive impact identified in the Pre-Construction Phase of the proposed project is a slight boost in the economic activities in the project communities. An assessment of this impact is presented in Table 5.10 below.

Table 5. 10: Impact significance of boost to local economy

Enhancement status	Extent	Duration	Magnitude	Probability
Without enhancement	Study area	Short term	Low	Probable
	2	2	4	3
	Result: (+24) Low positive			
Enhancement measures	Sokoto state will encourage its pre-construction consultants to source for as many goods as are required by them in the project communities to enable them to benefit from the available economic opportunities			

5.9.1.2 Potential negative impact on project communities

The Preconstruction Phase of the project is not expected to generate significant negative impacts. However, there will be negative impacts that will be consequent upon land loss by farmers using the existing plot of land dedicated for the proposed project.

Table 5. 11: Impact significance on land acquisition and resettlement

Enhancement status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Very short	Low	Definite
	2	1	4	5
	Result: (-40) medium negative			
Mitigation measures	Farmers that have grown crops should be allowed to harvest their crops prior to commencement of construction activities.			

5.9.2 Potential Impacts in the Construction Phase

5.9.2.1 Potential impacts on employment

The proposed project is expected to generate direct and indirect employment opportunities for both semi-skilled and unskilled workers. Direct employment will include for jobs in constructing required infrastructure, including earth dam and irrigational facilities for the grazing reserves, as well as for the building and associated components of the milk/meat processing plants and the veterinary hospital. Indirect employment will be generated through increased business opportunities and induced economic growth both at the local, regional and national levels through procurement of goods and services required in the execution of the project.

Creation of employment opportunities during the construction phase would be the most important benefit for the communities in the project area. Unemployment and under-employment levels are generally high in the area and had escalated insecurity in the State. Creation of job opportunities shall to a certain extent bring some relief to the troubled communities.

The proposed project will lead to a marked increase in individual income for many Nigerians. This will be as a result of increased purchases (from local, regional and national markets) and employment generated by construction activities.

Potential impacts associated with direct and indirect employment in the construction phase of the project are assessed in Table 5.12 the table below.

Table 5. 12: Significance of employment impact

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Regional	Short term	Low	Probable
	3	2	4	3
	Result: (+27) Low positive			
Enhancement measures	✓ Sokoto State Government will direct its Project Contractors to give priority to the local community during recruitment of construction personnel; ✓ Project Contractor shall also ensure opportunities for skill acquisition and capacity building are given to the local employees; and ✓ The Project Contractor shall whenever possible, source for expert employees locally first, then regionally and nationally before engaging international experts.			

5.9.2.2 Potential impacts on economic development

The proposed project is of such magnitude that it will impact positively on the economy of the project area and by extension the entire country. Implementation of the proposed project is expected to stimulate economic growth through:

- ✓ Provision of beef, diary, pasture and host of others which will enhance agricultural productivity in the area;
- ✓ Attraction of new businesses (in both the formal and informal sectors), especially those that will be facilitated by the presence of the project components;
- ✓ Increased revenue as a result of secondary employment and creation of small businesses; and
- ✓ Increase in tax revenue generation through direct and indirect taxes on goods and services associated with the project.

An assessment of the positive impacts that will be created in the construction phase resulting from implementation of the proposed project is given in Table 5.13 below.

Table 5. 13: Impact significance on economic development

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Regional	Short term	Low	Probable
	3	2	4	3
	Result: (+27) Low positive			
Enhancement measures	✓ Sokoto State Government shall encourage the Project Contractor to source for as many materials required for construction purposes as possible locally, prioritizing from the region to the rest of the Country, before resorting to importation; and ✓ Community Liaison Personnel shall be used by Project Contractors to manage community expectations and target local service providers			

5.9.2.3 Soil pollution

The proposed project will require the removal of significant amount of vegetation on the existing farmlands for the proposed veterinary hospital and for the feed and pasture project components.
Similarly, movement of construction equipment such as trucks, Four-Wheel Drive (4WD) vehicles, etc. will lead to a compaction of soils along the access roads used in the construction phase of the project.
Construction equipment used for the project, if not well-serviced, may cause fugitive spills due to leaks and lead to surface and subsurface soil contamination.

Soils may also be contaminated through accidental spills caused during field refueling. Based on the above facts, the impact assessment on soils resulting from the construction phase activities is given in Table 5.14 below.

Table 5. 14: Significance of impact on soils

Enhancement status	Extent	Duration	Magnitude	Probability
Without Mitigation	Study area	Short	Minor	Probable
	1	2	2	3
	Result: (-15) Low positive			
Mitigation measures	✓ Regularly service and maintain construction equipment; ✓ Restrict construction activities and movement of equipment to existing roads; ✓ Implement erosion and sediment control plans in the rainy season, in areas within the sites identified as having high erosion potential; and ✓ Hazardous materials must be stored in a manner that prevents interaction with each other or with the environment			

5.9.2.4 Water pollution

Vegetation removal in some areas can increase soil erosion, causing sediment to be transported and deposited into water bodies, especially during rainy season. This could lead to the deterioration of water quality of these water bodies.

In the construction phase, ground and surface water may be exposed to contamination by spills or leaks of contaminants. Sources of impacts to groundwater are the same as for soil in the project area. Hazardous materials from leaking construction equipment or from accidental spillage may be washed down during the rainy season into ground and surface water and this could lead to adverse water quality.

The significance of the impacts on water resources during the construction phase is given in Table 5.15.

Table 5. 15: Significance of impact on ground and surface water resources

Enhancement status	Extent	Duration	Magnitude	Probability
Without Mitigation	Study area	Short	Minor	Probable
	2	2	2	3
	Result: (-18) Low negative			
Mitigation measures	✓ Regularly service and maintain construction equipment; and ✓ Hazardous materials must be stored in a manner that prevents interaction with each other or with the environment.			

5.9.2.5 Noise pollution

Construction work will be carried out close to existing homes and farmlands. The construction plant and equipment used for construction work will most likely cause temporary noise emissions which may cause nuisance to neighboring residences, businesses and farmers.

The significance of the impacts associated with air quality and noise are given in Table 5.16 below.

Table 5. 16: Impact significance of noise

Enhancement status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Low	Highly probable
	2	2	4	4
	Result: (-32) Medium negative			
Mitigation measures	✓ The Project Contractors shall limit the construction times to daylight hours and only in exceptional cases will they work beyond daylight hours; ✓ The Project Contractors shall select low-noise construction equipment; and ✓ The Project Contractor shall locate noisy equipment far away from communities			

5.9.2.6 Alteration of terrestrial vegetation

In the construction phase, local vegetation will be removed from the land already acquired for the proposed grazing reserve and veterinary hospital. Vegetation clearing will lead to a permanent loss of terrestrial habitats on the sites. However, since no endangered species have been identified on the land and the area to be impacted is relatively small and the existing vegetation has a widespread population over the area, overall, terrestrial vegetation will not be significantly affected. Table 5.17 presents the impact assessment of the potential impact.

Table 5. 17: Impact significance of habitat alteration

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Project area	Permanent	Low	Probable
	1	5	2	3
	Result: (-24) Low negative			
Mitigation measures	✓ Restrict vegetation clearing to just the actual area where the buildings would be erected; and ✓ Replant native vegetation on exposed soils wherever possible			

5.9.2.7 Introduction of Alien Invasive Plant Species

Alien Invasive Plant Species (AIPS) are introduced in the environment through construction plant, equipment, and containers imported into the country that have not undergone decontamination. The propagules of AIPS attach themselves to construction plant and equipment and get introduced into the project environment through interactions with native soils.

Once introduced into the landscape, AIPS usually displace indigenous plant species and do not provide good habitat and forage for animal species in the project area. In areas where AIPS are introduced, the landscape in terrestrial habitat changes significantly with other plant species displaced or suppressed. The AIPS pose unusual characteristics which lack management measures. For instance, some AIPS could be poisonous when eaten by animals.

The proposed project will most likely require the importation of operational equipment. Lack of appropriate enforcement, by Nigerian authorities, of equipment inspection and decontamination procedures will create opportunities for introduction of AIPS in the project area. If contaminated construction plant and equipment is used, chances of AIPS being introduced into the indigenous environment are high. This could leave Sokoto State and Nigerian Governments with a new problem to deal with in the operational phase of the project. The impact of introducing AIPS into the project area is assessed in Table 5.18.

Table 5. 18: Impact significance of AIPS

Enhancement status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Low	Probable
	1	4	4	3
	Result: (-27) Medium negative			
Mitigation measures	✓ Contractors, especially for the grazing reserve component, shall develop and implement an AIPS prevention strategy which shall include monitoring for invasive alien plants, effective rehabilitation of disturbed areas and prevention of unnecessary disturbance of natural areas; and ✓ Any alien invasive plant found on site should be controlled as soon as possible			

5.9.2.8 Impact on farming

Sokoto State Government has already acquired lands for the proposed project. The size of the land is over 3ooo hectres. The farmers currently using parts of the acquire land may be affected adversely as they will have to look for new areas to resettle and perform their farming activities. Table 5.19 below assess the significance of this impact.

Table 5. 19: Impact significance of land use

Enhancement status	Extent	Duration	Magnitude	Probability
Without enhancement	Study area	Short term	Low	Definite
	2	2	3	5
	Result: (-35) Medium negative			
Enhancement measures	✓ Sokoto State Government shall allow farmers who have grown crops to harvest their crops prior to commencement of construction activities; and ✓ The State Government shall consider giving the farmers alternative farmlands to use.			

5.9.2.9 Impacts on traffic and roads

In the construction phase, construction equipment and materials will be transported to the construction yards and sites. This may have negative impacts, such as disrupting traffic and

damaging existing highways and local/township roads, if the Project Contractors do not comply with the speed and axle load limits.

Table 5.20 presents the impact significance on infrastructure.

Table 5. 20: Impact significance on traffic and damage to roads

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without Mitigation	Regional	Short	Low	Probable
	3	2	3	3
	Result: (-24) Low negative			
Mitigation measures	✓ The Project Contractors shall ensure compliance with speed and axle load requirements of all road classes to be used in transporting equipment and materials for construction work; and ✓ The Project Contractors shall devise and implement effective Traffic Management Plans for deployment of equipment and materials to construction sites.			

5.9.2.10 Impact on ccommunity health and safety

In the construction phase, communities living near the proposed project sites may be exposed to construction related impacts such as accidents with construction equipment.

Likewise, the proposed project has the potential to result in spread of Sexually Transmitted Infections (STIs) such as HIV/AIDS as a result of migrant workers interacting with community members, especially vulnerable women and young girls.

Table 5.21 presents the analysis of significance of impacts on community health and safety.

Table 5. 21: Significance of impacts on community health and safety

Enhancement status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Low	Highly probable
	2	4	3	4
	Result: (-36) Medium negative			
Mitigation measures	✓ The Project Contractors shall develop and implement a written Emergency Response Plan (ERP) for traffic accidents and other emergencies for the construction phase; ✓ Sokoto State Government shall create awareness in the project communities on the dangers of illicit sexual relationship; and ✓ Sokoto State Government shall sensitize members of the project community on dangers and practical means of protection against communicable diseases and STDs.			

5.9.2.11 Impacts on health and safety of workers

The proposed project will employ many workers in the construction phase. The majority of unskilled workers to be recruited will be from the project communities and will most likely have minimal Health, Safety and Environment (HSE) knowledge, skills and competencies. Consequently, lack of development and implementation of risk control measures such as Safe Work Procedures (SWP), inadequate supervision and untrained workforce could potentially lead to safety and health incidents. Table 5.22 presents impact assessment on health and safety of workers.

Table 5. 22: Significance of impacts on health and safety of workers

Enhance-ment status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short term	Moderate	Probable
	3	2	6	3
	Result: (-33) Medium negative			
Mitigation measures	✓ The Project Contractors shall develop and implement an Occupational Safety and Health (OSH) Management System which is in line with Nigerian Factory Act and other relevant legal provisions; ✓ Project Contractors shall develop and implement HSE training program for all workers that are employed during the construction phase of the project; ✓ Project Contractors shall implement regular toolbox meetings for all workers that are employed during the construction phase of the project; ✓ Project Contractors shall ensure that every employee working at the project site is provided with appropriate and adequate PPE; and ✓ Project Contractors shall ensure educating employees on the detrimental effects of drug and alcohol abuse, the risk and concerns relating to HIV/AIDS and other health risk-related activities.			

5.9.3 Potential Impacts in the Operational Phase

The following subsections highlight some of the socio-economic impacts of the proposed project in the operational phase.

5.9.3.1 Increasing the availability and affordability of Breeds, Beef, Dairy and Pasture

The proposed project when completed will go a long way in boosting the supply of good cattle breeds and improved healthcare delivery for livestock and enhanced earning from livestock rearing, with an overall, positive impact on job and wealth creation. The project will enhance the production of high-quality beef, diary, and pasture in our markets. Processing of locally produced cattle and milk will bring about a reduction in the cost of beef and dairy owing to improvement in their production and processing. This will ultimately make them more affordable to consumers in the project area and consequently improve nutrition and public health in Sokoto State and the country at large.

Commercial scale production of pasture from grasses grown in the grazing reserves will go a long way in solving our animal feeds scarcity in the dry seasons, while operating the modern meat processing factory will also enhance the production of high-quality leather and bring about increased foreign earnings for the country. An assessments of these impacts is presented in Table 5.23 below.

Table 5. 23: Impact significance on availability of meat, milk and pasture

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Regional	Long term	Medium	Probable
	2	3	6	4
	Result: (+44) Low positive			
Enhancement measures	Sokoto State Government shall encourage local businessmen to take up distributorship/dealership for the meat and milk processing; and shall give these businessmen special incentives so as to encourage them			

5.9.3.2 Stimulating agricultural and livestock development in the project area

Establishment of grazing reserves in the area will encourage more people to engage in farming and livestock rearing activities so as to take advantage of the proximity of the grazing reserves and affordability of their operations. Other entrepreneurs may also be encouraged, by improved agricultural activities in the area, to set up services as well as livestock and agro-based industries to cater for the needs of cattle farmers. An assessment of this impact is provided in Table 5.24 below.

Table 5. 24: Impact significance on stimulation of livestock and agricultural development

Enhancement status	Extent	Duration	Magnitude	Probability
Without enhancement	Regional	Long term	Medium	Probable
	2	3	4	3
	Result: (+27) Low positive			
Enhancement measures	FGN and SOSG should encourage local farmers/herders to take up loans and improve their livestock production and to set up agro-based factories in the project area; FGN and SOSG should give herders credit facilities to encourage local husbandry; and FGN and SOSG should give farmers/herders special financial incentives to encourage them.			

5.9.3.3 Improved regional security and national economy

All the twenty-three (23) LGAs of Sokoto State are very important in the role they will play in this grazing reserves project. Production of meat, dairy and pasture in the proposed grazing reserves is expected to impact positively on the economy of these LGAs as well as on the regional and national economies. The proposed project will facilitate livestock and agricultural productivity which will, in turn, impact positively on local and national economies. Economic benefits will include higher efficiency in meat and dairy processing as well as improvement in the quality and quantity of locally produced pasture. With the existing rich agricultural lands in the State, the proposed livestock production scheme as well as the suitable conditions for extensive subsistence and commercial cattle farming in the project area, the proposed project is of strategic importance to commerce and trade as well as economic and social security in Sokoto State and the entire country. Table 5.25 presents the impact significance assessment of the project on regional and national security.

Table 5. 25: Impact significance of improved regional security and economy

Enhancement status	Extent	Duration	Magnitude	Probability
Without enhancement	Region	Long term	Minor	Probable
	3	4	4	4
	Result: (+40) Medium positive			
Enhancement measures	✓ Farmers should be encouraged to form cooperative societies so as to benefit from the livestock and dairy production financing schemes to be executed by both SOSG and Federal Government; ✓ Farmers should be advised to insure their investment through appropriate schemes so as to reduce their operational risks; and ✓ Federal Government should ensure an enhanced security provision especially in rural areas to protect farmers from activities of bandits and other criminals such as kidnappers and armed robbers.			

5.9.3.4 Direct and indirect employment opportunities

The proposed grazing reserve will, in its operational phase, provide direct and indirect jobs for people in the project area. Direct jobs will be for people that will man daily production operations of the various components units of the project such as abattoir, dairy plant as well as the pasture fields, while indirect jobs will be inform of service provision to the respective components such as by food vendors, service industries such transport, dealers in meat and dairy products, banking, insurance, etc.

Significance of direct and indirect job creation is assessed in Table 5.26.

Table 5. 26: Significance of direct and indirect job creation

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Study area	Long term	Low	Probable
	2	4	4	3
	Result: (+30) Medium positive			
Enhancement measures	✓ SOSG should give preference to the people of the project area when recruiting employees; and ✓ SOSG should make sure that people from the project area are given opportunity to provide essential services such as food, transportation, and other services			

5.9.3.5 Reduction of crime rate

Provision of employment opportunities for people in the project area will go a long way in reducing crime rate. In every community, crime rate is generally associated with unemployment. It therefore follows that provision of employment to the people in the project area, especially the youth, will lead to a reduction in crime rate of the project area.

Impact significance of reduction in crime rate in the project area as a result of the project is assessed in Table 5.27.

Table 5. 27: Significance of reduction in crime rate

Enhancement status	Extent	Duration	Magnitude	Probability
Without enhancement	Study area	Long term	Minor	Probable
	2	4	2	3
	Result: (+24) Medium positive			
Enhancement measures	✓ SOSG should give preference to the people of the project area when recruiting for operational employees; ✓ SOSG should make sure that people from the project area are given opportunity to provide essential services such as food and transportation to factory employees; and ✓ SOSG should support local security arrangements operated by vigilante groups in the project area.			

CHAPTER SIX: MITIGATION MEASURES

6.1 INTRODUCTION

The rationale for impact quantification and significance has been discussed in Chapter 5; the results indicate that various components would be impacted positively or negatively. This chapter presents remedies for the identified potential negative impacts as well as enhancement measures for the positive impacts that are likely to result from the execution of the proposed project. The mitigation measures proposed in the various phases of this project will ensure minimal negative impacts of the proposed project on the environment.

Apart from identifying and predicting the likely impacts that may arise from the project development, there is need to provide abatement strategies and cost–effective environmental controls to ensure that environmental resources are harnessed in a sustainable manner. In order to preserve the present integrity of the environment, certain measures have been recommended to mitigate the impacts identified in this study; enhancement measures are also proffered for the positive impacts. The mitigation measures are provided to ensure that potential and associated negative impacts of the various project activities on the biophysical, socio-economic and health environments are eliminated or reduced to as low as reasonably possible (ALARP).

6.2 MITIGATION MEASURES

Mitigation measures are activities aimed at reducing the severity, avoiding or controlling project impacts and where possible they are used to enhance environmental quality through designed alternatives, scheduling or other means. Mitigation may be in form of avoidance (alternative action taken to avoid impact), compensatory payment of money or replacement in kind for losses or recreation of lost/damaged habitat. These set of mitigations took into account the environmental laws in Nigeria as well as international principles of sustainable development and best available technology relevant to the proposed development.

The main essence of mitigation measures in an EIA is to ensure safeguarding both the environment and socio-economic aspects of the proposed project environment. Mitigation is both a creative and practical phase of an EIA process. It seeks to find the best ways and means of avoiding, minimizing and remedying impacts. The main objectives of providing mitigation measures include the following:

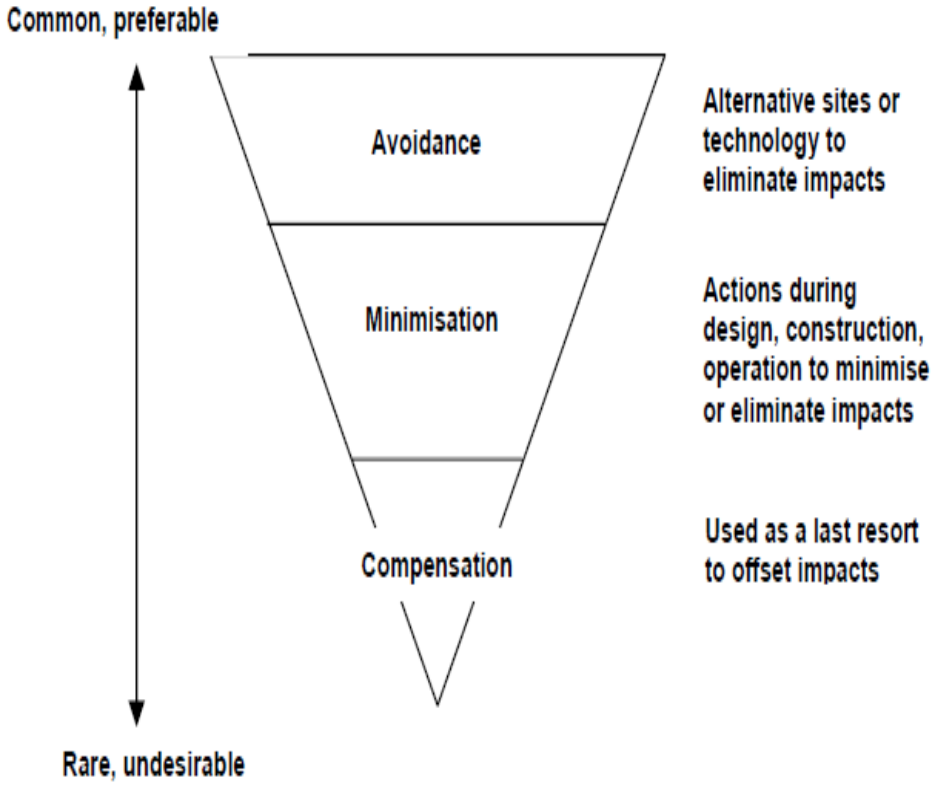
- ✓ Finding better alternatives and ways of doing things;
- ✓ Enhancing the environmental and social benefits of a proposal;
- ✓ Avoiding, minimising or remedying adverse impacts; and
- ✓ Ensuring that residual adverse impacts are kept within acceptable levels.

Elements of mitigation are organized into a hierarchy of actions:

- ✓ Firstly, avoid adverse impacts as far as possible by use of preventative measures;

- ✓ Secondly, minimise or reduce adverse impacts to 'as low as practicable' levels; and
- ✓ Thirdly, remedy or compensate for adverse residual impacts, which are unavoidable and cannot be reduced further.

A three-step process of mitigation can be applied to relate the hierarchy of elements to the stages of the EIA process when they are typically applied. Generally, as project design becomes more detailed, opportunities for impact avoidance narrow and the concern is then to minimize and compensate for unavoidable impacts. However, these distinctions are not rigid and opportunities for creative mitigation should be sought at all stages of project planning. Figure 6.1 presents the hierarchy of action steps to mitigate impacts.



Source: UNEP, 2002

Figure 6. 1: The Elements of Mitigation

Step One: Impact Avoidance

This step is most effective when applied at an early stage of project planning. It can be achieved by:

- ✓ Not undertaking certain projects or elements that could result in adverse impacts;

- ✓ Avoiding areas that are environmentally sensitive; and
- ✓ Putting in place preventative measures to stop adverse impacts from occurring.

Neither the proposed project nor any of its elements will result in any significant adverse effect on the environment. Moreover, the proposed site for the project is not environmentally sensitive. Equally important is the fact that preventive measures have been designed to ensure that the project is implemented in a sustainable manner.

Step Two: Impact Minimisation

This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude, or duration of adverse impacts. It can be achieved by:

- ✓ Scaling down or relocating the proposal;
- ✓ Redesigning elements of the project; and
- ✓ Taking supplementary measures to manage the impacts.

Step Three: Impact Compensation

This step is usually applied to remedy unavoidable residual adverse impacts. It can be achieved by:

- ✓ Rehabilitation of the affected site or environment;
- ✓ Restoration of the affected site or environment to its previous state or better; and
- ✓ Replacement of the same resource values at another location.

Environmental enhancements/ mitigations are essential and shall therefore be undertaken in the various phases of the proposed project, that is, during pre-construction (including those already undertaken), construction/installation and operation phases of the project.

The measures being proposed are specific, measurable, achievable, relevant and time-bound (SMART) to the proposed project. The measures also took into account the environmental laws in Nigeria, and internationally and the principles of sustainable development and best available technology.

Most of the likely impacts due to the proposed project which are majorly during construction and operation stages have been considered in the design and implementation plan of the proposed project. Additional measures have been suggested herewith which might include sound operational procedures, good maintenance schedule and good housekeeping.

The mitigation measures proposed for the predicted impacts were based on the following considerations among others:

- ✓Environmental laws in Nigeria, with emphasis on permissible limits for waste streams
- ✓Best Available Technology for Sustainable Development
- ✓Feasibility of application of the measures in Nigeria
- ✓Concerns of stakeholders during consultation meetings, etc.

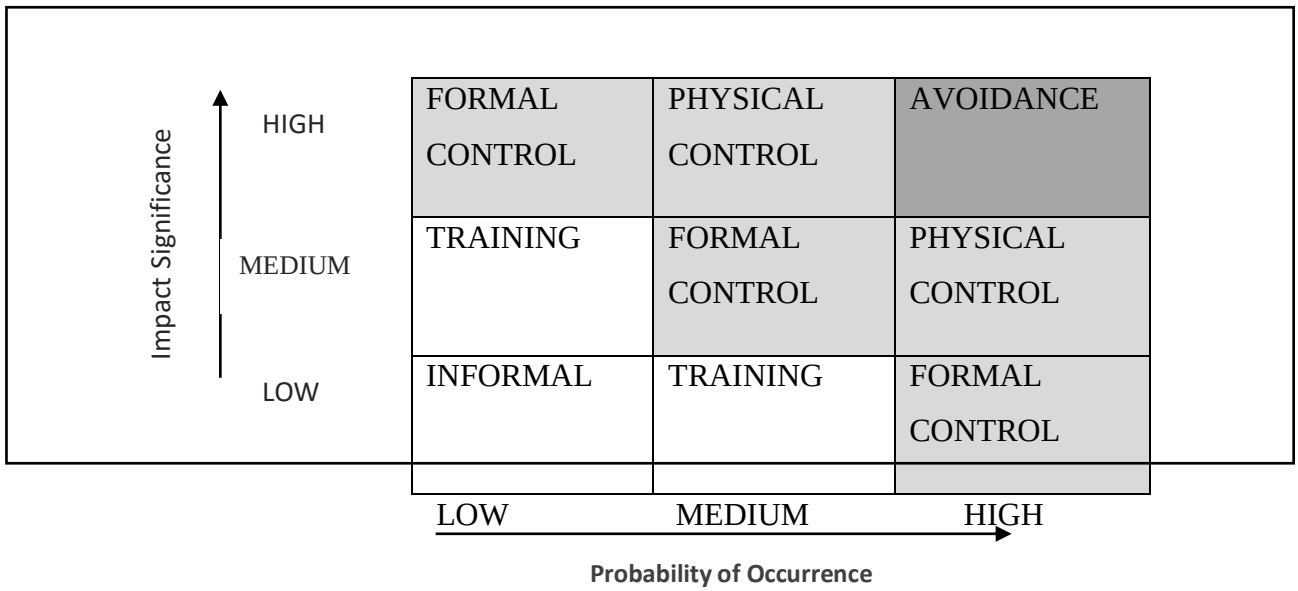


Figure 6. 2: Matrix for Determinat

Source: UNEP 2002

The description of the mitigation requirements is explained below:

- ✓**Formal Control:** Involves the application of documented policy, process or procedure in mitigating the impacts of project activities.

- ✓**Informal Control**: Involves the application of sound judgment and best practice in mitigating the impacts of project activities.

- ✓**Physical Control:** Involves application of physical processes/ instruments, not necessarily requiring any special technology, in order to mitigate the impacts of a project activity.

- ✓**Avoidance:** Involves the modification of plans, designs or schedules in order to prevent the occurrence of an impact or impacts.

- ✓ **Training:** Involves personnel awareness in specific/specialised areas.

The mitigation measures are summarized in the following tables.

Table 6. 1: Mitigation and enhancement measures for pre-construction phase

S/No	Impact	Mitigation measures
1.	Land acquisition	✓ SOSG shall allow all PAPs that have grown crops on the proposed grazing reserve and veterinary hospital sites to harvest their crops prior to commencement of construction activities; ✓ In case damage is done to the crops before harvest, they shall be compensated for their agricultural crops at the most current market rates;
2.	i.Erosion ii.Subsidence iii.Compaction iv. oil spillage	✓ At construction site, the topography of the graded surface shall be designed to minimize uncontrolled flow of runoff; ✓ Earthworks shall be planned and designed by appropriately trained personnel and must be designed for the appropriate soil type, topography and factory usage
3.	Ground water pollution	✓ Fuel and chemical storage shall be designed in line with best practice
4.	Air pollution	✓ Contractor shall select 'low-emission' construction equipment/machinery
5.	Noise pollution	✓ Plan to locate noisy equipment as far as practicable from receptors; ✓ Plan to appoint a Community Liaison Officer (CLO) to establish a complaint response programme to identify and resolve any noise related concerns at an early stage
6.	Socio-economic impacts on communities	✓ Plan for local employment and procurement; ✓ Plan to unbundle large procurement contracts to be more suitable for local suppliers.

Table 6. 2: Mitigation and enhancement measures for construction phase

S/No	Impact	Mitigation and enhancement measures
1.	Employment and job creation	✓ SOSG shall direct its Project Contractors to give priority to the local community during recruitment of construction personnel; ✓ Project Contractors shall also ensure opportunities for skill acquisition and capacity building are given to the local employees; and ✓ The Project Contractors shall whenever possible, source for expert employees locally first, then regionally and nationally before engaging international experts.
2.	Local economic development	✓ SOSG shall encourage the Project Contractors to source for as many materials required for construction purposes as possible locally, prioritizing from the region to the rest of the country, before resorting to importation; and ✓ Community Liaison Personnel shall be used by Project Contractors to manage expectations and target local service providers
3.	Soil pollution and degradation	✓ Contractors shall regularly service and maintain construction equipment; ✓ Contractors shall restrict construction activities and movement of equipment to existing roads; ✓ Contractors shall implement erosion and sediment control plans in the rainy season, in areas within the site identified as having high erosion potential; and ✓ Hazardous materials shall be stored in a manner that prevents interaction with each other or with the environment

Table 6.2 continued

	Impact	Mitigation measures
4.	Surface and groundwater pollution	✓ Contractors shall regularly service and maintain construction equipment; and ✓ Hazardous materials must be stored in a manner that prevents interaction with each other or with the environment.
5.	Noise pollution	✓ The Project Contractors shall limit the construction times preferably to daylight hours and only in exceptional cases will he work beyond daylight hours; and ✓ The Project Contractors shall locate noisy equipment far away from communities
6.	Vegetation destruction	✓ Contractors shall restrict vegetation clearing to just the actual area where the buildings would be erected; and ✓ Replant native and beneficial vegetation on exposed soils wherever possible
7.	Alien Invasive Plant Species (AIPS)	✓ Contractor shall develop and implement an AIPS prevention strategy which shall include monitoring for invasive alien plants, effective rehabilitation of disturbed areas and prevention of unnecessary disturbance of natural areas; and ✓ Any alien invasive plants found on site shall be controlled as soon as possible
8.	Traffic problems and destruction of roads	✓ Project Contractors shall ensure compliance with speed and axle load requirements of all road classes to be used in transporting equipment and materials for construction work; ✓ Project Contractors shall devise and implement an effective Traffic Management Plan for deployment of equipment to construction site; ✓ Project Contractors shall ensure that his drivers comply with set road safety standards; and ✓ Non-regular loads shall be transported to avoid times of the day when traffic volumes are likely to be high;

Table 6.2 continued

	Impact	Mitigation measures
9.	Community health and safety	✓ Project Contractors shall develop and implement a written Emergency Response Plan (ERP) for the construction phase; ✓ Project Contractors shall create awareness in the project communities on the dangers of illicit sexual relationship; and Project Contractors shall sensitize members of the project community on dangers and practical means of protection against communicable diseases.
10.	Workers' health and safety	✓ Project Contractors shall develop and implement an Occupational Safety and Health (OSH) Management System which is in line with Nigerian Factory Act and other relevant legal provisions; ✓ Project Contractors shall develop and implement an HSE training program for all workers that are employed during the construction phase of the project; ✓ Project Contractors shall conduct regular toolbox meetings for all workers that are employed in the construction phase of the project; ✓ Project Contractors shall ensure that every employee working at the project site is provided with appropriate and adequate PPE; ✓ Project Contractors shall provide First Aid kits on site and station a standby ambulance for evacuation of accidents victims requiring higher level of urgent treatment than can be provided on site; Project Contractors shall ensure educating employees on the detrimental effects of drug and alcohol abuse, the risk and concerns relating to HIV/AIDS and other health risk-related activities.

Table 6. 3: Mitigation and enhancement measures for the operations phase

S/No	Impact	Enhancement measures
1.	Availability and affordability of good quality hide/skin, milk and beef	✓ SOSG shall encourage local businessmen to take up distributorship/dealership from it; and ✓ SOSG shall give the local businessmen special financial incentives to encourage them
2.	Stimulating agricultural development	✓ SOSG should encourage local businessmen to set up related factories in the project area; and ✓ SOSG shall give the businessmen special incentives so as to encourage them
3.	Improvement in regional economy	✓ Herders/Farmers shall be encouraged to form cooperative societies so as to benefit from various agricultural financing schemes to be executed by both SOSG and Federal Government; ✓ Farmers shall be advised to take insurance for their investment through appropriate schemes so as to reduce their operational risks; and ✓ Federal Government shall ensure an enhanced security provision especially in rural areas to protect farmers from activities of bandits and other criminals such as kidnappers and armed robbers.
4.	Direct and indirect employment opportunities	✓ SOSG shall give preference to the people of the project area when recruiting employees; and ✓ SOSG shall make sure that people from the project area are given opportunities take up trading dealerships and to provide essential services such as food and transportation to factory employees;
5.	Reduction of crime rate	✓ SOSG shall give preference to the people of the project area when recruiting operations personnel; and SOSG shall support local security arrangements operated by vigilante groups in the project area.

Table 6.3 continued

S/No	Impact	Mitigation measures
6.	Health and safety of factory workers	✓ Provisions of Nigerian Factory Act 1978 shall be well adhered to by SOSG in the milk and meat processing factories; ✓ Adequate provision of PPEs such as hand gloves, safety boots, safety harness shall be made to relevant factory workers by SOSG; ✓ Safety training shall be given to all fresh employees and periodic re-training of every personnel shall be ensured by SOSG; ✓ Fire-fighting equipment shall be provided at strategic locations within the premises of the process industries; ✓ First Aid Kits shall be provided in every process department; and ✓ Ambulance and emergency medical team shall be provided and be ready for medical emergencies.
7.	Health and safety of communities	✓ SOSG shall sensitize employees and project communities on dangers of improper sexual relationship and behaviours; ✓ SOSE shall sensitize employees and communities on the need to protect themselves against communicable diseases; and ✓ SOSG shall train employees on methods of protection against communicable and sexually transmitted diseases.
8.	Waste management	✓ All waste categories shall be segregated and managed appropriately; ✓ Accredited waste managers shall be employed to treat and dispose of various categories of waste; ✓ Toilets shall be provided at suitable places and maintained appropriately; and ✓ Good house-keeping shall be ensured in all work areas and offices;

6.3 ASSESSMENT OF POSITIVE IMPACTS: PRE-CONSTRUCTION PHASE

In this section, assessment of the respective potential impacts are provided along with the impact ratings before application of mitigation measures and as well as the ratings after application of mitigation measures.

6.3.1 Potential impacts on project communities

Positive impacts expected in this phase include a slight boost to the local economy in terms of increase in demand for goods and accommodation as a result of presence of some of the project personnel carrying out preliminary studies and works in the project area. Both goods and services such as food supplies will be required during the pre-construction phase.

An assessment of the positive impacts to be created during the pre-construction phase of the proposed project is given in Table 6.4 below.

Table 6. 4: Impact significance of boost to local economy

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Study area	Short term	Low	Probable
	2	2	4	3
	Result: (+24) Low positive			
Enhancement measures	Sokoto state will encourage its pre-construction consultants to source for as many goods as are required by them in the project communities to enable them to benefit from the available economic opportunities			
With enhancement	Study area	Short term	Medium	High
	4	2	6	3
	Result: (+36) Low positive			

6.4 ASSESSMENT OF NEGATIVE IMPACTS: PRE-CONSTRUCTION PHASE

This phase of the project is not expected to generate significant negative impacts. However, there will be negative impacts that will be consequent upon land loss by farmers using the existing plot of land dedicated for the proposed project.

Table 6. 5: Impact significance on land acquisition and resettlement

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Study area	Very short	Low	Definite
	2	1	4	5
	Result: (-40) medium negative			
Mitigation measures	Farmers that have grown crops should be allowed to harvest their crops prior to commencement of construction activities;			
With mitigation	Study area	Very short	Low	Improbable
	2	1	4	2
	Result: (-14) Low negative			

6.5 ASSESSMENT OF POSITIVE IMPACTS: CONSTRUCTION PHASE

6.5.1 Potential impacts on employment

The proposed project is expected to generate direct and indirect employment opportunities for both semi-skilled and unskilled workers. Direct employment will include for jobs in constructing required infrastructure, including earth dam and irrigational facilities for the grazing reserves, as well as for the building and associated components of the milk/meat processing plants and the veterinary hospital. Indirect employment will be generated through increased business opportunities and induced economic growth both at the local, regional and national levels through procurement of goods and services required in the execution of the project.

Creation of employment opportunities during the construction phase would be the most important benefit for the communities in the project area. Unemployment and under-employment levels are generally high in the area and had escalated insecurity in the State. Creation of job opportunities shall to a certain extent bring some relief to the troubled communities.

The proposed project will lead to a marked increase in individual income for many Nigerians. This will be as a result of increased purchases (from local, regional and national markets) and employment generated by construction activities.

Potential impacts associated with direct and indirect employment in the construction phase of the project are assessed in Table 6.6 the table below.

Table 6. 6: Significance of employment impact

Enhancement status	Extent	Duration	Magnitude	Probability
Without enhancement	Regional	Short term	Low	Probable
	3	2	4	3
	Result: (+27) Low positive			
Enhancement measures	✓ Sokoto State Government will direct its Project Contractors to give priority to the local community during recruitment of construction personnel; ✓ Project Contractor shall also ensure opportunities for skill acquisition and capacity building are given to the local employees; and ✓ The Project Contractor shall whenever possible, source for expert employees locally first, then regionally and nationally before engaging international experts.			
With enhancement				
	Regional	Short term	Moderate	Definite
	3	2	6	5
	Result: (+55) Medium positive			

6.5.2 Potential impacts on economic development

The proposed project is of such magnitude that it will impact positively on the economy of the project area and by extension the entire country. Implementation of the proposed project is expected to stimulate economic growth through:

- ✓ Provision of beef, diary, pasture and host of others which will enhance agricultural productivity in the area;
- ✓ Attraction of new businesses (in both the formal and informal sectors), especially those that will be facilitated by the presence of the project components;
- ✓ Increased revenue as a result of secondary employment and creation of small businesses; and
- ✓ Increase in tax revenue generation through direct and indirect taxes on goods and services associated with the project.

An assessment of the positive impacts that will be created in the construction phase resulting from implementation of the proposed project is given in Table 6.7 below.

Table 6. 7: Impact significance on economic development

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Regional	Short term	Low	Probable
	3	2	4	3
	Result: (+27) Low positive			
Enhancement measures	✓ Sokoto State Government shall encourage the Project Contractor to source for as many materials required for construction purposes as possible locally, prioritizing from the region to the rest of the Country, before resorting to importation; and ✓ Community Liaison Personnel shall be used by Project Contractors to manage community expectations and target local service providers			
With enhancement	Regional	Short term	Moderate	Definite
	3	2	6	4
	Result: (+44) Medium positive			

6.6 ASSESSMENT OF NEGATIVE IMPACTS – CONSTRUCTION PHASE

6.6.1 Impacts on the physical environment

6.6.1.1 Soil pollution

The proposed project will require the removal of significant amount of vegetation on the existing farmlands for the proposed veterinary hospital and for the feed and pasture project components.

Similarly, movement of construction equipment such as trucks, Four-Wheel Drive (4WD) vehicles, etc. will lead to a compaction of soils along the access roads used in the construction phase of the project.

Construction equipment used for the project, if not well-serviced, may cause fugitive spills due to leaks and lead to surface and subsurface soil contamination.

Soils may also be contaminated through accidental spills caused during field refueling. Based on the above facts, the impact assessment on soils resulting from the construction phase activities is given in Table 6.8 below.

Table 6. 8: Significance of impact on soils

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without Mitigation	Study area	Short	Minor	Probable
	1	2	2	3
	Result: (-15) Low positive			
Mitigation measures	✓ Regularly service and maintain construction equipment; ✓ Restrict construction activities and movement of equipment to existing roads; ✓ Implement erosion and sediment control plans in the rainy season, in areas within the sites identified as having high erosion potential; and ✓ Hazardous materials must be stored in a manner that prevents interaction with each other or with the environment			
With mitigation	Study area	Short term	Small	Probable
	1	2	0	3
	Result: (-9) Low negative			

6.6.1.2 Water pollution

Vegetation removal in some areas can increase soil erosion, causing sediment to be transported and deposited into water bodies, especially during rainy season. This could lead to the deterioration of water quality of these water bodies.

In the construction phase, ground and surface water may be exposed to contamination by spills or leaks of contaminants. Sources of impacts to groundwater are the same as for soil in the project area. Hazardous materials from leaking construction equipment or from accidental spillage may be washed down during the rainy season into ground and surface water and this could lead to adverse water quality.

The significance of the impacts on water resources during the construction phase is given in Table 6.9 below.

Table 6. 9: Significance of impact on ground and surface water resources

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without Mitigation	Study area	Short	Minor	Probable
	2	2	2	3
	Result: (-18) Low negative			
Mitigation measures	✓ Regularly service and maintain construction equipment; and ✓ Hazardous materials must be stored in a manner that prevents interaction with each other or with the environment.			
With mitigation				
	Study area	Short term	Small	Improbable
	2	2	0	2
	Result: (-8) Low negative			

6.6.1.3 Noise

Construction work will be carried out close to existing homes and farm lands. The construction plant and equipment used for construction work will most likely cause temporary noise emissions which may cause nuisance to neighboring residences, businesses and farmers.

The significance of the impacts associated with air quality and noise are given in Table 6.10 below.

Table 6. 10: Impact significance of noise

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Study area	Short	Low	Highly probable
	2	2	4	4
	Result: (-32) Medium negative			
Mitigation measures	✓ The Project Contractors shall limit the construction times to daylight hours and only in exceptional cases will they work beyond daylight hours; ✓ The Project Contractors shall select low-noise construction equipment; and ✓ The Project Contractor shall locate noisy equipment far away from communities			

6.7 ASSESSMENT OF POSITIVE OPERATIONAL IMPACTS

6.7.1 Socio-economic impacts

The following subsections highlight some of the positive socio-economic impacts of the proposed project.

6.7.1.1 Increasing the availability and affordability of Breeds, Beef, Dairy and Pasture

The proposed project when completed will go a long way in boosting the supply of good cattle breeds and improved healthcare delivery for livestock and enhanced earning from livestock rearing, with an overall, positive impact on job and wealth creation. The project will enhance the production of high-quality beef, diary, and pasture in our markets. Processing of locally produced cattle and milk will bring about a reduction in the cost of beef and dairy owing to improvement in their production and processing. This will ultimately make them more affordable to consumers in the project area and consequently improve nutrition and public health in Sokoto State and the country at large.

Commercial scale production of pasture from grasses grown in the grazing reserves will go a long way in solving our animal feeds scarcity in the dry seasons, while operating the modern meat processing factory will also enhance the production of high-quality leather and bring about increased foreign earnings for the country.

Table 6. 11: Impact significance on availability of meat, milk and pasture

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Regional	Long term	Medium	Probable
	2	3	6	4
	Result: (+44) Low positive			
Enhancement measures	Sokoto State Government shall encourage local businessmen to take up distributorship/dealership for the meat and milk processing; and shall give these businessmen special incentives so as to encourage them			
With Enhancement				
	Regional	Long term	High	Probable
	2	3	8	4
	Result: (+52) Medium positive			

6.7.1.2 Stimulating agricultural and livestock development in the project area

Establishment of grazing reserves in the area will encourage more people to engage in farming and livestock rearing activities so as to take advantage of the proximity of the grazing reserves and affordability of their operations. Other entrepreneurs may also be encouraged, by improved

agricultural activities in the area, to set up services as well as livestock and agro-based industries to cater for the needs of cattle farmers.

Table 6. 12: Impact significance on stimulation of livestock and agricultural development

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Regional	Long term	Medium	Probable
	2	3	4	3
	Result: (+27) Low positive			
Enhancement measures	FGN and SOSG should encourage local farmers/herders to take up loans and improve their livestock production and to set up agro-based factories in the project area; FGN and SOSG should give herders credit facilities to encourage local husbandry; and FGN and SOSG should give farmers/herders special financial incentives to encourage them.			
With Enhancement				
	Regional	Long term	High	Probable
	2	3	8	3
	Result: (+39) Medium positive			

6.7.1.3 Improved regional security and national economy

All the twenty-three (23) LGAs of Sokoto State are very important in the role they will play in this grazing reserves project. Production of meat, dairy and pasture in the proposed grazing reserves is expected to impact positively on the economy of these LGAs as well as on the regional and national economies. The proposed project will facilitate livestock and agricultural productivity which will, in turn, impact positively on local and national economies. Economic benefits will include higher efficiency in meat and dairy processing as well as improvement in the quality and quantity of locally produced pasture. With the existing rich agricultural lands in the State, the proposed livestock production scheme as well as the suitable conditions for extensive subsistence and commercial cattle farming in the project area, the proposed project is of strategic importance to commerce and trade as well as economic and social security in Sokoto State and the entire country.

Table 6.13 presents the impact significance assessment of the project on regional and national security.

Table 6. 13: Impact significance of improved regional security and economy

Enhancement status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Region	Long term	Minor	Probable
	3	4	4	4
	Result: (+40) Medium positive			
Enhancement measures	✓ Farmers should be encouraged to form cooperative societies so as to benefit from the livestock and dairy production financing schemes to be executed by both SOSG and Federal Government; ✓ Farmers should be advised to insure their investment through appropriate schemes so as to reduce their operational risks; and ✓ Federal Government should ensure an enhanced security provision especially in rural areas to protect farmers from activities of bandits and other criminals such as kidnappers and armed robbers.			
With enhancement				
	Region	Long term	Moderate	Highly probable
	3	4	6	4
	Result: (+52) Medium positive			

6.7.1.4 Direct and indirect employment opportunities

The proposed grazing reserve will, in its operational phase, provide direct and indirect jobs for people in the project area. Direct jobs will be for people that will man daily production operations of the various components units of the project such as abattoir, dairy plant as well as the pasture fields, while indirect jobs will be inform of service provision to the respective components such as by food vendors, service industries such transport, dealers in meat and dairy products, banking, insurance, etc. Significance of direct and indirect job creation is assessed in Table 6.14.

Table 6. 14: Significance of direct and indirect job creation

Enhancement status	Extent	Duration	Magnitude	Probability
Without enhancement	Study area	Long term	Low	Probable
	2	4	4	3
	Result: (+30) Medium positive			
Enhancement measures	✓ SOSG should give preference to the people of the project area when recruiting employees; and ✓ SOSG should make sure that people from the project area are given opportunity to provide essential services such as food, transportation, and other services			
With enhancement				
	Study area	Long term	Medium	Probable
	2	4	6	3
	Result: (+36) Medium positive			

6.7.1.5 Reduction of crime rate

Provision of employment opportunities for people in the project area will go a long way in reducing crime rate. In every community, crime rate is generally associated with unemployment. It therefore follows that provision of employment to the people in the project area, especially the youth, will lead to a reduction in crime rate of the project area. Impact significance of reduction in crime rate in the project area as a result of the project is assessed in Table 6.15.

Table 6. 15: Significance of reduction in crime rate

Enhancement status	Extent	Duration	Magnitude	Probability
Without enhancement	Study area	Long term	Minor	Probable
	2	4	2	3
	Result: (+24) Medium positive			
Enhancement measures	✓ SOSG should give preference to the people of the project area when recruiting for operational employees; ✓ SOSG should make sure that people from the project area are given opportunity to provide essential services such as food and transportation to factory employees; and ✓ SOSG should support local security arrangements operated by vigilante groups in the project area.			
With enhancement				
	Study area	Long term	Low	Probable
	2	4	4	3
	Result: (+30) Medium positive			

CHAPTER SEVEN:

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 INTRODUCTION

This chapter presents the Environmental and Social Management Plan (ESMP) designed for the proposed Enhanced Cattle Breeding Project.

An Environmental and Social Management Plan is an environmental management tool that stipulates strategies and procedures for managing potential environmental impacts associated with a proposed project. ESMP of a proposed project defines the actions that are needed to be taken, at specific times by specified parties (stakeholders), to address the issues raised in the impact identification process, during the lifecycle of the project, from design through construction and operation to decommissioning. ESMP is a dynamic document which should be responsive to changes in situation, unforeseen circumstances, and the results of project monitoring and review. This therefore means that the provisions in the plan can be modified in line with new realities in project implementation or newly acquired or additional information on potential or identified impacts.

7.2 OBJECTIVE OF THE ESMP

The objective of this ESMP is to minimize and manage bio-physical and socio-economic impacts of the proposed project in all its phases, especially the constructional and operational phases. The ESMP outlines specific mitigation measures and management interventions that are needed to minimize potentially negative and enhance potentially positive impacts of the project. The ESMP incorporates mitigation and enhancement measures that were developed as part of the outcomes of the ESIA process.

This ESMP shall be treated as a dynamic document and changes should be made to it as required through project evolution, while retaining the underlying principles and objectives on which the document is based.

To ensure the ESMP stays relevant, SOSG in conjunction with Project Contractor and regulatory authorities must review the document periodically. All proposed changes being considered must be discussed and agreed to by all parties involved. The changes must then be submitted to the Federal Ministry of Environment for its information and approval.

Anticipated impacts of the proposed project, corresponding mitigation measures, action party, timing, monitoring parameters and monitoring frequency are provided in the Plan for

construction, operation and decommissioning activities. The ESMP provides the procedures and processes that shall be incorporated into the project activities to measure and check, in a continuous nature, the compliance with, and effectiveness of the mitigation and enhancement measures recommended for managing the identified negative and positive impacts of the proposed project throughout its life cycle.

7.3 RESPONSIBILITIES AND INSTITUTIONAL ARRANGEMENTS

The key stakeholders involved in this project include; SOSG, the project contractors, Federal Ministry of Environment, Sokoto State Ministry of Environment, Sokoto Environmental Protection Agency as well as the affected/direct beneficiary communities.

The project contractors shall be responsible for implementation of the ESMP falling under the scope of their contracts. Sokoto State Ministry of Agriculture shall undertake monitoring of the ESMP for all the phases of the project. This shall be done in close collaboration with the Federal Ministry of environment (FMEnv) and Sokoto State Ministry of Environment.

To ensure the success of the environmental management of this project, the entire project team and other relevant stakeholders should be properly mobilized and oriented on the necessity and methods for sound and environmentally responsible project delivery. SOSG is expected to convey and discuss the contents of the EMP with the Contractors and his project personnel. FMEnv and SEPA and their local offices and project host communities are also expected to be part of the monitoring programme to be carried out under the ESMP. Good relations and interactions between the contractors and other stakeholders and exchange of timely information on project scheduling, duration of construction works and other issues that may arise will go a long way in avoiding social conflicts. Communication channels between the contractors, host communities and other stakeholders should always be open to ensure proper and timely response to any complaint that may arise during project execution.

7.4 ENVIRONMENTAL MONITORING PLAN

The Environmental Monitoring Plan will ensure that the environmental integrity of this project is fully developed covering the project activities from site preparation, through construction, commissioning, operation, decommissioning and abandonment. The plan relates to the handling of hazardous materials and wastes, emission and discharge monitoring, site inspection and auditing, adverse weather preparedness, and decommissioning. The plan takes account of national and international standards for (environmental) planning, such as the International Standards Organization, the Health, Safety and Environmental Management System. The programme will help to verify the effectiveness of the prescribed mitigation measures and help in the implementation of the ESMP through;

- ✓ Effective integration of EMP into project design, from construction through to abandonment;

- ✓ Environmental monitoring of development phases including operations and close down;
- ✓ Specific training of staff and contractors to enhance environmental awareness; and
- ✓ Sustained consultation with all stakeholders always on the project development.

The environmental monitoring program for this project will serve as an integral part of the operational activities and is expected to generate the requisite information for environmental management and information dissemination.

It is anticipated that monitoring will be conducted during all phases of the project. This plan will play a pivotal role in ensuring that the trends for specific parameters are tracked and it will provide information on compliance with legislative norms, set guidelines or desirable operational limits; and form the basis for corrective actions and modification of activities where necessary. The frequency of sampling will depend on the time and location of project activities and results derived from monitoring data.

7.4.1 Monitoring Objectives

The aim of monitoring is to verify the predicted impacts of the project, and to ensure that any unforeseen impacts are detected early enough and appropriately mitigated. The programme will keep relevant records to ensure compliance with recommended environmental procedures. The monitoring plan will ensure that stipulated mitigation measures during construction and operation phases are implemented. Other specific objectives of the monitoring plan are to:

- ✓ Check the effectiveness of suggested mitigation measures;
- ✓ Demonstrate that the project activities (construction and operation) are carried out in accordance with the prescribed mitigation measures and regulatory procedures; and
- ✓ Provide early warning signals whenever an impact indicator approaches a critical level.

Impact indicators are defined in terms of threshold levels, and regulation and enforcement standards. Implementation of the ESMP will allow for control and management of the timing, location and level of impacts and potentially provide the data for the empirical verification or validation of various predictive models of action/impact relationships.

The following tables (Tables 7.1-7.4) present summary of the EMP for the various phases of the proposed project.

Table 7. 1: ESMP for the Pre-construction Phase

S/No.	Receptor	Project Activity	Impact	Mitigation	Responsibility
1.	Soil resources	i. Design of earthworks ii. Design of site layout	i. Erosion ii. Subsidence iii. Compaction	Earthworks must be planned and designed by appropriately trained personnel and must be designed for the appropriate soil type, topography, climatic conditions etc.	Contractor
				At construction sites, the overall topography of the graded surface should be designed to minimize the uncontrolled flow of runoff	Contractor
2.	Ground water	Design of fuel and chemical storage facilities	Pollution	Design fuel and chemical storage in line with best international practice	Contractor
3.	Air quality	Plant and equipment selection	Air pollution	✓ Select 'low-emission' construction vehicles and machinery when planning works;	Contractor
4.	Noise	Design of site layout	Noise pollution	i. Plan to locate noisy equipment as far as practicable from receptors ii. Plan to appoint a Community Liaison Officer (CLO) to establish a complaint response programme to identify and resolve any noise related concerns at an early stage	Contractor

Table 7.1 continued

S/No.	Receptor	Project Activity	Impact	Mitigation	Responsibility
5.	Local population	i. Employment ii. Procurement iii. Public relations iv. HSE planning v. Design of earthworks	i. Landlessness ii. Local opportunities iii. Social pathologies iv. Social conflict v. Health and safety	✓ Plan for local employment and procurement; ✓ Plan to unbundle large procurement contracts to be more suitable for local suppliers; ✓ Local expectations regarding project benefits should be carefully managed by means of appropriate stakeholder consultation throughout the lifecycle of the project; and ✓ Plan to Develop a project-specific Community Health, Safety and Security Plan (CHSSP).	SOSG and Contractor

Table 7. 2: ESMP for the Construction Phase

S/N	Receptor	Project Activity	Impact	Mitigation	Responsib-ility
1.	Socio-economy of project area	Employment of construction personnel	Provision of jobs to people in the project area	✓ SOSG shall direct its Project Contractors to give priority to the local communities during recruitment of construction personnel; ✓ Project Contractors shall ensure opportunities for skill acquisition and capacity building are given to the local employees; and ✓ The Project Contractors shall whenever possible, source for expert employees locally first, then regionally and nationally before engaging any international expert.	Project contractor
2.		Local economic empowerment	Provision of business opportunities to people in the project area	✓ SOSG shall encourage the Project Contractors to source for as many materials required for construction purposes as possible locally, prioritizing from the region to the rest of the country, before resorting to importation; and ✓ Community Liaison personnel shall be used by Project Contractors to manage expectations and target local service providers;	SOSG

Table 7.2 continued

S/No.	Receptor	Project Activity	Impact	Mitigation	Responsi-bility
3.	Soil resources of the project area	Construction activities	Soil pollution and erosion	✓ Regularly service and maintain construction equipment to prevent oil leakage/spillage; ✓ Restrict construction activities and movement of equipment to existing roads; ✓ Implement erosion and sediment control plans in the rainy season, in areas within the project sites, such as Dogon-Daji, identified as having high erosion potential; and ✓ Hazardous construction materials must be stored in a manner that prevents interaction with each other or with the environment project environment	Project Contractors
4.	Surface and ground water resources	Operating of construction machinery	Water pollution	✓ Regularly service and maintain construction equipment to prevent leakage/spillage; and ✓ Hazardous materials must be stored in a manner that prevents interaction with each other or with the environment project environment.	Project Contractors

Table 7.2 continued

S/No.	Receptor	Project Activity	Impact		Responsibility
5.	Project environment	Operating of construction machinery	Noise pollution	✓ The Project Contractors shall limit the construction times preferably to daylight hours and only in exceptional cases will he work beyond daylight hours; and ✓ The Project Contractors shall locate noisy equipment far away from communities	Project Contractors
6.	Plant bio-diversity	Construction activities	Destruction of vegetation	✓ Restrict vegetation clearing to just the actual area where the buildings would be erected; and ✓ Replant native vegetation on exposed soils wherever possible ✓ Where existing habitat is fragmented, consider measures to enhance connectivity by growing more trees and using buffers to protect important biodiversity areas; ✓ The communities of Dogon Daji that should be supported with some of the tree seedlings of some of the indigenous species to plant around their houses.	Project Contractors

Table 7.2 continued

S/N	Receptor	Project Activity	Impact		Responsi-bility
7.	Project environment	Presence of construction and factory equipment	Infestation by Alien Invasive Plant Species	✓ Project Contractors shall develop and implement an AIPS prevention strategy which shall include monitoring for invasive alien plants, effective rehabilitation of disturbed areas and prevention of unnecessary disturbance of natural areas; and Any alien invasive plants found on site shall be controlled as soon as possible	Project Contractors and SOSG
8.	Road infrastructure and project communities	Transportation of procured materials for implementation of project	Traffic disruption and destruction of roads	✓ The Project Contractor shall ensure compliance with speed and axle load requirements of all road classes to be used in transporting equipment and materials for construction work; ✓ The Project Contractor shall devise and implement an effective Traffic Management Plan for deployment of equipment to construction site;	Project Contractors

Table 7.2 continued

S/N	Receptor	Project Activity	Impact		Responsi-bility
				✓ Project Contractors shall ensure that its drivers comply with road safety regulations; and ✓ Non-regular loads shall be transported to avoid times of the day when traffic volumes are likely to be high;	
9.	Communities in the project area	Presence of construction workers	Community health and safety	✓ The Project Contractors shall develop and implement a written Emergency Response Plan (ERP) for the construction phase; ✓ SOSG shall create awareness in the project communities on the dangers of illicit sexual relationship; and ✓ SOSG shall sensitize members of the project community on dangers and means of protection against communicable diseases and STIs.	Project Contractors
10.	Construction employees	Construction activities	Workers health and safety	✓ The Project Contractor shall develop and implement an Occupational Safety and Health (OSH) Management System which is in line with Nigerian Factory Act and other relevant legal provisions;	Project Contractor

				✓ Project Contractors shall develop and implement HSE training program for all workers employed during the construction phase of the project; ✓ Project Contractors shall ensure that toolbox meeting are carried out regularly for the construction employees; ✓ Project Contractors shall ensure that every employee working at the project site is provided with appropriate and adequate PPE; ✓ Project Contractors shall provide First Aid kits on site and station a standby ambulance for evacuation of accidents victims requiring higher level of urgent treatment than can be provided on site; ✓ Project Contractors shall ensure educating employees on the detrimental effects of drug and alcohol abuse, the risk and concerns relating to HIV/AIDS and other health risk-related activities.	

Table 7. 3: ESMP for the Operations Phase

S/No.	Receptor	Project Activity	Impact	Mitigation	Responsib-ility
1.	Socio-economy of the project area	Operating the pasture, milk, meat, units and the veterinary hospital plant	Availability and affordability of pasture, milk, and meat	✓ SOSG shall encourage local business men to take up distributorship/dealership from pasture, milk and meat processing outlets ; and ✓ SOSG shall give these businessmen special financial incentives so as to encourage them	SOSG
2.	Socio-economy of the project area	Operating the pasture, milk, meat, units and the veterinary hospital plant	Stimulating agricultural development	✓ SOSG shall encourage local businessmen to set up agro-based and supporting industries in the project area; and ✓ SOSG should give these businessmen special incentives to encourage them	SOSG
3.	Socio-economy of the project area	Operating the pasture, milk, meat, units and the veterinary hospital plant	Improvement in regional economy	✓ Farmers shall be encouraged to form cooperative societies so as to benefit from various agricultural financing schemes to be executed by both SOSG and Federal Government; and ✓ Farmers shall be provided with incentives investment through appropriate schemes to reduce their operational risks;	FGN and SOSG

Table 7.3 continued

S/No.	Receptor	Project Activity	Impact	Mitigation/Enhancement	Responsi-bility
				✓ Federal Government shall ensure an enhanced security provision especially in rural areas to protect farmers from activities of bandits and other criminals such as kidnappers and armed robbers.	
4.	Socio-economy of the project area	Operating the pasture milk and meat plants and the veterinary hospital	Direct and indirect employment opportunities	✓ SOSG shall give preference to the people of the project area when recruiting employees; and ✓ SOSG shall make sure that people from the project area are given opportunity to provide essential services such as food and transportation, procurement of consumables, etc.	SOSG
5.	Socio-economy of the project area	Operating the pasture milk and meat plants and the veterinary hospital	Reduction of crime rate	✓ SOSG shall give preference to the people of the project area when recruiting operations personnel; ✓ SOSG shall make sure that people from the project area are given opportunity to provide essential services; and ✓ SOSG shall support local security arrangements operated by vigilante groups in the project area.	SOSG

Table 7.3, continued

S/No.	Receptor	Project Activity	Impact	Mitigation	Responsib-ility
6.	Socio-economy of the project area	Operational activities of the meat, milk and pasture production	Adverse effects on health and safety of factory workers	✓ Provisions of Nigerian Factory Act 1978 shall be strictly adhered to by SOSG; ✓ Adequate provision of PPEs such as hand gloves, safety boots, etc. should be made to relevant factory workers by SOSG; ✓ Safety training shall be given to all fresh employees and periodic re-training of every personnel shall be ensured by SOSG; ✓ Fire-fighting equipment shall be provided at strategic locations within factory and veterinary hospital premises; ✓ First Aid Kits shall be provided and made accessible in every process department and the veterinary hospital; and ✓ Ambulance and emergency medical team shall be provided and be ready for medical emergencies.	SOSG
7.	Socio-economy of the project area	Operational activities of the meat, milk and pasture production	Adverse effects on health and safety of communities	✓ Factory employees and project communities shall be sensitized on dangers of improper sexual relationship and behaviours;	SOSG

Table 7.3 continued

S/No.	Receptor	Project Activity	Impact	Mitigation	Responsib-ility
				✓ Employees and communities shall be sensitized on the need to protect themselves against communicable diseases and STIs; and ✓ Communities and employees shall be trained on methods of protection against communicable and sexually transmitted diseases.	
8.	Project environment	Presence of employees and production operations	Environment-al pollution	✓ All waste categories shall be segregated and managed appropriately; ✓ Accredited waste managers shall be employed to treat and dispose of various categories of waste; ✓ Toilets shall be provided at suitable places and maintained appropriately; and ✓ Good house-keeping shall be ensured in all work areas and offices;	SOSG
9.	Project environment	Presence of more people in the project area and carrying out production operations	Increase pressure on transportation facilities and infrastructure	✓ To facilitate public transport in the project area and ease pressure on the existing transport system, more rural and township roads should be designed and developed after performing a deligent needs analysis exercise ✓ ii. The public transport system should be improved through provision of mass transit vehicles such as buses, motorcycles and animal driven carts in the rural areas	SOSG

Table 7.3 continued

S/No.	Receptor	Project Activity	Impact	Mitigation	Responsib-ility
10.	Immediate project environment	Operations of the proposed project	Health and safety risks on the project employees and general public	Carry out biannual (6-monthly) periodic maintenance operations on the respective project components	The Management of the respective project components
11.	The general project environment	Operations of the proposed project	Health and safety risks on the project employees and general public	The project communities as very important stakeholders shall be carried along and should be part of the project operations in various ways such as by providing feedback on project operations impact and by forming community project implementation committee as well as being members of Grievance Redress Committee.	SOSG

Table 7. 4: Environmental and Social Monitoring Programme for the Construction Phase

S/N	Impact	Proposed Mitigation	Responsible Party	Targets to Achieve	Monitoring Method	Monitor. Period	Monitor. Indicators
1.	Employment	Give priority to people from project communities	SOSG	Improve the socio-economic well-being of project communities	Monitoring visits by regulators	3-monthly (quarterly)	Personnel record of contractor
2.	Procurement opportunities	Give priority to people from project communities	SOSG and regulators	Improve the socio-economic well-being of project communities	Monitoring visits	3-monthly (quarterly)	Procurement records of contractor and field verification
3.	Soil pollution	i. Regular maintenance of equipment; ii. Restrict movement of equipment to existing roads; iii. Implement erosion control measures in the rainy season.	Project Contractors	i. Compliance with water use regulations ii. Minimize social conflicts over water sources	i. Sampling of physico-chemical parameters and microbiologi-al parameters	Three-monthly water quality monitoring from commenc-ement of earthworks	i. Relevant water quality parameters to include BOD, COD, TSS etc ii. Disharmony and social conflicts

Table 7.4 continued

S/N	Impact	Proposed Mitigation	Responsible Party	Targets to Achieve	Monitoring Method	Monitoring Period	Monitoring Indicators
		iv. Appropriate storage of hazardous materials					
4.	Water pollution	i. Regular maintenance of construction equipment; ii. Store hazardous materials appropriately	Project Contractors	To prevent water pollution	i. Visual observation of construction equipment and storage facilities	3-monthly inspection	Physical conditions of construction equipment and storage facilities
5.	Noise pollution	i. Limit construction time to daylight hours ii. Locate noisy equipment far away from communities	Project Contractors	To minimize noise pollution	Physical examination of location of noisy construction equipment	Monthly	Nature and location of noisy equipment

Table 7.4 continued

S/N	Impact	Proposed Mitigation	Responsible Party	Targets to Achieve	Monitoring Method	Monitor. Period	Monitor. Indicators
6.	Vegetation destruction	i. Restrict vegetation clearing to actual work areas ii. Replant native vegetation on exposed soils	SOSG/ Contractors	To minimize vegetation destruction	Visual observation of areas cleared of vegetation	3-monthly	Nature of cleared areas
7.	Proliferation of Alien Invasive Plant Species (AIPS)	i. Implement an AIPS prevention strategy which shall ii. Rehabilitate disturbed areas iii. Control any alien invasive plants found on site ASAP	SOSG/ Contractors	To prevent proliferation of AIPS	Physical inspection of construction site	3-monthly	Physical condition of vegetation on construction site
8.	Traffic problems and destruction of roads	i. Comply with speed and axle load requirements of vehicles	SOSG/ Contractors	To prevent traffic accidents	Physical inspection of material delivery and	Weekly	Loading and driving manner of drivers

Table 7.4 continued

S/N	Impact	Proposed Mitigation	Responsible Party	Targets	Monitoring Method	Monitor. Period	Monitor. Indicators
		ii. Devise and implement an effective Traffic Management Plan for deployment of equipment to construction sites; iii. Ensure that drivers comply with road safety rules iv. Non-regular loads shall be transported at periods when traffic is low	Contractor	and destruction of roads	driving manner of construction drivers	Weekly	Loading and driving manner of drivers
9.	Community health and safety	i. Create awareness in the project communities on the dangers of illicit sexual relationship; and ii. Sensitize members of community on means of protection against communicable diseases.	SOSG	To safeguard community health and safety	Field inquiries on evidence of community sensitization	At the start of constructi-on work	Feedback from interaction with communit-ies

Table 7.4 continued

S/N	Impact	Proposed Mitigation	Responsible Party	Targets to Achieve	Monitoring Method	Monitoring Period	Monitor. Indicators
10.	Workers' health and safety	i. Develop and implement an Occupational Safety and Health (OSH) Management System in line with Nigerian Factory Act and other relevant legal provisions; ii. Develop & implement HSE training for all construction workers	Project Contractors	To safeguard construction workers' health and safety	Field inquiries on evidence of workers' sensitization	At commenc-ement of construction work	Feedback from interaction with workers
		iii. Provide employees with adequate PPEs; iv. Provide First Aid kits on site and a standby ambulance for evacuation of accident victims; v. Educate employees on the effects of drug and alcohol abuse, HIV/AIDS and other health risk-related activities	SOSG and federal and state regulators	To safeguard construction workers' health and safety	Field inquiries on evidence of compliance	At commenc-ement of construction work	Feedback from interaction with workers

Table 7. 5: Environmental and Social Monitoring Programme for the Operations Phase

S/N	Impact	Proposed Mitigation	Respons. Party	Targets	Monitoring Method	Monitor. Period	Monitoring Indicators
1.	Availability and affordability of pasture, milk and meat	i. Encourage local businessmen to take up distributorship/ dealership; and ii. Give financial incentives to local businessmen	SOSG	To encourage businessmen to develop the local markets	Market survey to investigate market penetration by products	At the initial phase of production	Level of products penetration in local markets
2.	Stimulating agricultural development	i. SOSG should encourage local businessmen to set up agro-allied factories in the project area; and ii. SOSG should give these businessmen special financial incentives to encourage them	Federal and State regulators	To encourage businessmen to develop more agricultural activities in the project area	Field survey to determine other areas of agricultural develop-ent	One year after start of operations	Level of other agricultural activities
3.	Improvement in regional economy	i. Encourage farmers to form cooperative societies;	Federal and State Governm-ents	i. To benefit from agricultural financing schemes	Field survey	One year after start of operation	Level of participation of farmers

Table 7.5 continued

S/N	Impact	Proposed Mitigation	Respons. Party	Targets	Monitoring Method	Monitor. Period	Monitor. Indicators
		ii. Advise farmers to insure their investments; iii. Ensure an enhanced security provision especially in rural areas		ii. To reduce farmers' risks iii. To protect farmers from activities of criminals			In various schemes
4.	Direct and indirect employme-nt opportunity-es	i. Give preference to people of the project area when recruiting for employees; and ii. Give opportunity to people of the project area to provide services such as food and transportation to factory employees	SOSG	To provide employment for people in the project area	Visits to the pasture, milk and meat product-ion sites	Quarterly (three-monthly)	Status of provision of services to employees

Table 7.5 continued

S/N	Impact	Proposed Mitigation	Respons. Party	Targets	Monitoring Method	Monitoring Period	Monitoring Indicators
5.	Reduction in crime rate	i. Give preference to people of the project area when recruiting operations personnel; ii. Ensure that they are given opportunity to provide essential services to factory employees; and iii. Support local security arrangements in the project area.	SOSG	To provide employment for people in the project area	Visits to the production sites	Quarterly (three-monthly)	Indigene status of factory employees and other service providers
6.	Health and safety of factory workers	i. Adhere to provisions of Nigerian Factory Act 1978; ii. Provide adequate PPEs to relevant employees; iii. Give regular safety training to all employees;	SOSG	To safeguard the health and safety of factory workers	Visits to the factory	Quarterly (three-monthly)	Status of production sites in terms of emergency prepared-ness

Table 7.5 continued

S/N	Impact	Proposed Mitigation	Responsible Party	Targets	Monitoring Method	Monitoring Period	Monitoring Indicators
		iv. Provide fire-fighting equipment within the factory and veterinary hospital premises v. Provide First Aid Kits and emergency ambulance and medical team against medical emergencies.	SOSG	To safeguard the health and safety of factory workers	Visits to the production sites and the veterinary clinic	Quarterly (three-monthly)	Status of sites and veterinary clinic in terms of emergency prepared-ness
7.	Health and safety of communities	i. Sensitize communities on dangers of improper sexual relationship and behaviours; ii. Sensitize communities on ways of protecting themselves against communicable diseases	SOSG	To safeguard the health and safety of communities against communic-able diseases	Field investigation to confirm sensitization efforts of SOSG	Quarterly (three-monthly)	Feedback from interaction with communities in the project area

Table 7.5 continued

S/N	Impact	Proposed Mitigation	Responsible Party	Targets	Monitoring Method	Monitoring Period	Monitor. Indicators
8.	Waste management	i. All waste categories should be segregated and managed appropriately; ii. Employ accredited waste managers to treat and dispose of various categories of waste; iii. Provide toilets at suitable places and maintain them appropriately; and iv. Ensure good house keeping in all work areas and offices	SOSG	To safeguard general project environm-ent	Physical inspection visits to the project sites and the veterinary hospital	Quarterly (three-monthly)	Status of waste management in the sites and veterinary hospital

7.5 SITE REHABILATION ACTIVITIES

Over time, it has been discovered that the lifespan of any production project is primarily hinged on a number of factors, including; the design parameters and construction materials; availability of raw materials and feedstock; acceptability of the end-product; maintenance and technological development. The design life of the proposed project, depending on proper maintenance, is at least 50 years. This, in effect, means that the plant will be expected to be fully operational for at least 50 years, and may be more, if the components are in good shape.

Therefore, should the project require decommissioning, it would be distant enough to assume that the existing legislative context and receiving environment would have changed. Decommissioning would then need to comply with the relevant legislation of the time and guidance may be required from the relevant environmental authority of the time and the most feasible option for the end use of the various components of project would then be determined.

Since the proposed project is not expected to be decommissioned soon and given the known fact that projects always have both positive and negative impacts on their physical and social environments, especially in the construction phase; it is important to put in place plans to recover and/or restore the project sites to their original states at the end of the construction phase. This requires a good understanding of all the environmental components of the project in the ecosystem during the construction phase.

On the other hand, impacts of dismantling the process and veterinary hospital equipment and demolishing the built area are likely to be like those that occur in the construction phase. A decommissioning ESMP would therefore need to be developed and approved by the relevant authority of the time, to effectively manage these impacts. The plan must include management measures to mitigate unavoidable negative impacts to acceptable levels. Similarly, any potential positive impacts, e.g., job creation must also be managed to maximize the benefits.

This section of the report will therefore be restricted to providing an overview of the various site rehabilitation activities that will be carried out at the end of the construction phase.

7.5.1. Rehabilitation of Construction Activities

The following structures will be affected:

- ✓ Concrete structures;
- ✓ Excavation for septic tank; and
- ✓ Access roads into premises

Temporary concrete structures will need to be broken up and their rubble taken to an approved waste dump site or used to rehabilitate impacted areas. The exposed surface must be tested for contamination by FMEnv accredited laboratory. If any contaminants are found, the contaminated

soil shall be removed along with the concrete to an acceptable waste disposal site. Re-vegetation must also be carried out.

Access road, if untarred, is to be checked for any substantial spillage of contaminants including oils and fuels.

Temporary construction yard;

Rehabilitation will be necessary for compacted earth and un-compacted earth platforms. Compacted and un-compacted earth platforms will be rehabilitated according to the methods described above.

Spoil Dumps

Spoil material shall be the last option; however, permanent spoil dumps would be established if required. Spoil material shall be minimized through use in filling of erosion gullies, stone pitching, and any other construction-related use. The exact locations of spoil dumps should be negotiated with nearby landowners, local administrators, and officials, and compensation paid as per the accepted procedure. No spoil dumps will be allowed in drainage areas where they will block drainage channels. Permanent spoil dumps should be shaped 1v: 3h, top soiled and vegetated. Care must be taken to ensure that the material is adequately compacted to allow for safe access.

Re-vegetation Process

The basic re-vegetation steps, which need to be adapted to the project-specific environmental conditions, are detailed below.

- ✓ Prepare the area to be re-vegetated for top soiling – this may require soil ripping and/or scarifying and digging of steps or terraces. The scarification should take place to a depth of 150mm. If ridges are made, they should be about 100mm high and about 400mm wide.

- ✓ Replace stored topsoil on the slope to be re-vegetated to a depth of between 75mm and 150mm (depending on the soil and slope conditions). The topsoil should be spread when it is dry by means of hand raking or mechanical balding and trimmed to a uniform thickness of not less than 100mm.

- ✓ Apply seeds or grass sods according to the supplier's specifications. The seed must be fresh, good quality seed as specified in the sod mix, certified by the supplier and free from contamination by seeds of other species.

- ✓ If the indigenous grass seeds are used, they should be placed close together and label put on each. Gaps between the sods should be filled in with topsoil.

- ✓ Mulch should be applied to protect the seeded area from erosion. The mulch must be excessively fresh and green or in an advanced stage of decomposition as it could smother growth. It must be applied to a depth and manner that will prevent erosion by wind and

water, but not completely block out the rays of sunlight to the soil or prevent penetration by young plants.

- ✓ Protect the re-vegetated area from excessive trampling and any other factor that might cause erosion or compaction. No construction equipment, trucks or heavy equipment should be allowed onto re-vegetated areas.

- ✓ Ensure that suitable temporary and permanent drainage protection is installed parallel with the re-vegetation process.

- ✓ Water the seeded/planted area on a regular basis (according to need, but on average of twice per week).

- ✓ Institute an appropriate maintenance and monitoring program for a minimum of one year. This program should include, monitoring of the success of seed germination, growth of the plants, removal of invasive weeds, replanting of areas where re-vegetation has not been successful once the cause of the inhibiting factor has been identified and remedied. Repair of any funnels or erosion channel by the contractor must not allow erosion to develop on a large scale before implementing repairs.

Seed Mixes

Alternative seed mixes are provided for use under the various topographical condition of Nigeria. Vetiver grass (*Vetiveria zizaniodes*) for stabilization of steep slopes and erosion areas, are readily available, should a suitable indigenous mix not be available. The seeds applied by utilizing a combination of hand seeding with local labour (for minor work) and hydro seeding (for major grassing works). Vetiver grass (*Vetiveria zizanioides*) is not indigenous but is sterile and will not be invasive.

Animal manure

This will be managed by conversion to organic manure that would provide nutrient for the pasture farm. An immediate term plan is now proposed that the cow dung in particular and any other biomass may be converted to biogas for heat and electricity provisions to the participation livestock keepers and pasture farmers. This will provide additional source of energy to further reduce expenditures of participation individuals for increased family economy.

CHAPTER EIGHT: CONCLUSIONS

8.1 CONCLUSIONS

The proposed Improved Cattle Breeding Project could not have been proposed at a better time, considering the drive for self-sufficiency in agricultural production by the present Administration, which calls for increased local agricultural production. The proposed project, when executed, will enhance the socio-economic status of communities in its zone of influence. The impact of the project on development of the agricultural potential of the area will be immense, as it will significantly improve cattle rearing, pasture improvement and production as well as facilitate milk and meat production and enhanced livestock healthcare delivery, livestock farming and most importantly the security of the region.

The Environmental and Social Impact Assessment for the proposed project was carried out in compliance with existing national and international guidelines and regulations. Relevant stakeholders were duly consulted during the study to ensure the success of the implementation of the environmental and social management frameworks for the project.

The study has investigated the baseline conditions of the project area, identified the potential environmental impacts of the project, and proffered appropriate mitigation measures to be carried out under the Environmental Management Plan designed for the project. The associated and potential impacts of the proposed project, in the construction phase, were identified and include, bio-diversity loss, operational/equipment noise, potential for soil erosion and water pollution. Other identified impacts of the proposed project include the potential for occupational accidents and spread of communicable diseases such as HIV/AIDs and other STDs.

On the other hand, the proposed project is expected to, in the construction phase, boost local trading activities as well as provide employment and procurement opportunities for the local community.

In its operational phase, the project is expected to significantly enhance the socio-economic status of the communities in the project area as well as the regional and national economies. A potential negative impact identified in the operational phase of the project is occupational hazards from daily production activities.

Although the project is expected to produce some negative impacts, most of which are expected to occur in the constructional phase, these impacts can be mitigated by strictly implementing appropriate actions stipulated in the project design and ESMP.

In conclusion, the proposed project is environmentally and socially justified and acceptable to the entire project stakeholders, if the Environmental and Social Management Plan is strictly implemented. The project is therefore recommended for an integrated implementation with the Environmental Management Plan.

8.2 RECOMMENDATIONS

To ensure the success of the environmental and social management of the proposed project, the following are recommended:

- ✓ Recommendations presented in the ESMP should be strictly implemented to mitigate/enhance the identified potential environmental and socio-economic impacts of the project;

- ✓ Stakeholders and the general public should be fully involved in monitoring the implementation of the ESMP constructional and operational phases of the project to ensure the success of the project;

- ✓ Since the contractor will be expected to strictly implement the ESMP developed herein, there is a need to ensure strict supervision and continuous monitoring by FMEnv, SEPA and SOSG;

- ✓ Continuous engagement with the construction and operations employees as well as the project communities will be necessary for the long-term environmental management of the project; and

- ✓ Federal Ministry of Environment should approve and issue a certificate of compliance for the implementation of the project.

REFERENCES

1. Adefila J. O. (2014). Pattern of Agricultural Development in Southern Parts of Sokoto State, Nigeria: IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) p-ISSN: 2319-2372.Volume 7, Issue 1 Ver. III (Jan. 2014), PP 14-20

2. Ayoade, J. O. (2004). Introduction to climatology for the Tropics. Spectrum books. Ibadan, 220-230.

3. Falola, Toyin, and Akanmu Adebayo (1985). "Pre-Colonial Nigeria: North of the Niger-Benue." In Nigerian History and Culture, edited by Richard Olaniyan, 56-96. London: Longman.

4. Glasson and Therivel (1999). Introduction to Environmental Impact Assessment: Principles and Procedure 3ppJeje 1978, Aspects of the Geomorphology of Nigeria in. A Geography of Nigerian Development Eds.

5. Itua, Eugene (2012): Environmental and Social Management Framework (Updated Draft Final) For Second Rural Access & Mobility Project (Ramp II) In Adamawa, Enugu, Niger and Osun States Nigeria. Prepared for Federal Ministry of Agriculture & Rural Development Federal Project Management Unit (FPMU) Second Rural Access & Mobility Project (Ramp 2).

6. Kirk-Greene, Anthony Hamilton (1972). *Gazetteers of the Northern Province of Nigeria,* vol. III. London: Frank Cass.

7. Leopold L.B, Clarke F.E, Henshaw B.B and Balsley J.R (1971). A procedure for evaluating environmental impacts. Geological survey Circular 645, Government Printing Office, Washington DC.

8. Morgan, William Thomas (1983). *Nigeria.* London: Longman.

9. Neff J.C. (2002). Vegetation and climate controls on the potential production of CO_2, DOC and DON Production in northern latitude soils. Global Change Biology. 8: 872-884.

10. N.G., Obaje (2009). Geology and Mineral Resources of Nigeria.MSpringer Dordrecht Heidelberg London New York Pp 14-17

11. Oguntoyinbo, J.S. (1978). Climate-Mean annual pattern of Insolation. A Geography of Nigerian Development Eds. Oguntoyinbo, J.S., Areola, O. O. and Filani, M. Heinemann Educational Books (Nigeria) Ltd. Second Edition Pg 456.

12. Powell, J., Fernandez-Rivera, P., Hiernaux, P., Turner, M., 1995. Nutrient Cycling in Integrated Rangeland-Cropland Systems of the Sahel. In: Vth International Rangelands Congress, Salt Lake City.

13. SIEP HSE-MS Manual part 5, 1999.

14. Udo, R. K. (2001). Geographical regions of Nigeria. Oxford University press. Ibadan

15. Updated Environmental & Social Impact Assessment Study for the proposed 340km Mbeya –Tunduma– Sumbawanga 400kV Transmission Line and ~4km Tunduma Substation to Tanzania-Zambia Border 330kV Transmission Line, April 2018

16. World Bank Report (1995) Environmental Assessment: Challenges and Good Practice. Washington DC: World Bank.