DRAFT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT

FOR

PROPOSED OBUDU CARGO AND PASSENGER AIRPORT, OBUDU LOCAL GOVERNMENT AREA, CROSS RIVER STATE

BY

CROSS RIVER STATE GOVERNMENT

SUBMITTED TO

FEDERAL MINISTRY OF ENVIRONMENT, ABUJA

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LIST OF ACRONYMS AND ABBREVIATIONS

ATC	-	Air Traffic Control
ATCO's	-	Aircrews and Air Traffic controllers
ATM	-	Automatic Teller Machine
BASA	-	Bilateral and Multilateral Air services Agreements
BAT	-	Best Available Technology
BOAC	-	British Overseas Airways Corporation
BOD	-	Bio-oxygen Demand
BTEX	-	Benzene, Toluene, Ethylbenzene and Xylene
Ca	-	Calcium
CAEP	-	Committee on Aviation Environmental Protection
CNS	-	Communication Navigation and surveillance
COD	-	Chemical oxygen Demand
CH_4	-	Methane
Cl	-	Chlorine
CNS	-	Central Nervous System
CO_2	-	Carbon dioxide
CO	-	Carbon monoxide
Cr	-	Chromium
DO	-	Dissolved Oxygen
DOC	-	Dissolved Organic Carbon
EA	-	Environmental Assessment
EC	-	Electrical Conductivity
EDTA	-	Ethylene Diamine Tetra acetic Acid
EIA	-	Environmental Imp Assessment
EQP's	-	Environmental Performance Indicators
EQI's	-	Environmental Quality Indicators
ESMP	-	Environmental and Social Management Plan
ESIA	-	Environmental and Social Impact Assessment
ETP	-	Effluent treatment plant
FAAN	-	Federal Aviation Authority of Nigeria
TFCC	-	Total Faecal Coliform Count
FDI	-	Foreign Direct Investment
Fe	-	Iron
FGD	-	Focus Group Discussion
FMA	-	Federal Ministry of Aviation
FMEnv	-	Federal Ministry of Environment
FPIC	-	Free, Prior, and Informed Consent
GEF	-	Global Environmental Facility
GERL	-	Geo Environmental Resources Limited
GIS	-	Geographic Information System
GW	-	Ground Water

H_2S	-	Hydrogen Sulphide
HCHO	-	Formaldehyde
Hg	-	Mercury
HID	-	Health Impact Assessment
ICP	-	Informed Consultation and Participation
IDI	-	In-Depth Interview
IFC	-	International Finance Corporation
ILO	-	International Labour Organisation
IPCC	-	Intergovernmental Panel on Climate Change
IUCN	-	International Union for the Conservation of Nature
K	-	Potassium
LGA	-	Local Government Area
MFMP	-	Multilateral Fund for the Implementation of Montreal Protocol
Mg	-	Magnesium
MMA	-	Murtala Mohammed Airport
Mn	-	Manganese
Na	-	Sodium
NACEDO	-	Nature Conservation and Environmental Development Organization
NAMA	-	Nigerian Airspace Management Agency
NCAA	-	Nigerian Civil Aviation Authority
NCARs	-	Nigerian Civil Aviation Regulations
NESREA	-	National Environmental Standards and Regulations Enforcement Agency
NGO's	-	Non-Governmental Organisations
NIMET	-	Nigerian Meteorological Institute
NO	-	Nitrous oxide
NPC	-	National Population Commission
OCPA	-	Obudu Cargo and Passenger Airport
O_2	-	Oxygen
O_3	-	Ozone
O&G	-	Oil and Gas
PAPs	-	Project Affected Communities/Project Affected Persons
PAH	-	Polycyclic Aromatic Hydrocarbons
Pb	-	Lead
PCF	-	Prototype Carbon Fund
PHC	-	Primary Healthcare
PHEDC	-	Port Harcourt Electricity Distribution Company
PM	-	Particulate Matter
PPA	-	Project Affected Persons
PPE	-	Personal Protective equipment
PS	-	Performance Standards
RFS	-	Road Feeder Service

SO_2	-	Sulphur oxide
SO_4	-	Sulphate
SACPs	-	Standards and Recommended Practices
SCCU	-	Special Climate Change Unit
SMART	-	Specific, Measurable, Attainable, Realistic and Time based
SPM	-	Suspended Particulate Matter
SW	-	Surface Water
TCC	-	Total Coliform Count
TDS	-	Total Dissolved Solid
THB	-	Total Heterotrophic Bacteria
TOC	-	Total Organic Carbon
TPH	-	Total Petroleum Hydrocarbon
UNEP	-	United Nations Environment Programme
VOCs	-	Volatile Organic Compounds
WAAC	-	West African Airways Corporation
WCN	-	Waste Consignment Note
WCS	-	Wildlife Conservation Society
WMS	-	Waste Management System
Zn	-	Zinc

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EXECUTIVE SUMMARY

1.0 Project Proponent

Cross River State government is the proponent of the proposed Obudu Cargo and Passenger Airport. The State government is desirous of setting up the Obudu Cargo and Passenger Airport to boost the State economy by increasing its internally generated revenue, create jobs for the teaming unemployed youths in the State, establish a transportation link between farmers in the State and the market, enhance the States' tourism and make it more accessible to both local and international tourists etc.

In compliance with the Nigerian Federal Ministry of Environment's Environmental Impact Assessment Act (No. 86 of 1992 i.e CAP E12 LFN, 2004), Cross River State government is carrying out this Environmental and Social Impact Assessment (ESIA) study for the construction of its proposed Obudu Cargo and Passenger Airport hereinafter referred to as OCPA project.

Legal and Administrative Framework

The ESIA has been carried out in line with the applicable legal and administrative framework. Some of these include, but are not limited to;

- *National Policy on Environment, 1999*
- *Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004*
- *Federal Airport Authority of Nigeria (FAAN) Act 1996 Cap F5*
- *Nigerian Civil Aviation Authority (NCAA) Repeat and Re-enactment Act 2006*
- *Nigerian Civil Aviation Regulations 2006 Part 2*
- *Nigerian Civil Aviation Regulations 2006 Part 12: Particulars of the Aerodrome Site*
- *The Civil Aviation Act, 2006,*
- *National Environmental (Construction Sector) Regulations, 2010. S.I. 19,*
- *Standards Organisation of Nigeria Act, 2015,*
- *National Environmental Protection (Effluent Limitation) Regulations, S.I. 8 of 1991,*
- *National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Waste) Regulation 1991,*
- *National Environmental Protection (Management of Solid and Hazardous Waste) Regulation 1991,*
- *National Guidelines and Standards for Environmental Pollution Control in Nigeria (1991),*
- *Department of Climate Change 2011,*
- *Forestry Law CAP 51 LFN 1994,*
- *Nigerian Criminal Code Act CAP 77 LFN 2004,*
- *Land Use Act CAP L5 LFN 2004,*
- *Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN 2004,*
- *Water Resources Act, CAP W2, LFN 2004,*
- *Endangered Species Act, CAP E9, LFN 2004,*
- *Employees Compensation Act, 2010,*
- *Nature Conservation and Environmental Development Organization (NACEDO), 2001,*
- *The Wildlife Conservation Society, 1895,*
- *Montreal Protocol on Substances that Deplete the Ozone Layer 1987,*
- *United Nations Convention on Climate Change 1992,*
- *Convention to Regulate International Trade in Endangered Species of Fauna and Flora 1973,*
- *Convention on Conservation of Migratory species of Wild Animals 1979,*
- *Vienna Convention for the Protection of the Ozone Layer 1985,*
- *International Labour Organisation (ILO) Health and Safety Laws 2003,*
- *Occupational Safety and Health Convention, 1981 (No. 155),*
- *Occupational Health Services Convention, 1985 (No. 161),*

- *Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187),*
- *Kyoto Protocol 1997,*
- *Stockholm Convention on Persistent Organic Pollutants 2004,*
- *Environmental and Social Framework (ESF) 2016,*
- *Cross River State Ministry of Environment*

The relevant list of Cross River State Forestry, Biodiversity and Conservation Legislation are shown below;

  - *Law for the preservation and control of forests in Eastern Nigeria CAP 55, 1956 (E.R.N. 41 of 1955, 5 of 1957, 3 of 1958, E.N.L.N. 79 of 1961 1955)*
  - *Cross River State Forest Law Cap. 55*
  - *Wild Animal Preservation Ordinance Cap. 99*
  - *Wild Animal Preservation Law Cap.127 of 1916*
  - *Cross River State Wild Animal Preservation Law CAP. 127*
  - *Wild Animals Laws (Eastern Nigeria), 1965*
  - *Cross River State Forestry Commission Law No. 3, 2010*
- *Cross River State Urban Development Authority*
- *Cross River State Environmental Protection Agency Cap E5, 1996*
- *Cross River State Environmental Sanitation Enforcement (Urban Area) law Cap E6*

Field Data Gathering

A field data gathering exercise was carried out to fill the information gap identified from literature review and also to validate existing information as well as to establish baseline data for future references. It entailed visual observation, on-site measurements and collection of samples for laboratory analysis/testing, the laboratory work was handled by affiliate laboratory Labchemnec Jans Limited (an accredited laboratory with the Federal Ministry of Environment with its head office located at No. 5 Port-Loko Street, Wuse Zone 3, Abuja). A multi-disciplinary team of experts (Aviation experts, Socio-economists, Taxonomists, Chemists, Environmental Scientists, GIS analysts and Geographers) were involved in the fieldwork carried out from 23rd to 26th July, 2019 and 20th to 23rd January, 2020 for wet & dry season respectively.

2.0 Project Justification

The justification for the Cross River State Government proposed Obudu Cargo and Passenger Airport in Obudu Local Government Areas, Cross River State were discussed under the subheading below:

Need for the Project

Cross River state has a functional airport in Calabar (Margaret Ekpo International Airport) which unfortunately is well over 200 km from the northern part of the state. This has partly affected patronage of tourist sites like the Obudu mountain resort as well as the many other tourist locations in the northern and central part of Cross River State. Asides from tourism, agricultural produce such as cocoa, oil plam, cassava, kolanut, maize, plaintain, banana, yam etc, are massively cultivated in the state especially in the northern part of the state covering local government areas including Yala, Ogoja, Bekawara, Obanliku and Obudu. To provide efficient transportation access, other than road for tourism and agriculture, the government of Cross River State have proposed to set up the Obudu Cargo and Passenger Airport.

Project Benefits

The Project shall offer a number of benefits at the national and local community levels. Some of these are as outlined below:

- *Creation of jobs and employment,*
- *Enhancement of tourism,*
- *Improved Revenue Generation and Cash Flow,*
- *Skill Acquisition and Technology Transfer*
- *Value Added Developments*

Value of the Project

The total investment cost estimate for the proposed project works out to One Hundred Million United States Dollars (USD 100,000,000.00). The estimated Investment Cost for the project is based on the requirement of fixed and non-fixed assets.

- ***Envisaged Sustainability***

The envisaged sustainability of the Cross River State Government proposed Obudu Cargo and Passenger Airport is discussed under technical sustainability, social sustainability, economic sustainability and environmental sustainability.

Technical Sustainability

Cross River State Government have technically sustainable plan for operating the OCPA project. The use and adoption of Best Available Technology (BAT) in the design, construction and operational phases of the project will ensure technical sustainability of the proposed project. The OCPA project shall equally be managed by experienced experts who are well vast in the aviation technology. The installation of equipment will be done following internationally approved standards such that the proposed project not have much negative effect on the host community.

Social Sustainability

The proposed OCPA project will achieve social sustainability in that the project will not only provide employment for the indigenes of the host communities at the pre-construction, construction and operation phase, but will create room for the training and retraining of the project personnel. Furthermore, the proposed project will result in the provision of certain social infrastructures and amenities such as road, water, healthcare and educational support etc.

Economic Sustainability

Air travel in Nigeria is currently experiencing a boom owing to the bad nature of most of the federal roads in Nigeria as well as security concerns in the country. Investment in air transportation infrastructure, especially for an area with huge tourism potentials, will yield high return on investment for the government of Cross River State.

Environmental Sustainability

The project will be implemented and operated in accordance with guidelines and recommended best practices of the Federal Ministry of Environment (FMEnv), Federal Ministry of Aviation, and that of other international environmental organizations such as United Nations Environment Programme (UNEP), Intergovernmental Panel on Climate Change (IPCC), Global Environment Facility (GEF) and so on. The environmental aspects of the project shall be given accurate attention to ensure the environment is protected during the project implementation and operation. The integration of the findings and recommendations of this ESIA study into the various phases of the project will to a very large extent see to its environmental sustainability.

Project Options/Alternatives

The OCPA project is to be sited at the proposed location after due consideration of all environmental and social factors. However, three options were considered before a decision was reached on the implementation of this project, these options are:

- ***No Project Option***

This option implies that the proposed project should not be implemented. This option would be typically considered if the proposed project lacks benefits to society such that its negative impacts outweigh the benefits. Essentially, the proposed project is expected to contribute immense benefits particularly on socio-economic growth and other benefits.

Preliminary environmental assessment shows that the proposed project is most likely going to have significant environmental impact. Identified impacts which could be major, moderate or minor during pre-construction, construction, and operation phases can be effectively mitigated by proper environmental management plan. Hence, the No Project option was therefore considered non-favorable and disregarded.

- ***Delayed Project Option***

This alternative implies postponement of the implementation period of the proposed project. Delay of project implementation becomes necessary under certain circumstances such as; war, civil unrest, antagonistic public opinion, government policy, prevailing economic conditions, or other force majeure. Presently, none of these circumstances that would warrant the postponement of the proposed project exists. Preliminary planning activities for the proposed project including consultations with stakeholders during the scoping workshop held in Obudu show that the project is highly desirable. Any delay would result in several negative effects, including possible inflation in project implementation costs, which could render the project non-viable in the future.

- ***Go Ahead Project Option***

This option involves the implementation of the project as planned. Although preliminary environmental assessment indicates that there may be a number of adverse effects associated with various project phases, especially during construction and operation phases, these impacts are either major, moderate or minor, and with adequate mitigation and environmental management plans, these impacts can be further reduced, or completely eliminated. Therefore, the go-ahead project option, as planned, is the most attractive and is being adopted.

Project Alternatives

A number of alternatives have been considered alongside this proposed project. Some of the project alternatives contemplated as asides the proposed project include.

- ***Donald Duke Airstrip***

Donald Duke Airstrip formerly known as Bebi Airstrip is located in Bebi, Cross River State of Nigeria. The airstrip was established primarily to serve the Obudu mountain resort and is located at about 18 km east of Obudu town. By road, the Donald Duke airstrip is about 45 km from the Obudu mountain resort. A major reason why this infrastructure is not considered as a viable project alternative is the history of mishaps that are associated with the airstrip on account of poor air traffic control service, lack of international standard aviation safety equipments among other factors.

- ***Calabar Airport***

The Calabar airport also known as the Margaret Ekpo International airport is located in Calabar, the capital of Cross River State. The airport is well over 200 km by road from the northern part of Cross River State. Distance is therefore the major challenge in having the Calabar airport serve as a viable project alternative.

- ***Helipad***

A helipad is a landing area or platform for helicopters and powered lift aircraft. This is yet another alternative for the proposed project. In fact, it is the most cost effective option. However, it is unfortunately not suited as a viable alternative considering the fact that it cannot accommodate the targeted freight and passage volume anticipated.

3.0 Project Description

Project Initiation

The Cross River State government is desirous of setting up the proposed Obudu Cargo and Passenger Airport (OCPA) project to boost the State economy by increasing its internally generated revenue, create jobs for the teaming unemployed youths in the State, establish a transportation link between farmers in the State and the markets, enhance the States' tourism potentials and make it more accessible to both local and international tourists etc.

Project Size and Location

The proposed OCPA project traverses four (4) communities in Obudu Local Government Area of Cross River State within the geographic coordinates of 6^0 39' 32.4"N, 9^0 8' 40.8"E, 6^0 39' 43.3"N, 9^0 8' 35.2"E, 6^0 40' 8.9.4"N, 9^0 8' 28.5"E and 6^0 48' 56.4"N, 9^0 7' 21.6"E Below are the proposed airport project host communities.

- *Atiekpe*
- *Ikwomikwu*

- *Okambi and*
- *Igwo*

The proposed project will occupy a total land area of 1,842.316 hectares with a dimension of 3km by 5km. The landing/runway length spans 3.6km.

Components of the Proposed Project/Facility Layout

The project shall entail extended facilities, mostly for commercial air transport. The facilities will include: Landing/Runway, Terminal (Airline Booking/Ticketing, Aquarium, Arrival Hall, Arrival Immigration, ATM Stand, Atrium, Baggage Reclaim, Custom Channel Departure Exit, Emergency Exit, Fire Hydrant, General Waiting Room, International Departure Hall, Luggage Platform, Male/Female Toilet, Medical Hall, National Departure Hall, Offices, Passport Control Room, Security Room, Control Tower), Maintenance Building, Aircraft Stand, Taxiway, Parking Lot, Cargo Buildings, Fuel Station & Fire Station.

Other components shall include Walkway, Access Road, Car Rental, Air Traffic Control Centre, Fire Station and Entrance Gate.

i. Runway

As only one runway is proposed, it shall be oriented to take maximum advantage of the prevailing wind. Alignment with built-up and planted areas shall been avoided, hence the takeoff and landing paths shall not positioned over built-up areas in order to avoid complaints from inhabitants of the neighbouring communities. Essentially, no built up areas or communities are located within 1km horizontal distance during takeoffs, approaches and landings.

- ***Runway Surface***

The runway shall be man-made surface (Asphalt) capable of supporting the weight of any aircraft likely to make use of the airport. The runway will be constructed to have a maximum end-to-end slope of two and a half per cent (2.5%) with no abrupt changes. For drainage purposes the runway will be crowned with two per cent (2%) slopes down to the runway edges. Care shall be taken to avoid areas where water pooling could create soft spots that will hamper aircraft directional control.

- ***Runway Dimensions***

The runway length will be adequate to meet the operational requirements for the aircraft intended. The runway will have a minimum width of 25m and length of 3,400m with allowance for expansion possibilities.

- ***Section of a Runway***

The following are the sections of the runway;

*i) The **runway thresholds** are markings across the runway that denote the beginning and end of the designated space for landing and takeoff under non-emergency conditions.*

*ii) The **runway safety area** is the cleared, smoothed and graded area around the paved runway. It is kept free from any obstacles that might impede flight or ground roll of aircraft.*

*iii) The **runway** is the surface from threshold to threshold, which typically features threshold markings, numbers, and centerlines, but not overrun areas at both ends.*

*iv) **Blast pads**, also known as overrun areas or stop ways, are often before the start of a runway where jet blast produced by large planes during the takeoff roll could otherwise erode the ground and eventually damage the runway. Overrun area shall also constructed at the end of runways as emergency space to slowly stop planes that overrun the runway on a landing gone wrong, or to slowly stop a plane on a rejected takeoff or a takeoff gone wrong.*

*v) **Displaced threshold** shall be used for taxing, takeoff, and landing rollout, but not for touchdown. A displaced threshold often exists because obstacles just before the runway, runway strength, or noise restrictions may make the beginning section of runways unsuitable for landings. It shall be marked with white paint arrows that lea up to the beginning of the landing portion of the runway.*

- ***Runway markings***

This shall be markings and signs on runways. The runway shall have a distance remaining sign (black box with white numbers). This sign shall use a single number to indicate the thousands of feet remaining, so 7 will indicate 7,000ft (2,134m) remaining. The runway threshold shall be marked by a line of green lights.

- ***Runway Lighting***

Runway lighting is a line of lights on an airfield to guide aircraft in taking off or landing.

ii. Terminal Building

This is a building where passengers shall get on and off aircraft, book ticket, pick up luggages etc. Components of the Obudu Passenger and Cargo Terminal includes: Airline Booking and Ticketing Center, Aquarium, Arrival, Halls, Arrival Immigration, ATM Stand, Atrium, Baggage Reclaim, Car Rental Center, Custom Center, Departure Exit, Emergency Exit, Fire Station, General Waiting Room, International Departure Hall, Luggage Platform, Male & Female Toilet, National Departure Hall, Off 001 – 006, Passport Control, Rooms, Security, Store.

iii. Maintenance Building

Maintenance building shall be where the performance of task required to ensure the continuing air worthiness of aircraft or aircraft part are done. This includes overhaul, inspection, replacement, defect rectification, embodiment of modifications, compliance with air worthiness directive and repair.

iv. Aircraft Stand

This shall be a vast area inside the airport where aircraft shall be parked. Its landtake is about 200m length and 100m with a capacity to take about twenty (20) aircrafts.

v. Taxiway

This shall serve as a path connecting runways with aprons, hangars, terminals and other facilities.

vi. Parking Lot

The parking lot will be located in front of the terminal building. Its landtake is about 100m length and 50m width with a capacity to take not less than fifty (50) vehicles per time.

vii. Cargo Buildings

Cargo building (warehouses) shall provide a holding area for goods awaiting air and road feeder service (RFS) connections to final destination. This facility shall serve as sortation center for cargo carriers. The number of warehouses for cargo operation at Obudu Cargo and Passenger Airport shall be ten (10) with a total land take of 300m^2.

viii. Fuel Station

Fuel station shall be located at about 200m away from the cargo warehouse. Its proposed land take is about 100m^2.

ix. Fire Station

The Airport Fire Service shall have a total of ten (10) personnel which includes the following; airport fire manager, station/watch manager, crew manager, crew commander, firefighters etc. and five (5) firefighting trucks and shall be divided into four (4) units ie:

- *Operational Unit;*
- *Training & Development Unit;*
- *Safety & Standard Unit; and*
- *Support & Planning Unit.*

Function & Responsibilities

- *To provide and maintain Fire Protection and Safety Services to aircrafts in accordance with the recommendation and requirements of the International Civil Aviation Organisation (ICAO);*

- *To provide Rescue and Fire Fighting Services to passengers involved in aircraft accident or incident both on and within the immediate vicinity of the airport;*
- *To provide a Fire Fighting Service to fight fire in aircrafts and buildings on any part of the airport;*
- *To provide Fire Protection Services and to give Technical Advices on fire precautions and fire fighting.*

x. Control Tower
This shall be a building from which instructions shall be given to the pilots when they are taking off and landing.

xi. Access Road
Access to the proposed Obudu Passenger and Cargo Air shall be a key component in the efficient operation of the airport. The access road is about 8km dual carriageway by length and 7.4m width.

Mobilization Phase
i. Site Preparation
The site preparation will cover the following;
- *Site clearing,*
- *Construction of access road,*
- *Construction of terminal and maintenance buildings, control tower, warehouses, runway, taxiways, airport stand etc.*

ii. Mobilization of Construction Materials and Equipment
Sources of Materials
The project will require various standard construction materials including aggregates (granite), sand and water. These construction materials shall be sourced locally.

iii. Equipment and Machinery
The project will employ various standard construction equipment which includes Excavators, Wheel loader, Generator, Pay loaders, Tower crane etc.

iv. Personnel
- **Construction Phase**

The construction will be undertaken by an EPC contractor. It is envisaged that the contractor personnel will include skilled and semi-skilled personnel. A good number of labourers will also be employed from the neighbouring communities. For the size of the Obudu Cargo and Passenger Airport, it is estimated that 90% of the construction crew will be Nigerians especially Cross Riverians.

- **Operation Phase**

The project will engage a total of 100 persons (within Cross River State and Nigeria) and in response to the Nigerian Government set minimum local content target of 75%. Cross River State Government shall ensure that preference with respect to employment is given to host and neighboring communities (where requisite skills are available).

v. Energy Input
The Obudu Cargo and Passenger Airport shall be connected to the national grid. As alternative source of power, the airport facility shall have installed two (2) 450KVA generators for its power needs.

Water
The water requirement for the project is relatively high during construction and minimal during operation. The main consumption of the water during construction is for mixing of cement and concrete. The water requirement during construction is estimated at 10,000 liters per day. During construction, water shall be sourced from water vendors.

Water requirement during the operational phase of Obudu Cargo and Passenger Airport will be minimal. Water will be used for cleaning, it will also be used at the rest rooms. Water shall be sourced from the borehole which will be drilled on site.

Waste Management

The waste management for the proposed Obudu Cargo and Passenger Airport involves a comprehensive description and analysis of activities at preconstruction, construction, operational and abandonment phases of project. It also involves a review of the existing waste management and environmental management system of the proponent.

4.0 Description of the Environment/Baseline Condition

Environmental Settings

Geology

The Geology of Cross River State is dominated principally by the basement complex of the Oban massif, which extends from the Central Region to the southeastern part and the Obudu Plateau of the Northeast. The sedimentary terrain comprises rocks of the lower Benue trough and Calabar flank. The area has been subjected to periods of tectonism, magmatism and regional metaphorism leading to the development of fractures faults and folds creating favourable sites for mineralization.

Geologically, Cross River State can be subdivided into four units for ease of description. These are:

i. *The Oban Massif*
ii. *The Calabar Flank*
iii. *The Mamfe Embayment*
iv. *The Obudu Plateau*

The mapping of the rocks of the Oban Massif revealed rocks similar to the well-established occurrences in southwestern Nigeria. According to Ekwueme, (2003) they fall within the already established groupings of the Nigerian Basement Complex namely;

a) *Schist belts,*
b) *The Migmatite – gneiss complex,*
c) *Charnockitic rocks,*
d) *Gabbro and doleritic rocks,*
e) *Older granites with Amphiboles,*
f) *Syenites, basic and acidic intrusive rocks like granodiorites, pegmatites and quartz veins.*

The inaccessibility of the terrains is a major factor hindering exploration. The Obudu Plateau belongs to the Precambrian and include metamorphic rocks as well as intermediate and acidic igneous rocks intruding them. These rocks include the gneisses, Amphiobolites, Schists, Charnockites and meta-ultramafic rocks.

The Calabar Flank represents that part of the Southern Nigerian Continental Margin bounded in the North by the Oban Massif and by the Calabar Hinge line delineating the Niger Delta Basin to the West. It has Early Cretaceous deposits followed by the first marine incursion that resulted in the deposition of the platform, the Mfamosing Limestone during the middle Albian (Petters, 1962). During the Cenomanian and Turonian, subsidence of faulted blocks resulted in widespread deposition of shales with minor Calcarous intercalations. These sediments are uncomformably overlain by a domainantly shale lithology with occasional mudstone and thin gypsum beds during the Campanian to Mastrichtian (Nyong & Ramanthan, 1985).

The Mamfe Embayment situated between the Oban Massif and the Obudu Plateau is predominantly fluviatile clastic sequence that exhibit point bar-fining upward cycles and over bank mud cracks (Ekwueme et al; 1995). This formation belongs to the Asu River Group. Rocks associated with the sedimentary rocks of the Mamfe rift are Basaltic, abundantly found around Ikom bridge.

Hydrogeology

There are 3 main sources of groundwater in Cross River State:

- *The regional aquifer of the Coastal Plain Sands covering 10% of the area of the State,*
- *The fractured Shale of the Eze- Aku and Asu River Group, (55%),*
- *The weathered and fractured zone aquifers of the Oban and Obudu Basement complex (35%).*

As the shales and basement complex rocks are essentially impermeable, about 85% of the State has poor groundwater resources, accounting for the difficulty in providing safe drinking water through ground.

Relief

The topography of Cross River State is low lying landmass rising gradually upwards towards the town of Ugep, Ikom, Bekirana and Obudu (the project host Local Government).

Biodiversity

- ***Flora***

The vegetation ranges from mangrove swamps, through rainforest, to derived savannah, and montane parkland. Just as its rocks are diverse, so also are the mineral resource potentials of the State. Cross River State contains the largest amount of Tropical High Forest remaining in Nigeria and largest remaining rainforest in West Africa (0.85 million hectares), although its quality and density varies across the State's three agro-ecological zones. Cross River State also contains 1,000 sq. kilometres of mangrove and swamp forest. The main tree species found here include gmelina, albizia, iroko, ebony, mahogany, cedar, ukong, brachystegia and obeche. Cross River State due to her rich biodiversity and ecology remains an ideal biometry resource data base for tropical plant and animal research.

- ***Fauna***

The fauna composition of the project area like most tropical rain forest areas comprise of Mammals such as Erythrocebus patas (Monkeys), Bos Taurus (Cows), Capra hircus (Goats) etc. There are also Reptiles such as Rana temporaria (Frogs), etc.

Amphibians such as Toads abound in the project area. Examples of common worms found include Lumbricus terrestris (Earthworm). Obudu has a very diverse collection of birds such as Buteo platypterus (Broad-Winged Hawk), Aegypius monachus (Vulture), Columbidae colombiformes (Pigeon), Aquila accipitridae (Eagles) etc.

Insects include, Morpho peleides (Blue Morpho Butterfly), Atta spp (Leafcutter Ant), Danaus plexippus (Monarch Butterfly), Stagmomantis sp (Praying Mantis), Acrocinus longimanus (Harlequin Bettle) etc.

Soil

Cross River soils are predominantly of five types. These are:

(i) The steep, shallow, yellowish and red gravely soils on the Oban Obudu Hills (the project location);
(ii) The deep lateritic, fertile soils on the Cross River Plain;
(iii) The dark clayey basaltic soils in Ikorn;
(iv) The sandy, heavily leached soils on the older coastal plain which are highly susceptible to gully erosion; and
(v) The swampy hydromorphic soils of the lower deltaic coastal plain that is usually floated during the rains.

Climate and Meteorology

The climate within Cross River State is tropical-humid with wet and dry seasons and average temperatures ranging between 15°C - 30°C, and the annual rainfall between 1300 – 3000mm. The high plateau of Obudu experience climatic conditions which are markedly different from the generalised dry and wet period in the rest of Cross River State. Temperatures are 4°C - 10°C lower due to high altitude than in the surrounding areas. Similarly, the annual rainfall figures are higher than in areas around them, particularly on the windward side. Cross River State can, thus, be broadly divided into the following sub-climatic regions:

- *The moderated sub-temperate within the high plateaus of Obudu; and*
- *The hot, wet tropical extending from the southern lowlands to the central and northern hinterland parts.*

5.0 Baseline Data Acquisition Method

Baseline Study Team

Considering the inter-disciplinary need for conducting the ESIA, Geo Environmental Resources Limited (GERL) ensured that relevant and well experienced team were assembled to deliver on the set objectives. To achieve this, a multi-disciplinary team of experienced scientists and environmental professionals were assembled to carry out the required resource assessment, generation and analysis of baseline data, determination of potential impacts and recommendation of mitigation measures. An interactive approach among the environmental team members and other project professionals was adopted and facilitated by team meetings as required. The following were sampled based on categorization letter from the Federal Ministry of Environment:-

Air quality: 75 plus 5 control samples
Soil quality: 75 plus 5 control samples
Surface water quality: 4 samples (Litam river, Adima stream, Obudu dam and Abeb river)
Ground Water: 5 samples (Four boreholes and One Well water)

Sampling Collection Methodology

- ***Air Quality Assessment Method***

The spatial boundary for the air quality assessment of this project was limited to 5 km radius; this is so chiefly because of the land take for the project. For sampling of the air quality, the duration was between the hours of 8.00am and 6.00pm.

The following specific air quality assessment were carried out:

- *Micro and macro-climatology: Ambient temperature, relative humidity, rainfall, wind speed, wind direction, etc.*
- *Toxic gases: SOx, NOx, COx, H_2S, etc.*
- *Greenhouse gases: NOx, etc.*
- *Dust and particulates: Dust and SPM*
- *Noise and other Nuisances: Ambient Noise level, vibration, visual impact, odour, flies, heat, etc.*

- ***Method of Soil Studies***

The spatial boundary taken for soil quality assessment was 5 km radius of the proposed project site. Sampling locations for soil samples at the project site were chosen in a way that enhances mapping. At each sampling point, soil samples were collected from two depths, representing surface (0-15 cm) and subsurface soil (16 – 30 cm), these two were uniformly mixed in the laboratory to obtain composite samples. These composite samples were then tested for physico-chemical and microbial parameters. In all, 75 samples were collected from the proposed project site with soil auger while 5 control samples were collected outside the proposed project site. The samples were stored in labeled polythene bags.

- ***Method of Water Sampling***

The spatial boundary taken for water quality assessment was 5 km. Surface water sources are Litam river, Liwhan river, and Adima stream. Control samples for surface water were collected at Abeb river and dam. Ground water samples were collected at a borehole in Ikwomikwu and well in Okambi communities respectively. Control samples of ground water were collected in Okwortug and Atiekpe respectively. The water quality study of the project environment was undertaken to provide baseline information on the water resources of the project site environment.

- ***Method of Socio Economic Assessment***

The survey was undertaken with respect to demography, occupational pattern, land holding, literacy rate and other important socio-economic indicators of the project host and neighbouring communities to decipher the socio-economic nature of the entire project area. 10 km spatial boundary was maintained to able to capture Okambi, Atiekpe, Ikwomikwu and Igwo communities.

A multi-method approach was used in gathering socio-economic data and information, namely, (1) Focus Group Discussion (FGD), (2) In-Depth Interview (IDI) with questionnaire administration, and (3) Field observation.

1) Focus Group Discussion (FGD) *- Here, consultations and engagements were held with the project host community traditional heads, community chiefs, community youth groups, other interest groups as well as individuals. Public consultation/forum with the communities represented by all social strata/groups was equally carried out.*

2) In-Depth Interviews (IDI) *- In order to gather information and opinion of residents of Okambi, Atiekpe, Ikwomikwu and Igwo communities, personal interviews were conducted. Households were sampled for interview using probability sampling method. At 95% confidence level with 5% margin error using an estimate population of about 24,500 people, 420 population sample size was used (Denscombe, 2010). A comprehensive questionnaire for data collection was developed, wherein certain information were requested such as: household bio-data, livelihoods, infrastructural facilities currently available. These included road/access, water, electricity, education and healthcare infrastructures available. A total of 420 questionnaires were administered and 400 copies were retrieved for analysis of the socio economic baseline for the project area.*

3) Field Observation *- The socio-economic study team also physically inspected major facilities and landmarks, such as water supply points, school buildings, health care facilities, markets, town halls, occupational activities, informal sector activities and conditions of roads and houses. Other areas of interest studied include cultural heritage/artefact and other historical/cultural patrimony of the communities. Demography was yet another area that wasn't left out. The size, land use, economic activities (with emphasis on low income groups highly dependent on primary activities), community structure, employment, markets, labour supply, income distribution, consumption, and migration pattern of the host and neighboring communities was also studied.*

Quality Assurance and Quality Control Measures

A quality control programme was established at the beginning of the fieldwork in order to ensure the validity of results and comparability of acquired biological data. This involved detailed procedural guidelines for sampling, preservation, labeling, and storage and laboratory analysis. To ensure the accuracy and reliability of in-situ field measurements, field instruments were calibrated prior to use and cross checked from time to time. Field data sheets were carefully kept and inspected at the end of the day's fieldwork to make sure that no samples were missed out. Other Quality Control measures adopted in the field included:

a) Representativeness of samples and repeatability of data,
b) Samples collection and labelling, preservation and storage,
c) Minimizing laboratory sampling error or bias and
d) Data verification

Data sheets for relevant environmental and ecological observations as well as laboratory logbook for laboratory-based aspects of the study were kept throughout the duration of the field work. To ensure that results obtained during analysis compare favourably with the in-situ environment, all samples were analyzed soon after collection. Standard laboratory quality control procedures were adhered to.

Analysis of Result

- ***Air Quality***

The results of air quality for the proposed project at baseline level falls within the Federal Ministry of Environment's limit which is the guiding principle for Nigeria Air Quality Standard. The results of measured parameters show that NO_2, SO_2, NO, CO, NH_3, and H_2S recorded values that were below detection limit. Average value for PM10 recorded 10.2µg/m^3 and 65.6µg/m^3 for wet and dry seasons respectively which are far below FMEnv limit of 150µg/m^3.

Average value for PM2.5 recorded 8.1µg/m^3 and 53.5µg/m^3 for wet and dry seasons respectively which are far below FMEnv limit of 112.5µg/m^3. Suspended Particulate Matter (SPM) would be monitored monthly when the project becomes operational, which is a major part of the Environmental Management Plan (EMP) for the project operation.

Asides from the monthly environmental monitoring, already mentioned as a means of checking the air quality during operation, there shall equally be the conduct of a more detailed and comprehensive triennial environmental audit of the project to follow up on the checking of the general environmental quality so as to benchmark current realities against the baseline and ascertain the trend of change against the latter.

Relative Humidity measured an average of 19.8% - 20.5% during wet season and 16.2% - 16.8% during dry season. Temperature measured an average of 32.4^{0}C during wet season and 33.6^{0}C during dry season while Noise measured an average of 30.5dB - 46.4dB during wet season and 41.1dB – 48.4dB during dry season. The noise level is very much within human tolerable limit (for 8-hour exposure duration) set by the Federal Ministry of Environment (FMEnv).

- ***Soil Analysis and Results***

Analysis of soil results (physical and Chemical)

i) Colour:-

The soil colour ranges from brownish, brown, dark brown, strong brown, grey to greyish for both seasons. This is generally attributable to the presence of organic matter in the soil.

ii) Texture:-

The soil texture of the project site area show that it is majorly of the coarse and scanty fine class belonging to sand, loamy and sandy loam type for both seasons.

iii) pH:-

The range of the soil pH from 5.22 to 6.93 during the wet season sampling and 5.69 to 6.94 during the dry season sampling indicating that the soil at the project are very acidic, distinctly acidic to acidic.

iv) Total Nitrogen:-

The concentration of Total Nitrogen present in the soil for wet season ranges 6.45% to 10.92% and 7.58% to 18.76% for dry season.

v) Heavy Metals:-

These include the following elements as contained in the tables above, viz; Nickel (Ni) Lead (Pb), Chromium (Cr), Cadmium (Cd) etc. These metals are relatively present for both seasons as can be seen from the Table. Cobalt (C) was not detected in all the samples collected for both seasons.

vi) Electric Conductivity: -

The electric conductivity of the soil for wet season ranges for from 59.0µS/cm^3 to 423.0µS/cm^3 and 121.0µS/cm^3 to 211.0µS/cm^3 for dry season.

Microbial Analysis of Soil Results

i) THB

From the microbial result of the soil analysis, the Total Heterotrophic Bacterial (THB) counts ranges from 5x10^{0}cfu/g to 8.2x10^{2}cfu/g during wet season and 1.2x10^{1}cfu/g to 2.04x10^{2}cfu/g during dry seasons. The THB counts give a general indication of the bacterial carrying quality of the soil in the area which is relevant in pollution control by remediation.

ii) Yeast and Mold

Yeast and Mold during wet season ranges from 2.0cfu/g to 184.0cfu/g and 3.0cfu/g to 84.0cfu/g for during dry season.

iii) Total Coliform Count

The total coliform count during wet season ranges from 1.3x10^1 to 3.0x10^3 (cfu/100ml) and 1.7x10^1 to 2.5x10^2 (cfu/100ml) during dry season. The total coliform counts give a general indication of the sanitary condition of soil water in the area.

iii) Faecal Coliform Count

The Total Faecal Coliform Count (FCC) showed little presence for both seasons. The Faecal coliform count give a general indication of the pathogenic composition of the soil.

iv) E. Coli

The total E. Coli count showed little presence for both seasons. E. Coli count is important health-wise. Most E. coli are harmless and actually are an important part of a healthy human intestinal tract however, some E. coli are pathogenic.

T. H. Fungi

The T. H. Fungi during wet season ranges from 5.0×10^0 to 3.69×10^2 (cfu/100ml) and 7.0×10^0 to 1.46×10^2 (cfu/100ml) during dry season.

- ***Water Sampling Analysis***

Chemical Analysis of Ground and Surface Water during Wet Season

- ***Ground Water (Hand pump borehole & Well water)***
  - *pH values for all the ground water samples collected shows that the results are faintly acidic to acidic and it is below FMEnv permissible limit for drinking water standard of 6.5-8.5,*
  - *Turbidity of ground water GW2, GW3, GW4 GW5 recorded 1.36NTU, 11.28NTU, 19.23NTU & 11.20NTU respectively, which are above FMEnv permissible limit for drinking water standard of 1.0NTU,*
  - *Total hardness of GW1 & GW2 recorded 234mg/l and 229mg/l, which are above FMEnv permissible limit for drinking water standard of 200mg/l,*
  - *Nickel for GW1, GW2, GW3 and GW4 recorded 0.09mg/l, 0.173mg/l, 0.12mg/l & 0.2681mg/l which are above FMEnv permissible limit for drinking water standard of 0.05mg/l,*
  - *Sulphate for GW1-GW5 recorded values which are above FMEnv permissible limit for drinking water standard of 5.0mg/l,*
  - *Nitrite for GW1-GW5 recorded values which are above FMEnv permissible limit for drinking water standard of 1.0mg/l,*
  - *Lead for GW1, GW2 & GW4 recorded 2.48mg/l, 2.28mg/l and 2.8713mg/l above FMEnv permissible limit for drinking water standard of 0.05mg/l,*
  - *Copper for GW1, GW2 & GW3 recorded 2.10mg/l, 0.12mg/l & 0.8384mg/l which are above FMEnv permissible limit for drinking water standard of 0.1mg/l,*
  - *Manganese for GW1-GW5 recorded values which are above FMEnv permissible limit for drinking water standard of 0.05mg/l. etc.*
  - *Calcium for GW1 and GW2 recorded 109.5mg/l and 125.1mg/l, which are above FMEnv permissible limit for drinking water standard of 75mg/l,*
  - *Patassium for GW1, GW2 & GW4 recorded 37.1mg/l, 21.2mg/l & 10.6mg/l which are above FMEnv permissible limit for drinking water standard of 10mg/l,*
  - *Cadmium for GW1, GW2 & GW4 recorded values which are above FMEnv permissible limit for drinking water standard of 0.01mg/l.*

Results from the laboratory show that Turbidity, Total hardness, Nickel, Sulphate, Nitrite, Lead, Copper, Manganese, Calcium, Potassium and Cadmium were above FMEnv permissible limit for drinking water.

- ***Microbiological Analysis of Groundwater during Wet Season***
  - *THB for GW5 recorded 1.5×10^1 which is below FMEnv Permissible Limit for Drinking Water of 1.0×10^3,*
  - *TCC for GW5 recorded 5.0×10^0 which is below FMEnv Permissible Limit for Drinking Water of 4.0×10^2,*

Laboratory results of water samples show that THB and TCC were found to be below FMEnv permissible limit for drinking water in sample water GW5. Nevertheless, all the water samples should be properly treated before concumption.

- ***Surface Water (Litam River, Adima Stream, Dam & Abeb River)***

From the laboratory results, most of the parameters have not been assessed (NS).

- *BOD of SW1, SW2, SW3 & SW4 recorded 6.0mg/l, 5.4mg/l, 6.5mg/l and 7.0mg/l which are above FMEnv permissible limit for aquatic life standard of 4mg/l,*
- *Nitrite (NO_2) of SW1, SW2, SW3 & SW4 recorded 1.39mg/l, 1.92mg/l, 2.0mg/l and 1.87mg/l which are above FMEnv permissible limit for aquatic life standard of 0.06mg/l,*
- *Iron (Fe) of SW3 recorded 1.3153mg/l which is above FMEnv permissible limit for aquatic life standard of 1.0mg/l,*
- *Lead (Pb) of SW2, SW3 & SW4 recorded 2.662mg/l, 2.7597mg/l and 0.039mg/l which are above FMEnv permissible limit for aquatic life standard of 0.0017mg/l,*
- *Zinc (Zn) of SW1 & SW4 recorded 0.15mg/l and 0.90mg/l which are above FMEnv permissible limit for aquatic life standard of 0.03mg/l,*
- *Copper (Cu) of SW1, SW2, SW3 & SW4 recorded 0.15mg/l, 0.21mg/l, 0.08384mg/l and 0.009mg/l which are above FMEnv permissible limit for aquatic life standard of 0.04mg/l,*
- *Cadmium of SW1, SW2, SW3 & SW4 recorded 0.10mg/l, 11.20mg/l, 18.20mg/l and 0.12mg/l which are above FMEnv permissible limit for aquatic life standard of 0.0018mg/l.*

- ***Microbiological Analysis***

There were presence of Total heterotrophic bacteria (THB) and Total coliform count (TCC) in the surface water sampled.

This further affirms the fact that the surface water samples collected were unfit for human consumption.

Chemical Analysis of Groundwater during Dry Season

- ***Ground Water (Hand pump borehole & Well water)***
  - *pH values for all the ground water samples collected ranges from 6.48 – 6.82, this goes to show that the ground water collected are acidic to faintly acidic and the results falls within the FMEnv permissible limit for drinking water standard of 6.5-8.5,*
  - *Nickel (Ni) of GW4 recorded 0.074mg/l, which is above FMEnv permissible limit for drinking water standard of 0.05mg/l,*
  - *Sulfate (SO_4) of GW1, GW2 and GW4 recorded 12.61mg/l, 20.82mg/l and 8.75mg/l which are above FMEnv permissible limit for drinking water standard of 5mg/l,*
  - *Nitrite (NO_2) of GW5 recorded 1.06mg/l, which is above FMEnv permissible limit for drinking water standard of 1.00mg/l,*
  - *Lead (Pb) of GW1 and GW2 recorded 0.68mg/l and 0.073 which are above FMEnv permissible limit for drinking water standard of 0.05mg/l,*
  - *Copper (Cu) of GW4 recorded 0.019mg/l, which is above FMEnv permissible limit for drinking water standard of 0.1mg/l,*
  - *Manganese (Mn) of GW2 recorded 0.21mg/l, which is above FMEnv permissible limit for drinking water standard of 0.05mg/l,*
  - *Calcium (Ca) of GW4 recorded 78.46mg/l, which is above FMEnv permissible limit for drinking water standard of 75mg/l,*

Results from the laboratory show that Nickel (Ni), Sulfate (SO4), Nitrite (NO2), Lead (Pb) Copper (Cu), Manganese and Calcilmu were above FMEnv permissible limit for drinking water.

- ***Microbiological Analysis of Groundwater during Dry Season***

The microbial parameters (THB, TCC, FCC, E. coli and Salmonella) were not recorded during the dry season sampling.

- ***Surface Water (Litam River, Adima Stream, Dam & Abeb River)***

From the laboratory results, most of the parameters have not been assessed (NS).

- *BOD of SW1 & SW4 recorded 6.6mg/l and 6.5mg/l which are above FMEnv permissible limit for aquatic life standard of 4mg/l,*
- *Nitrite (NO_2) of SW1 & SW4 recorded 1.85mg/l and 1.99mg/l which are above FMEnv permissible limit for aquatic life standard of 0.06mg/l,*
- *Iron (Fe) of SW1 recorded 1.24mg/l which is above FMEnv permissible limit for aquatic life standard of 1.0mg/l,*
- *Lead (Pb) of SW1, SW2 & SW4 recorded 2.72mg/l, 1.05mg/l and 2.78mg/l which are above FMEnv permissible limit for aquatic life standard of 0.0017mg/l,*
- *Copper (Cu) of SW1 & SW4 recorded 1.0856mg/l and 0.123mg/l which are above FMEnv permissible limit for aquatic life standard of 0.04mg/l.*

- ***Microbiological Analysis***

There were presence of Total heterotrophic bacteria (THB) and Total coliform count (TCC) in the surface water sampled.

This further affirms the fact that the surface water samples collected were unfit for human consumption.

Biodiversity

Flora

Vegetal species types encountered and those studied from literature include: Garcinia cola, Gambaya albida, Cocos nucifera, Milicia excels, Oxytenanthera albyssinica, Terminalia superba, Pentaclethra mcrophylla, Laccosperma spp, Tetrapleutra tetraptera, Tetracarpidum sp.

Fauna

Information on fauna within the project site and its environs were gathered from interviews and field observations. the fauna composition of the project location like most rain forest areas comprise of mammals such as monkeys, cattles, goats, dogs, antelopes, squirrels, rabbits, grass cutter, etc. there are also reptiles such as lizards, crocodile, snakes, etc.

Amphibians such as toads abound in the state. There are also wall gecko and worms. Examples of common worms found include earthworm. The project location also has a very diverse collection of birds such as green fruit-pigeon, broad-winged hawk, vulture, laughing doves, eagles etc.

Insects include, blue morpho butterfly, leafcutter ant, monarch butterfly, praying mantis, harleguin bettle etc.

- ***Socio Economic Analysis***

The socio-economic survey of the project environment was carried out at Atiekpe, Igwo, Okambi and Ikwomikwu communities, Obudu Local Government Area, Cross River State. Focus group discussions were carried out with youths and elders within the community while public consultation was also conducted with the chiefs.

Respondent Overall Perspective of the Project

The survey findings revealed that residents of the area hold different views about the project. 95% of the respondents were of the view that the project would provide jobs on completion, 5% were indifferent as to whether the project will create jobs. On the other hand, 87% of the respondents are of the view that the project would attract more people to work and live in the community while 13% feel it would not, as there are already enough manpower from the community to man all the operation phases of the project. 85% of the respondents feel that the project would have significant impact on the environment while 15% think otherwise. 82% feel the project during operation would enhance the economic life of the host community while 13% think otherwise and 5% are indifferent.

6.0 Identified Impacts and Mitigation Measures of the Project

Pre-construction

Air

Impacts

- *Fugitive dust emissions due to vehicular movement*
- *Gaseous emissions from construction equipment and machinery*

Mitigation

- *Application of dust suppressants (Water sprinkling)*
- *Speed limits shall be set to minimize the generation of fugitive dust*

Water

Impacts

- *Run-off from storage areas of construction materials*

Mitigation

- *Construction materials shall be properly stored in an enclosed warehouse and metallic containers*

Land and natural resources

Impacts

- *Loss of top soil*

Mitigation

- *There shall be the undertaking of stripping and effective stockpiling management*

Ecology

Impacts

- *Loss of vegetation/habitat*

Mitigation

- *A programme for the control of alien invasive plants in the concession shall be developed and implemented,*
- *Access roads to the site for preliminary studies shall be made in a way that sensitive ecosystems are avoided,*
- *No fauna shall be hunted or destroyed by any project personnel*

Public utilities

Impacts

- *Increased flow of traffic*

Mitigation

- *Clear signage and traffic calming measures on the intersection between the facility's access road and the main expressway (Obudu-Abouchichi road)*
- *Prohibit parking of trucks along the Obudu-Abouchichi road and enforce the use of truck parking lot to be constructed within the project facility*

Construction

Visual

- *Loss of sense of place affecting local communities due to site clearing and construction activities*

Mitigation

- *Vegetation shall be cleared in phases so that only those areas required for immediate development are cleared*
- *There shall be the use of directional lighting in areas operating at night, if communities are affected by lighting*

Soils, land capability & land use

Impacts

- *Placement of permanent project infrastructure, resulting in a permanent loss of soil resource, and change in soil characteristics, land capability and land use*

- *Spillage of chemicals and seepage from waste resulting in permanent loss of soil resource, and change in soil characteristics, land capability and land use*
- *Site clearance resulting in a permanent loss of soil resource, and potential change in soil characteristics, land capability and land use as a result of increased erosion*

Mitigation

- *Community members shall be assisted where livelihood is impacted with establishing new agricultural areas on land of equal or better land capability*
- *There shall be the provision of appropriate secondary containment (to hold 110% of the stored volume) in areas where hydrocarbons, solvents and other potentially hazardous materials are stored*
- *There shall be the preparation of procedures to ensure that spillage during mobile equipment maintenance is minimized, and that only designated areas will be used for this purpose*
- *Stripping, stockpiling and stockpile management shall be undertaken*
- *Community members shall be assisted where livelihood is impacted with establishing new agricultural areas on land of equal or better land capability*

Air

Impacts

- *Increase in Particulate Matter (PM) emissions resulting from land clearing, earthworks, and vehicular movement*
- *Increase in gas (SO_2, NOx, CO and VOCs) emissions resulting from vehicle exhaust emission and biomass burning*

Mitigation

- *Speed limits shall be set to minimize the generation of fugitive dust*
- *Vehicles carrying dusty materials shall be covered to prevent materials being blown from off from the vehicles*
- *There shall be the application of dust suppressants (water sprinkling) to sections of roads used routinely by vehicles that pass through and close to communities*
- *Vehicle idling shall be limited and vehicles well maintained to minimize particulate and gaseous emissions*
- *As much as possible, biomass burning shall be discouraged*

Water Resources

Impacts

- *Sedimentation of surface water resulting from erosion and runoff from exposed surfaces and roads*
- *Contamination of groundwater resulting from seepage from sewage, chemicals and other waste.*

Mitigation

- *There shall be the construction of access roads and infrastructure in a way that sensitive ecosystems are avoided*
- *Proper designs shall be prepared and implemented to manage storm water runoff in a manner that minimizes sediment transport to the receiving water resource and minimizes erosion along runoff channels*
- *There shall be the construction of concave surfaces to ensure run-off is directed*
- *Effective storm water management shall be developed for all project components to address storm water run-off volumes, velocity, water quality to minimize impacts on natural areas, focusing on minimizing increased sedimentation.*
- *There shall be an effective waste collection mechanism including proper waste sorting, storage and disposal at approved dumpsites*
- *Properly constructed toilets with septic tanks shall be made available for construction staff to take care of sewage and minimise seepage*

Noise

Impacts

- *Continuous noise impact on project communities resulting from construction works*

Mitigation

- *There shall be the restriction of construction activities at the facility to daytime hours 07:00 am to 07:00 pm*

- *Noise screening measures e.g sound insulation and damping shall be implemented*

Ecology & biodiversity

Impacts

- *Loss of forest and savanna habitat due to site clearing and earthmoving activities*
- *Loss of aquatic habitat due to site clearing and earthmoving activities*
- *Loss or disturbance of species of special concern due to site clearing and construction activities*

Mitigation

- *A rehabilitation plan shall be developed and implemented (overseen by an appropriately qualified botanist/ ecologist), with different objectives and rehabilitation approaches established for each habitat/ecosystem*
- *Aquatic habitats and areas immediately adjacent to them that have been degraded during the construction phase shall be restored to their pre-construction condition*
- *Construction in or near to gallery forests, wetlands, streams and rivers shall be avoided to the greatest practical extent possible*

Traffic

Impacts

- *Impact of construction related traffic on utilization capacity project host communities road,*
- *Safety impacts on local communities and other road users due to increased road accident rates during construction*

Mitigation

- *Prohibit trucks from parking along the Obudu – Abouchichi road*
- *Clear signage and traffic calming measures on the intersection between the airport's access road and the main expressway. This will warn motorists of the intersection and would reduce potential traffic safety impacts at this intersection*
- *There shall be the provision of temporary on-site accommodation for construction personnel to limit the volumes of daily commuter traffic to the project site*
- *There shall be the provision of dedicated buses for construction personnel not accommodated on the site to reduce daily commuter traffic to the project site*
- *Rest area for drivers shall be implemented, and maximum driving hours per driver established and enforced*

Population & demographic movement

Impacts

- *Influx of potential job seekers into the area and associated risks*

Mitigation

- *There shall be optimization of the use of local labour as far as practically possible*
- *There shall be the development of a code of conduct with which contractors and their employees must comply. The code shall deal with the interaction with local communities and substance abuse among other things*
- *There shall be the development and communication of a clear and concise employment and recruitment policy to prevent opportunistic job seekers from settling in the area*

Health & Safety

Impacts

- *Increased chances of the spread of communicable diseases such as HIV/AIDS and STDs linked to influx of predominantly male job-seekers and workers*
- *Increased pressure on healthcare infrastructure due to project related influx*

Mitigation

- *There shall be the development of a comprehensive HIV/AIDS program to employees through employee wellness programmes which should include the following:*
- *Awareness campaigns targeting project workers, senior management, contractors, sub-contractors and their spouses, communities near project facilities, risk groups (commercial sex workers, truck drivers)*

- *Prevention, voluntary counselling for HIV testing, as well as anti-retroviral treatment for employees and surrounding communities,*
- *A clinic will be built to handle health care service delivery to project staff.*
- *There shall be the development of an MOU with the Sacred Heart Hospital in Obudu, for service provision to the local workforce and their dependents*
- *There shall be the development and implementation of community development/sustainability plans to support infrastructure development in the area.*

Ecosystem Services

Impacts

- *Reduced availability of natural resources and ecosystem services to local communities*

Mitigation

- *Remaining Forest habitat that has been degraded shall be restored to their pre-construction condition*
- *A Rehabilitation Plan shall be developed and implemented (overseen by an appropriately qualified botanist/ecologist), with different objectives and rehabilitation approaches established for each habitat/ecosystem*

Operation

Air

Impacts

- *Increase in gaseous emissions (SO_2, NO_x and CO etc.) from airplanes, vehicles and some other airport equipment*
- *Aircraft engines emit heat, particulates, lead Pb, black carbon, gases (such as Carbon dioxide CO_2, Dust, Cardon monoxide CO, Methane CH_4, Water vapour, Nitrous oxide N_2O and Ozone O_3) as well as condensation trails which contribute to climate change*

Mitigation

- *Gaseous emission reduction measures will be implemented. These include:*
  - *Reduction of aircraft taxi time*
  - *Derated take off*
  - *Reduced reverse thrust*
  - *Dispatch towing*
  - *Ground congestion reduction measures*
  - *Decentralised gates*
  - *Reduction of power output during taxi, takeoff and landing*
  - *Improving airlines overall operational efficiency*
- *Aviation air pollution reduction measures will be implemented. These include:*
  - *Reduction of aircraft taxi time*
  - *Derated take off*
  - *Reduced reverse thrust*
  - *Dispatch towing*
  - *Ground congestion reduction measures*
  - *Decentralised gates*
  - *Reduction of power output during taxi, takeoff and landing*
  - *Improving airlines overall operational efficiency*

Noise

Impacts

- *Continuous noise resulting from taking off and landing operations of aircraft,*

Mitigation

- *Noise management procedures such as flight path alteration and noise sharing are effective mitigation measures that shall be implemented*

- *Other noise improvement measures that shall be implemented include:*
  - *Automoted tug*
  - *Thrust reverse limitations*
  - *Low power/lowdrag operations*
  - *Departure and arrival management*
  - *Thrust managed climb profiles*

Ecology and biodiversity

Impacts

- *Introduction of alien invasive flora and fauna*
- *Dust particulates from aircraft operations settling on surrounding flora and impeding photosynthesis as well as transpiration rate of plants,*
- *Dust particulates from aircraft operations settling on surrounding flora and impeding photosynthesis as well as transpiration rate of plants*

Mitigation

- *The ecological water requirements of the aquatic ecosystems shall be determined. Water abstraction from any of the rivers and from groundwater must not exceed levels that result in the ecological water requirements of the aquatic ecosystems being compromised. Abstraction from wetlands and swamps shall not be allowed*
- *Sessile fauna present at construction sites will be relocated by appropriate experts prior to the commencement of site clearing*
- *Reduction of dust particle generation from aircraft operations shall be minised by implementing the following measures:*
  - *Reduction of aircraft taxi time*
  - *Derated take off*
  - *Reduced reverse thrust*
  - *Improving airlines overall operational efficiency*

Soil, land capability and landuse

Impacts

- *Fuel and chemical spills during fueling and maintenance operations resulting in degradation of soil quality, and change in soil characteristics as well as land capability*

Mitigation

- *Bunded wall shall be constructed around fuel dump in compliance with DPR standards*
- *There shall be the preparation of procedures to ensure that spillage during aircrafts, vehicles and equipment maintenance is minimized, and that only designated areas are used for this purpose*

Water resources

Impacts

- *Contaminated stormwater runoff from roads, runway and other surfaces affecting surface and groundwater quality*

Mitigation

- *Where contaminants are transported along construction roads, emergency contaminant and mitigation measures shall be developed to minimize impacts should accidental spillages occur along the transport routes*
- *There shall be equipping of all trucks and equipment carrying fuels or oil with spill response materials and train personnel in the use of such materials*
- *All potential sources of contamination shall be stored up in secure facilities with appropriate Storm Water management systems in place to ensure that contaminants are not released to the water resource through Storm Water runoff*
- *There shall be the use of oil & silt traps to remove these types of contaminants from storm water, and designated areas used for equipment servicing*

- *It will be ensured that proper designs are prepared and implemented to manage storm water runoff in a manner that minimizes sediment transport to the receiving water resource and minimizes erosion along runoff channels*

Traffic

Impacts

Impact on utilization capacity on the project affected and neighboring community roads

Mitigation

- *Trucks parking along the Obudu-Abouchichi road will be prohibited for truck drivers. Truck drivers will all be compelled to utilize the truck car park*
- *Clear signage and traffic calming measures shall be put in place on the intersection between the airport's access road and the main expressway. This will warn motorists of the intersection and would reduce potential traffic safety impacts at this intersection*
- *Scheduling the delivery of cargo outside peak traffic times shall be implemented*

Ecosystem services

Impacts

- *Reduced availability of natural resources and ecosystem services to local communities due to use by the project and impacts on these resources,*

Mitigation

- *A Biodiversity Action Plan shall be developed to inform the protection and management of biodiversity in the entire project area*

Population & demographic movement

Impacts

- *Influx of potential job seekers into the area and associated risks*

Mitigation

- *Optimizing the use of local labour as far as practically possible*
- *Developing and communicating a clear and concise employment and recruitment policy to prevent opportunistic job seekers from settling in the area shall be pursued*

Health and safety

Impacts

- *Increased chances of the spread of communicable diseases such as HIV/AIDS and STDs linked to influx of predominantly male job-seekers and workers*
- *Increased pressure on healthcare infrastructure due to project related influx*

Mitigation

- *There shall be the development of a comprehensive HIV/AIDS program to employees through employee wellness programmes which shall include the following:*
  - *Awareness campaigns targeting project workers, senior management, contractors, sub-contractors and their spouses, communities near project facilities, risk groups (commercial sex workers, truck drivers)*
  - *Prevention, voluntary counselling for HIV testing, as well as anti-retroviral treatment for employees and surrounding communities*
- *The airport shall be equipped with a clinic to provide healthcare service delivery to both staff and customers*

Decommissioning

Ecology and Biodiversity

Impacts

- *Introduction of alien invasive flora and fauna,*
- *Loss or disturbance of fauna species of special concern due to collisions and noise disturbance,*
- *Increased hunting/poaching of wildlife and loss of habitats for crop production*

Mitigation

- *A Rehabilitation Plan shall be developed and implemented (overseen by an appropriately qualified botanist/ ecologist), with different objectives and rehabilitation approaches established for each habitat/ecosystem*
- *A programme for the control of alien invasive plants in the concession shall be developed and implemented*
- *Areas immediately adjacent to important habitats (e.g. wetlands, swamps, Gallery and Swamp Forest) that have been degraded shall be restored to their natural, pre-construction condition*
- *As a management policy for staff, hunting/ poaching shall be vehemently prohibited for project staff and sub-contractors. Defaulters shall be severely penalized*

Social and economic

Impacts

- *Loss of jobs*

Mitigation

- *Project staff will given due notice before project closure*
- *Project staff shall either be adequately compensated or transferred to other projects*

Water Resources

Impacts

- *Chemical contamination of surface water resulting from accidental spills during transportation and handling, and seepage from waste*
- *Sedimentation of surface water resulting from erosion and runoff from exposed surfaces and roads*
- *Contamination of groundwater resulting from seepage from hazardous materials and waste*

Mitigation

- *There shall be the equipping of all trucks and equipment carrying fuels or oil with spill response materials and train personnel in the use of such materials*
- *Oil & silt traps shall be used to remove these types of contaminants from stormwater, and use designated areas for equipment servicing*
- *Where contaminants are transported, emergency contaminant and mitigation measures shall be developed to minimize impacts should accidental spillages occur along the transport routes*
- *All potential sources of contamination shall be stored in secure facilities with appropriate Storm Water management systems in place to ensure that contaminants are not released to the water resource through Storm Water runoff*
- *All cleared spaces and land after decommissioning shall be massively revegetated to prevent the direct exposure of the surface to rain and run off*
- *All harzardous materials shall be removed in line with international best practices*

Soils, land capacity & landuse

Impacts

- *Remediation of contaminated soils and demolition of project infrastructure, resulting in re-establishment of baseline soil characteristics and land capability*

Mitigation

- *Phytoremediation and bioremediation shall be carried out on contaminated soils*

Air Quality

Impacts

- *Increase in Particulate matter emissions resulting from land clearing, earthworks, and vehicular movement*

Mitigation

- *Dust suppressants (Water sprinkling) shall be applied to sections of roads used routinely by vehicles that pass through and around neighboring communities*
- *Vehicles carrying dusty materials will be covered to prevent materials being blown from the vehicles*

- *Speed limits shall be set to minimize the creation of fugitive dust within the project boundary*

Visual

Impacts

- *Dust generation and site disturbance due to earth moving and removal of project infrastructure, affecting the visual character for communities*

Mitigation

- *There shall be the revegetation and landscaping of disturbed areas as soon as possible, to reflect the surrounding topography and vegetation*

Health and Safety

Impacts

- *Increased risk of accidents and injuries to workers due dismantling of equipment*

Mitigation

- *Professionals shall be engaged to carryout equipment dismantling*
- *Standard health and safety guidelines will also be strictly observed in carrying out the exercise*

7.0 Environmental and Social Management Plan (ESMP)

ESMP during Planning and Design/Pre-construction Phase

The environmental issues during pre-construction stage generally involve land acquisition, facility layout design, requisite quantity for construction raw materials, and avoiding encroachment into sensitive ecological areas.

ESMP during Construction Phase

- ***Air Environment***

At the project construction phase, there will be increase of dust concentrations due to fugitive dust emission from vehicular movement and other such associated work activities. Frequent water sprinkling in the vicinity of the site shall be undertaken to mitigate dust emission. It shall also be ensured that both gasoline and diesel powered vehicles are properly maintained to comply with exhaust emission standard limits.

- ***Noise Level***

There will be marginal increase in noise levels during construction phase from vehicular use, operation of equipment such as concrete mixers, borehole drilling rig, generators etc. This however will be temporary and shall be approached with the aim of suppressing impacts especially on humans working within the site area by adequately providing Personnel Protective Equipment (PPEs) such as ear mufflers. Also regular servicing of generators and vehicles shall be imbibed to reduce noise from these.

- ***Water Quality***

During construction, water shall be sourced from both ground water (construction of boreholes) and water bodies in the communities. However, drilling shall be done to fulfill standard industrial best practices and water from streams/rivers shall be collected with the aid of a water pump via water tankers or pipes in a way that will least pollute the water body or even endanger the aquatic ecosystem contained therein.

- ***Land***

Generally, the cutting of herbaceous vegetation, during construction phase results in the loosening of the topsoil. However, after the construction work, there shall be massive re-vegetation by way of vigorously planting greeneries to check soil erosion and enhance aesthetics.

- ***Socio-Economics Environment***

Construction work will be made to benefit the local population in a number of ways. The airport project management will give preference to local eligible people through both direct and indirect employment in the area of working as labourers, *drivers, security personnel, machine operators etc. All these will be in an attempt to provide ample opportunities for the indigenes to enjoy improved living standards and also to demonstrate the State Government's readiness to make them a part of the project and not just to fulfill its corporate social responsibility.*

ESMP during Operation Phase

➢ ***Air Environment***

The major pollution sources envisaged at the operation phase of the airport include (but are not limited to) the following:

- *Combustion of aviation fuel – aviation fuel is composed mostly of kerosene which produces nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2), sulphur oxides (SOx), hydrocarbons and particulates when it burns.*
- *When airplanes are on descent or approach, their engines tend to work inefficiently because they only make use of 30% of the available power which leads to a certain amount of unburnt kerosene being released. These unburnt fuel droplets are a source of volatile organic compounds (VOCs) which in turn gives rise to odours.*
- *During take offs and especially landing, aircraft tyres get worn and burnt which leads to a release of particulate matter (PM).*
- *Vehicles travelling to and from the airport, and ground service equipment generate NOx, CO_2, particulates and indirectly ozone through the burning of petrol and diesel fuel.*
- *During aircraft and airfield maintenance (painting, metal cleaning, de-icing etc.), and emergency and fire training use complex chemicals which can release VOCs.*

➢ ***Noise Level***

Noise is one of the major pollution issue with airports expecially during operation. The taxing, taking off and landing of aircrafts are usually accompanied by very high noise level which often time affect neighboring dwellings, especially if they are located really close to the airport. To minise noise pollution on neighbouring communities, a safe distance (in line with international standard recommendation) shall be maintained between the proposed Obudu Cargo and Passenger Airport and the neighbouring communities. Furthermore, technical staff (especially those working around the run way area, maintenance hub and the cargo warehouse shall be compelled to use the appropriate PPEs (such as ear mufflers etc). Air line operators shall also has a safety and standard operating procedure, will be required to constantly maintain their aircrafts and other operational vehicles by qualified and experienced engineers/technicians. By these measures, it is anticipated that noise level will be highly checked.

➢ ***Socio-economics***

Cross River State Government, at project operation phase shall take measures to put in place various amenities and socio economic benefits in a bid to improve the general living standards of the indigenes of the host community(ies). Some of these include;

- *Provision of employment to indigenes as both casual and permanent staffs.*
- *Provision of basic infrastructures where necessary, etc.*

➢ ***Water Management***

Water shall be sourced from borehole at the project site. Ground water shall be adequately and continuously monitored to prevention pollution and minimize wastewater generation. Periodic water audits shall be conducted to engender water use management and also check water quality.

Based on the rainfall intensity of project site area, storm water drainage system will be designed to consist of well-designed network of surface drains and rainwater harvesting pits along the drains and channelled to the receiving body.

Waste Management

The following include plans that shall be put in place for the effective management of all classes of wastes generated during the operation phase of the project.

- *Spent oil shall be collected in collection trays, stored in leak-proof steel drums and resold to authorized buyers.*

- *Oil drums would be collected and stored properly for re-cycling.*
- *Dust bins with lids shall be strategically placed at requisite locations with appropriate signage urging people to use them.*
- *Metal scrap wastes shall be collected and stored either to be reused/re-cycled.*
- *Paper waste will be collected in waste bins and frequently evacuated by company trucks to approved dumpsites.*
- *Used plastics bottles shall be collected in waste bins and disposed at approved dumpsites.*
- *Used cartons, empty cans and bags shall be collected and disposed at aqpproved dumpsites.*

ESMP during Decommissioning Phase

This project involves a huge investment. While in Operation, the airport project management will employ the best maintenance techniques and systems. These efforts will help to engender sustainability of the airport project. Similarly efforts and investment for renovation and modernization will result in further life extension of the project. From the present trends, the life of the airport would not be less than 100 years. However when the airport facility becomes unviable due to major technological changes or due to regulations, decommissioning of the facility will be undertaken. This involves a series of steps to be planned and executed. The total operation can be broadly categorized in to De-operationalization and dismantling phases. De-operationalization is a technical activity carried out by experts. Dismantling operation however will have impact on environment due to noise and dust arising out of it.

Environmental Monitoring Programme (EMP)

Regular monitoring of critical environmental parameters is of immense importance to assess the status of environment during the project operation. The monitored data can serve as an indicator for any change in environmental quality due to operation of the proposed project with respect to baseline environmental conditions, so that suitable mitigatory steps could be taken in time to safeguard the environment.

Monitoring indicators have been developed for each of the activity considering the mitigation measures proposed. Indicators have been developed for ascertaining the environmental quality and the performance of the EMP implementation through Environmental Quality Indicators (EQI's) and Environmental Performance Indicators (EPI's) respectively which focus not only on quantifying or indexing activity-environment interactions that may potentially impact the environment but at the same time also help in comparing different components of environmental quality against previously established baseline values. Monitoring results would be documented, analyzed and reported by contracted accredited environmental consultant in conjunction with the HSE Manager.

Monitoring and Reporting

Environmental and social key performance indicators will be developed in accordance to the FMEnv guidelines and the International Finance Corporation (IFC)/World Bank Group's performance Standards. This will be monitored at regular intervals to identify changes in conditions, new issues, mitigation, successes and opportunities for improvement in consultation and disclosure. The monitoring results will be reported as required, and will be available to the public. Stakeholder perceptions will also be monitored by Cross River State Government Community Relations Team Representatives.

Furthermore, Cross River State Government shall also take up robust CSR programme geared towards community welfare and support activities for socio-economic development of the nearby areas, to build a good rapport with the local communities by engaging the local community along with the administrative machinery to develop an ongoing process of development of the communities/villages surrounding the airport.

8.0 Remediation Plans after Decommissioning/ Closure/ Abandonment

Decommissioning refers to the process by which the operations of a project is terminated. It is an administrative and technical process which includes clean-up of project materials and progressive demolition of developmental project. The costs of decommissioning are spread over the lifetime of a facility and saved in a decommissioning fund. After a facility has been *completely decommissioned, it is released from regulatory control and the project proponent is no longer responsible for environmental safety. Decommissioning may proceed all the way to "greenfield" status.*

Cross River State Government as part of its decommissioning plan for the proposed project shall properly treat all effluents and solid wastes. Excavated areas shall be backfilled and graded. Furthermore, all solid waste excluding scraps shall be disposed in an environmentally sound manner while scraps shall be recycled as much as possible. The State Government shall also restore the site as much as possible and all surfaces shall be stabilized and protected to control landslides/subsidence, erosion, water pollution and human hazards.

The overall project planning shall include land reclamation operations including sufficient budget allocation. The environmental baseline data which has been collected prior to the project implementation will be valuable in the re-establishment of natural or agricultural ecosystem on the site once project is decommissioned. Prior to commencing removal of items of equipment, Cross River State Government shall ensure that the equipment has been approved for decommissioning by reviewing the Equipment Decommissioning Note.

Closure Outcomes/Completion Criteria

The expected closure outcomes for all site components are that: community and future generations are left with no residual liability for site rehabilitation and maintenance; public health and safety is not endangered; landscape function and vegetation is resilient, self-sustaining and comparable to the surrounding areas; and no increase in contamination level above baseline condition. The completion criteria for these are:

- *Government acceptance of project completion report which demonstrates achievement of all completion criteria.*
- *Audit shows if any remaining project infrastructure is left in a safe and secure manner, and discourages public access.*
- *Landscape and vegetation report undertaken and reported to show function is resilient, self-sustaining and comparable to the surrounding environment.*
- *Site contamination survey (conducted to relevant Nigerian standards) demonstrates no elevated level of selected contaminant.*

Handling of the Host Community

Closure of the project will have significant impact on the local community. This is likely to include:

- *Reduced purchasing power of the local people as a dependable source of income would have ceased to exist;*
- *A number of locally sourced employees will be laid off;*
- *Closure and/or relocation of businesses and services that were drawing clientele from the project; and*
- *Termination of certain services from the project operators to the community.*

In order to plan for the possible impacts, the company shall put the following measures in place well in advance of closure time:-

- *Transfer management of community services to the hands of locals at list six months in advance;*
- *Organise local people into responsible groups and train them on ways to manage community projects transferred to them; and*
- *Maintain certain aspects of the project that can attract revenue to the locality.*

9.0 Conclusion

Based on the findings of the ESIA study the following conclusions can be made:

- *The aviation activities of the proposed Obudu Cargo and Passenger Airport shall have its threat to human lives & the general environment of the host communities reduced if operated within the recommended industry best practices.*
- *With the proposed Mitigation Measures in Chapter Six, the airport project associated potential impacts will be reduced on the general environment which is in line with the outcry from governments of most nations in the world for global environmental sustainability.*

- *The results from the assessment of the baseline ambient air, soil and water quality as well as noise level of the immediate environment of the proposed project conforms to the regulatory standard limits for healthy living condition.*
- *The proposed project has more beneficial impacts on the host community, Cross River State and the Nation at large than negative effects.*

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We at **Cross River State Government** wish to thank the Environmental Consultant – **Geo Environmental Resources Limited** for their commitment to the success of this project. We are proud to present this report and to partner with various stakeholders in ensuring sound Environmental Management and sustainability.

We have not forgotten the dedication and professionalism displayed by all throughout the execution of this project. More importantly, we say thank you for your depth of knowledge of the project requirements.

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CHAPTER ONE
INTRODUCTION

1.1 Background Information

For many decades, the aviation industry has played a significant role in developing economies around the globe. It is reported that there are over two thousand (2,000) airlines operating more than twenty-three thousand (23,000) aircraft that serves about three thousand seven hundred (3,700) airports around the world (Aerospace Global Report, 2011). This makes the industry the gateway to any economy aspiring to develop, enabling globalization, trade facilitation and tourism development. It is very crucial in the promotion of foreign direct investment (FDI) (Ladele, 2012). One can therefore say that the industry is crucial to the growth of the economy and national development. Ladele (2012).

Air transportation in Nigeria commenced during World War II (1939-1945) when it became necessary to move troops and supplies fast across the country. Several air strips were built then which were converted after the war, to civilian use (Ileoje, 2003). Nigerian Airways was established in October, 1958 as a Joint Venture between the Nigerian Government, Elder Dempster Lines and the British Overseas Airways Corporation (BOAC). The Airways took over the operation of domestic flights from the disbanded West African Airways Corporation (WAAC) which had been operating commercial aircraft within the country since 1946 (Filani, 1983). Statistics have shown that from the beginning of the Millennium 2000, there has been a rapid increase in air transportation in Nigeria. This is in the areas of number of departing/arriving passengers, loaded freight, and arriving aircrafts. Presently there are eight (8) International Airports at Abuja, Calabar, Enugu, Lagos, Kano, Maiduguri, Port Harcourt and Sokoto. Besides these, there are a number of other domestic airports across the country.

1.2 Project Proponent

Cross River State government is the proponent of the proposed Obudu Cargo and Passenger Airport. The State government is desirous of setting up the Obudu Cargo and Passenger Airport to boost the State economy by increasing its internally generated revenue, create jobs for the teaming unemployed youths in the State, establish a transportation link between farmers in the State and the market, enhance the States' tourism and make it more accessible to both local and international tourists etc.

In compliance with the Nigerian Federal Ministry of Environment's Environmental Impact Assessment Act (No. 86 of 1992) (i.e CAP E12 LFN, 2004), Cross River State government is prepared to carry out an Environmental and Social Impact Assessment (ESIA) study for the construction of its proposed Obudu Cargo and Passenger Airport hereinafter referred to as OCPA project.

1.3 Environmental and Social Impact Assessment (ESIA)

All prospective projects are required by law to undergo Environmental and Social Impact Assessment (ESIA)/Environmental Impact Assessment (EIA) before its eventual commencement, having been certified to continue by relevant government regulatory authorities. An ESIA is important because, for instance, a prospective project that is technically and economically feasible may not necessarily be ecologically or socially acceptable depending on many prevailing factors resulting from human and/or natural consequences.

The need to carry out a detailed Environmental and Social Impact Assessment (ESIA) of the proposed OCPA project is therefore, to establish a thorough scientific investigation(s) of environmental quality indicators (air, water, soil, biodiversity etc.), the possible impacts to expect and the environmental and social management plan, as well as mitigation measures to be applied to reduce adverse environmental and social impacts during the project's construction, operation and decommissioning stages.

The overall process of project-level Environmental and Social Impact Assessment (ESIA) encompasses all aspects of environmental and social assessment. The activities fall into three major phases, namely pre-study, ESIA study and post-study. The three major activities in the ESIA pre-study phase include screening, scoping and baseline studies. The screening process serves as a tool for determining whether or not an ESIA should be undertaken, while scoping involves the identification and narrowing down of potential adverse environmental impacts so that ESIA focuses on those that are likely to be significant. The role of the baseline studies on the other hand, is to direct the collection of background information and data on the physical environment and socio-economic setting of the proposed project.

The study phase is the central part of the overall ESIA process. The activities in the ESIA study comprise identification, prediction, mitigation and evaluation (assessment) of environmental impacts resulting from proposed development projects. Another component of the ESIA study is comparison of results or alternatives.

The post study phase steps are made up of inter-related activities which are constituent parts of the Environmental and Social Management Plan (ESMP). The major concern of the ESMP is mitigation via environmental monitoring, audits and institutional measures which are important aspects of ESIA preparation and implementation.

The setting up of OCPA project in Obudu Local Government Area, Cross River State by the State government will involve a range of construction/rehabilitation of critical infrastructure, economic support activities, civil works, land use planning, water resources development and management, policy and regulatory reform, social and environmental impact analysis among others.

1.4 ESIA Objectives

The aim of the ESIA study for the proposed project is to proactively evaluate the potential environmental (including health and socio-economic) impacts of the proposed development. This is to ensure that the planned activities exert minimal and reversible impacts on the environment and nearby communities. Therefore, the ESIA seeks to:

a) identify and evaluate the potential socio-economic effects of the project on the communities including impacts on cultural properties, social infrastructures and natural resources;
b) establish the baseline condition of the environment;
c) assess the potential environmental, social and health impacts of the project on the biophysical, social and health components of the environment;
d) provide appropriate mitigation measures for negative impacts and make recommendations aimed at sustaining/enhancing the beneficial impacts of the projects on the environment;
e) determine and document the sources of impact from the project activities and identify the environmental, social and health components which are critical to the impacts; and
f) develop a time bound cost effective Environmental & Social Management Plan (ESMP) for the project.

1.5 Terms of Reference of the Project

As contained in the Terms of Reference (ToR) for the preparation of a comprehensive Environmental and Social Impact Assessment (ESIA) report for the OCPA project given by Cross River State Government the study will address the potential environmental impacts associated with proposed project. These potential impacts will be assessed through, but not limited to the following:

i. Soil contamination studies;
ii. Hydrological investigation;
iii. Meteorological/weather investigation of site;
iv. Noise studies (both Baseline and Operational) – impacts of noise and air quality;
v. Environmental and Social Impact Assessment (ESIA) – Impacts on ecology, fauna and floral, impacts on heritage sites, impacts on visual quality and aesthetics, impacts on the social environment.

In addition, these specialist studies are to be undertaken in two phases:

i. A desktop scoping study, wherein potential issues associated with all alternatives identified are evaluated and the preferred alternative nominated for consideration in the ESIA phase.
ii. A detailed assessment of potentially significant impacts associated with nominated preferred alternative identified in the scoping phase. Practical and achievable mitigation measures recommended in order to minimize potentially significant impacts identified. These recommendations are to be included within the draft Environmental and Social Management Plan (ESMP).

Sequel to the above and in consonance with the laws and regulations operational in Nigeria, below is a well-structured TOR adopted for this study.

(A) Establish the baseline for the existing environmental conditions of the project area. The baseline environmental data for the project area shall involve field surveys to determine current status of environmental components including (air, water, and soil quality as well as noise level and biodiversity.

(i) Air Quality

Ambient air quality and pollution trends in terms of (SO_2, CO_2, NO_2, NO, NH_3, H_2S, SPM, O_2, CO, etc)

- Noise level - Noise level determination in (dB).

(ii) Water Quality

- Assessment of physical, chemical and biological analysis of both surface and ground water.

(iii) Soil Quality

- Soil - (Physical, chemical and biological analysis).
- Soil erosion and channel erosion sites.
- Auger and profile samples to be taken to determine morphological, physical and chemical properties.
- Assessment of geomorphic features.

(iv) Biodiversity/Ecological Studies

- To determine ecological species including composition, density, general biodiversity etc.

(B) Waste Management

- Identify current waste management system of the project area.
- Assess the likely waste type/classes from the proposed project
- Forecast proposed project waste quantification
- Compile a comprehensive waste management handling and disposal system

(C) With the aid of concise climatic data, describe the general climatic pattern of the project area particularly in terms of wind speed & direction, temperature, humidity, rainfall etc.

(D) Study and present study area data/details on topography, geomorphology, geology, natural hazard, drainage pattern, hydrology, and hydrogeology, land use pattern, cropping pattern etc. Data will be supported by relevant maps where applicable.

(E) Present details of environment sensitives such as ecology, water bodies, defense, habitation, industries, major transportation media (road, rail etc.) wetlands, natural hazards, archeological, religious, tourism and historical monuments/places etc. 10 km radius of the surrounding project site.

(F) Present details of demography, occupational pattern, general amenities, cropping pattern, practices used for agriculture & irrigation specific to the project area.

(G) Carryout a thorough and comprehensive stakeholder's workshop/public consultation as part of socio-economic assessment.

(H) Carryout door to door survey for the assessment of the socio-economic assessment of the project area with a target of not more than 250 households.

(I) Focus group discussions shall also be carried out for different groups (men, women, youths, and elderly) within the community.

(J) Identify and rank all project associated impacts for the pre-construction, construction, operation, and decommissioning phases of the project.

(K) Develop control strategies with a view to mitigate and ameliorate project potential and associated impacts.

(L) Recommend measures to increase the benefits derivable from the project.

(M) Estimate and describe the nature and likelihood of environmental damage and incidents and thus, provide a basis for contingence planning.

(N) Provide a comprehensive Environmental and Social Management Plan (ESMP): The ESMP shall contain, among other things, the following:
-The environmental objectives and commitments
-The means by which these will be achieved
-The responsibilities/accountabilities
-The corrective actions which will be employed should the needs arise
-Review schedules and criteria

1.6 ESIA Methodology

This study involved site identification, literature review, field data gathering, impact identification and evaluation, proffering of mitigative measures and development of an ESMP.

1.6.1 Reconnaissance Survey and Site Identification

i) Reconnaissance Survey

A reconnaissance survey was undertaken to familiarize the ESIA Team with the proposed project area. This helped in the concept design of field research execution.

ii) Site Identification

Maps, photographs, GPS locations were used to generate relevant information on the OCPA project location. This information generated enabled the delineation of the area studied.

1.6.2 Fieldwork Activities/Research

Fieldwork research was used to complement and verify information gathered from desk studies/research. It was also carried out in line with methods specified in (FMEnv) ESIA Procedural Guidelines. This was used to determine the specific baseline ecological, social and health conditions of the project environment.

1.6.3 Environmental and Social Impact Assessment Methodologies

Standards and recommended environmental assessment methodologies were used to identify potential impacts (Leopold Matrix) and to evaluate such impacts (Peterson Matrix). ISO 14001 procedures was also used to identify significant impacts associated with the project activities. Other impact evaluation methodology that are applicable, verifiable, specific and quantifiable, were used while the overall assessment was carried out through the use of the 'Strength of Relationship Matrix Approach' method and other methods that defines numerically the degree of interdependence of the various environmental parameters.

Environmental and Social Impact Assessment report is one of the management tools used today to control environmental pollution activities. It is a management tool comprising a systematic, documented, objective evaluation directed at proposed projects. The objective is to establish a comprehensive assessment of the environmental and human framework in this area together with trends in and pressures on these factors. The assessment, amongst other things, is expected to assemble, evaluate and present real time data on the environmental and social characteristics of the project area.

1.6.4 Literature Review

This involved studying existing literature particularly, reports of previous Federal Ministry of Environment approved ESIA studies and other relevant studies on the environmental characteristics of the study area. Materials to be reviewed include textbooks, reports, survey maps, aerial photographs, articles and other international journals. This will be used to establish environmental database for the ESIA.

1.6.5 Field Data Gathering

A field data gathering exercise was carried out to fill the information gap identified from literature review and also to validate existing information. It entailed visual observation, on-site measurements and collection of samples for laboratory analysis/testing, the laboratory work was handled by Labchemnec Jans Limited (an accredited laboratory with the Federal Ministry of Environment with its head office located at No. 5 Port-Loko Street, Wuse Zone 3, Abuja) our affiliate laboratory. A multi-disciplinary team of experts (Aviation experts, Socio-economists, Taxonomists, Chemists, Environmental

Scientists, GIS analysts and Geographers) were involved in the fieldwork carried out from 23rd to 26th July, 2019 for wet season, and 20th to 23rd January, 2020 for dry season.

1.6.6 Impact Identification and Evaluation

The environmental aspect of the project that may interact positively and negatively with the environment at the pre-operation, operation and decommissioning phases were identified. This identification was based on the knowledge of the project, Federal Ministry of Environment ESIA Sectoral Guidelines and World Bank Environment Guidelines while associated and potential impacts was evaluated using the ISO 14001-Environmental Management System approach.

1.6.7 Mitigation/Ameliorative Measures

The identified adverse impacts had mitigation proffered based on scientific conclusions and professional judgments in-line with safety, health and environment standards and codes (for design, operation and decommissioning/abandonment) as well as the recommended practices by the Federal Ministry of Environment (FMEnv), United Nations Guidelines and Standards, etc.

1.6.8 ESIA Study Consultation Programme (Consultation with Stakeholders and Experts)

Consultations shall be carried out throughout the project lifespan with all stakeholders to ensure that their views and opinions concerning the proposed project are integrated into the ESIA process. The stakeholders include the following:

- Federal Ministry of Environment (FMEnv)
- Federal Ministry of Aviation (FMA)
- Nigerian Civil Aviation Authority (NCAA)
- Nigerian Airspace Management Agency (NAMA)
- Federal Aviation Authority of Nigeria (FAAN)
- Cross River State Ministry of Environment
- Cross River State Environmental Protection Board
- Obudu Local Government Council
- Project Affected Communities/Project Affected Persons (PAPs)
- Community Based Organizations etc.

The first consultation programme which is the scoping workshop was held on the 11th – 12th of April, 2019 in Obudu LGA with representatives of the stakeholders listed above in attendance.

1.7 Legal and Administrative Framework

The Federal Government of Nigeria established the Federal Ministry of Environment from the defunct FEPA with an overall mandate to protect, restore and preserve all ecosystem of the Nigerian environment. Twenty-one guidelines for pollution abatement in all categories of industries were laid. Part of the guidelines is a mandatory requirement for environmental auditing of all existing industries and Environmental and Social Impact Assessment (ESIA) of new industries and major development projects. Today, The Federal Ministry of Environment is in the forefront of implementing the Nigerian policy on the environment coupled with some assistance from environmental friendly organizations and non-governmental organizations, especially in creating the awareness for environmental consciousness.

In order to show its readiness to ensure compliance, the Federal Government has in July 2007 released an official gazette establishing the National Environmental Standards and Regulations Enforcement Agency (Establishment) Act, 2007. The agency is charged with the enforcement of environmental standards, regulations, rules, laws, policies and guidelines. Above all the agency has been saddled with the huge responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources in general and environmental technology, including coordination and liaison with relevant stakeholders within and outside Nigeria on matters of enforcement of environmental standards, regulations, rules, laws, policies and guidelines.

In order to achieve sustainable development and live in harmony with nature, environmental protection and control has now become an integral part of laws/regulations/policies promulgated at international, national and state/local government levels. Also, responsible corporate organizations formulate policies that enable them establish and operate sound environmental management systems. The relevant policies, regulations, laws and guidelines that affect airport operations are highlighted below:

1.7.1 National Legislation

Relevant national environmental policies, laws, regulations and guidelines are reviewed to establish their applications and their requirements to the proposed project with the overall objective of ensuring regulatory compliance. Amongst the legislation that were reviewed are:

1.7.1.1 Environmental Impact Assessment Act No 86 of 1992 (CAP E12 LFN 2004)

Environmental Impact Assessment (EIA)/Environmental and Social Impact Assessment (ESIA) is an assessment of the potential impacts whether positive or negative, of a proposed project on the natural environment: The EIA/ESIA Act, as it is informally called, deals with the considerations of environmental impact in respect of public and private projects. Sections relevant to environmental emergency prevention under the ESIA include:-

- 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 Agency before embarking on projects for their environmental impact assessment to determine approval.
- Section 13 establishes cases where an ESIA is required and

- Section 60 creates a legal liability for contravention of any provision

By and large, the environmental management activities at each phase of the project should be guided by environmental standards including those posed by legislation and those established by self-regulating industrial codes of practice, industry standards and company policy.

Recently, FMEnv developed a National EIA/ESIA procedure 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 in order to ensure that the project is implemented with maximum consideration for the environment. This is presented in Figure 1.1.

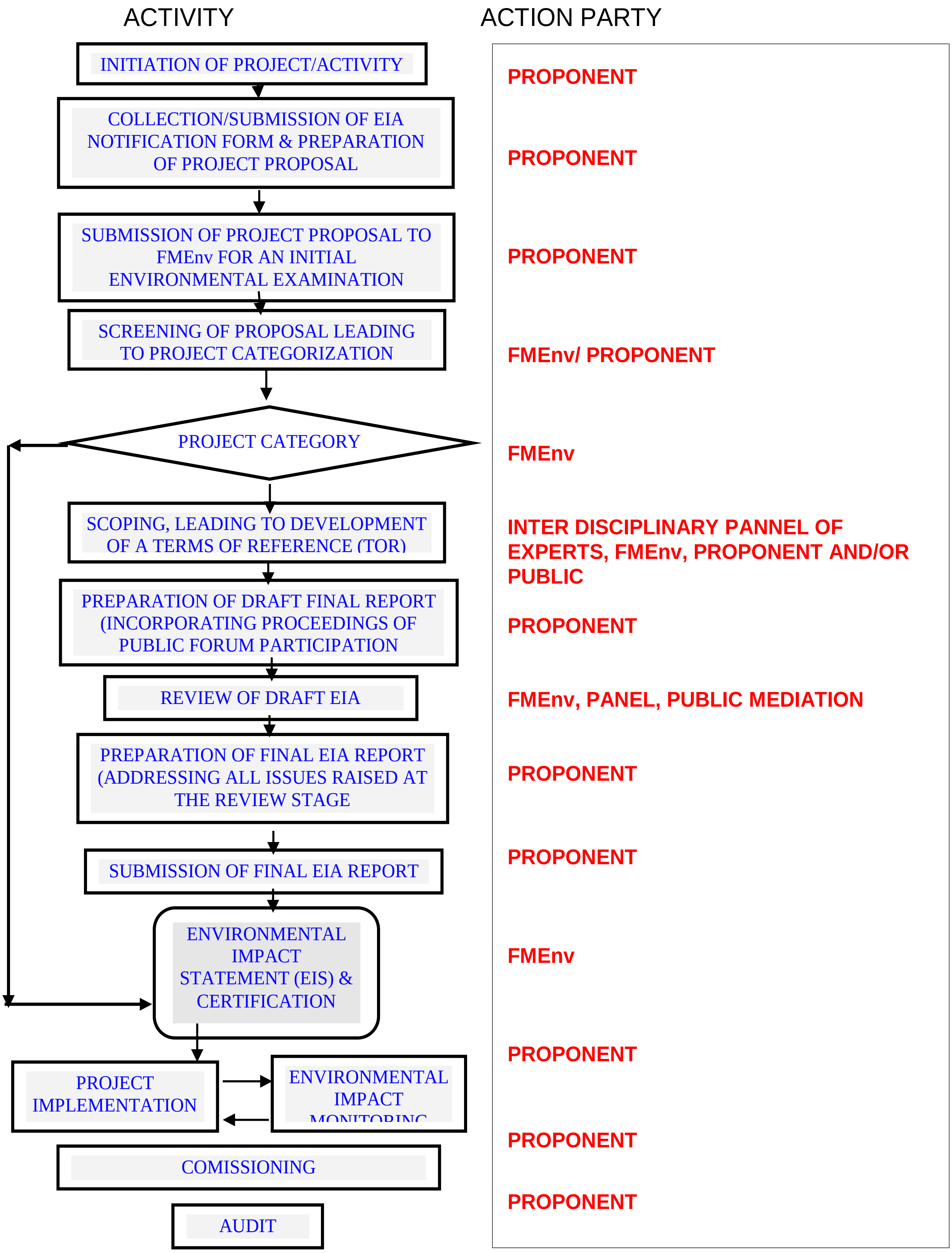

Figure 1.1: The FMEnv EIA/ESIA Process (adapted from FMEnv Green book)

1.7.1.2 Federal Airport Authority of Nigeria (FAAN) Act 1996 Cap F5

The principal functions of the authority shall be:

a) To develop, provide and maintain at Airport and within the Nigeria airspace all necessary services and facilities for the safe, orderly, expeditious and economic operation of air transport.

b) To provide adequate conditions under which passengers and goods may be carried by air and under which aircraft may be used for other gainful purposes and for profitability the carriage by air of goods of such closes as may be prescribed.

c) To prohibit the installation of any structure which by virtue of its high position is considered to endanger the safety of air navigation;

d) To charge for services provided by the authority at airports;

e) To provide accommodation and other facilities for the effective handling of passenger and freight.

f) To develop and provide facilities for surface transport within airports,

g) To carry out at airports (either by itself or by an agent or in partnership with any other person) such economic activities as are relevant to air transport.

h) To carry out airports (either by itself or by an agent or in partnership with any other person) such other commercial activities which are not relevant to air transport but which is in the opinion of the Authority may be conveniently carried out without prejudice to the functions specified in this subsection.

i) To provide adequate facilities and personnel for effective security at all airports; and

j) Generally to create conditions for the development in the most economic and efficient manner of air transport and the services connected with it.

k) Without prejudice to subsection 3 of section 1, the Authority may assume the management of any airport in Nigeria in addition to those transferred to it under this Act, but the Authority shall not exercise the power herein described without the consent in writing of the Minister.

1.7.1.3 Nigerian Civil Aviation Authority (NCAA) Repeat and Re-enactment Act 2006

The principal functions of the authority shall be:

a) To ensure that operators and service providers perform their business within mandatory limits of the ICAO standards and recommend practices.

b) To set Aircraft safety standards and ensure compliance with the Nigerian Civil Aviation Regulations (NCARs).

c) To ensure aviation safety and effective oversight functions through efficient surveillance and adequate licensing of technical personnel and ATO.

d) To ensure safety and security in all Nigerian Aeradional in consonance with the relevant standards and recommended practices of ICAO Annexes.

e) To oversee the regulation and safety of aircraft operating environment, including Air traffic control (ATC), communication Navigation and surveillance (CNS) standards as well as the planning, design and maintenance of physical structuring and airport ground handling operations airsides across the country.

f) These include the terminal and landside access at airports, airstrips and other aviation ground facilities from the planning up to the operational stage.

g) Set and issue guidelines for the establishment and registration of foreign airlines, cargo consolidators and handling companies and

h) Process applications for the establishment and registration of Aviation Training Institutions, Travel Agencies, Agents Foreign Airlines, Cargo Consolidators and Handling Companies.

i) Make technical inputs to Bilateral and Multilateral Air services Agreements (BASA/MASA) and commercial agreements etc signed by the Federal Government of Nigeria,

j) Liaise with the Ministry of Aviation on the issues of international organizations and cooperation.

k) Make technical inputs to the issue of tariff, francs and royalties, regarding international operations; and

l) Process applications for international charter operations by foreign airlines.

m) To ensure that only medically fit Aircrews and Air Traffic controllers (ATCO's) are licensed to operate in the Nigerian airspace in line with ICAO Annex.

1.7.1.4 Nigerian Civil Aviation Regulations 2006 Part 2

General information includes the following:

a) Purpose and scope of Aerodrome manual;

b) Conditions for use of a public/private aerodromes; a statement to indicate that the aerodrome shall at all times, when it is available to for the take-off and landing of aircraft, be also available to all persons on equal terms and conditions.

c) The available aeronautical information system is and procedures for its promulgation.

d) Obligations of the Aerodrome operator to the Authority including granting authorized personnel, access to the aerodrome to carry out safety audit inspection, testing and to be responsible for notifying/reporting as prescribed in the Regulation.

1.7.1.5 Nigerian Civil Aviation Regulations 2006 Part 12: Particulars of the Aerodrome Site

General information includes the following:

a) A plan of the aerodrome showing the main aerodrome facilities for the operation of the aerodrome including, particularly, the location of each wind direction indication;

b) A plan of the aerodrome showing the aerodrome boundaries;

c) A plan showing the distance of the aerodrome from the nearest city, town or other populous cores, and the locations of any aerodrome facilities and equipment outside the boundaries of the aerodrome; and

d) Particulars of the title of the aerodrome site. If the boundaries of the aerodrome are not defined in the title documents particulars of the title to, or interest in, the property in which the aerodrome is located and a plan showing the boundaries of the position of the aerodromes.

1.7.1.6 The Civil Aviation Act, 2006

Nigerian Civil Aviation Authority is the regulatory body for aviation in the country. It became autonomous with the passing into law of the Civil Aviation Act 2006 by the National Assembly and assent of the president. The Act not only empowers the Authority to regulate aviation safety without political interference, but also to carry out oversight functions of airports, airspace, meteorological Services, etc., as well as economic regulations of the industry.

1.7.1.7 National Environmental (Construction Sector) Regulations, 2010. S.I. 19

The purpose of this regulation is to prevent and minimize pollution from construction, decommissioning and demolition project activities to the Nigerian environment.

1.7.1.8 Standards Organisation of Nigeria Act, 2015

This act saddles the organisation with the responsibility of evaluating quality assurance activities, including certification of systems, products and laboratories throughout

Nigeria. The Organisation is to establish an Import and Export Product Surveillance, Certification and Conformity Assessment Scheme to ensure that all products imported and exported are up to the expected standards. It also establishes a mandatory conformity assessment programme for locally manufactured products in Nigeria. The Organisation is also empowered to impose fees, fines or penalties on a person who contravenes any Import or Export Surveillance, Certification or Conformity Assessment Scheme.

1.7.1.9 National Effluent Limitation Regulations, S.I. 8 of 1991

The National Environmental Protection (Effluent Limitation) Regulations, S.I. 8 of 1991 (No. 42, Vol. 78, August, 1991) makes it mandatory for industries and facilities generating waste to install anti-pollution and pollution abatement equipment on site. The regulation is specific for each category of waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem. Appropriate penalties for contravention are also prescribed. The requirements of this regulations will be considered for early section of effluent treatment plant (ETP) to be installed for the proposed project.

1.7.1.10 Pollution Abatement in Industries and Facilities Generating Wastes Regulations S.I. 9 of 1991

The National Environmental Protection (Pollution Abatement in Industries and Factories generating Wastes) Regulations, S.I. 9 of 1991 (No. 42, Vol. 78, August, 1991) imposes restrictions on the release of toxic substances and stipulates requirements for pollution monitoring units, machinery for combating pollution and contingency plan by industries; submission of lists and details of chemicals used by industries to Federal Ministry of Environment (FMEnv); requirement of permit by industries for the storage and transportation of harmful or toxic waste; the generator's (or the proponent's) liability; strategies for waste reduction; permissible limits of discharge into public drains; protection of workers and safety requirements; environmental audit (or environmental impact assessment for new industries) and penalty for contravention.

1.7.1.11 Management of Hazardous and Solid Wastes Regulations, S.I. 15 of 1991

The National Environmental Protection (Management of Hazardous and Solid Waste) Regulations, S.I. 15 of 1991 (No. 102, Vol. 78, August, 1991) defines the requirements for groundwater protection, surface impoundment, land treatment, waste piles, landfills, incinerators etc. It also describes the hazardous substances tracking program with a comprehensive list of acutely hazardous chemical products and dangerous waste constituents. It also states the requirements and procedure for inspection, enforcement and penalty.

1.7.1.12 National Guidelines and Standards for Environmental Pollution Control in Nigeria (1991)

This document was promulgated in March 1991 to serve as a basic instrument for monitoring and controlling both industrial and urban pollution. These guidelines were initiated sequel to the promulgation of the National Environmental Policy in 1989. The guidelines and standards relates to:

- o Effluent limitations.
- o Industrial emission limitations.
- o Noise exposure limitations.
- o Management of solid and hazardous wastes.

1.7.1.13 Department of Climate Change 2011

This is the newest of the eight technical departments of the Federal Ministry of Environment. It was upgraded from Special Climate Change Unit (SCCU) in December 2011 to demonstrate government's commitment to introducing and implementing adaptation and mitigation measures necessary to reduce vulnerability to climate change. The ESIA shall assess the climate change potential of the proposed project.

1.7.1.14 Forestry Law CAP 51 LFN 1994

This law provides for the preservation of forests and the setting up of forest reserves. It is an offense, punishable with up to 6 months imprisonment, to cut down trees over 2ft in girth or to set fire to the forest except under special circumstances.

1.7.1.15 Criminal code

The Nigerian Criminal Code makes it an offence punishable with up to 6 months imprisonment for any person who;

- o Violates the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carry on business in the neighbourhood, or passing along a public way; or
- o 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.

1.7.1.16 Land Use Act CAP 202 LFN 1990

The Act makes it public interest that the rights of all Nigerians to use and enjoy land in Nigeria and the natural fruits thereof in sufficient quantity to enable them to provide for the sustenance of themselves and their families be assured, protected and preserved.

1.7.1.17 Harmful Waste (Special Criminal Provisions etc.) Act CAP 165 LFN 1990

The Harmful Waste Act prohibits, without lawful authority, the carrying, dumping or depositing of harmful waste in the air, land or waters of Nigeria.

The following sections are notable:

- o Section 6 provides for a punishment of life imprisonment for offenders as well as the forfeiture of land or anything used to commit the offence.
- o Section 7 makes provision for the punishment accordingly, of any conniving, consenting or negligent officer where the offence is committed by a company.
- o Section 12 defines the civil liability of any offender. He would be liable to persons who have suffered injury as a result of his offending act.

1.7.1.18 Water Resources Act, CAP W2, LFN 2004

The Water Resources Act is targeted at developing and improving the quantity and quality of water resources. The following sections are pertinent: Section 5 and 6 provides authority to make pollution prevention plans and regulations for the protection of fisheries, flora and fauna. Section 18 makes offenders liable, under this Act, to be punished with a fine not exceeding N2000 or an imprisonment term of six months. He would also pay an additional fine of N100 for everyday the offence continues.

1.7.1.19 Endangered Species Act, CAP E9, LFN 2004

This Act focuses on the protection and management of Nigeria's wildlife and some of their species in danger of extinction as a result of over exploitation. These sections are noteworthy:

- Section 1 prohibits, except under a valid license, the hunting, capture or trade in animal species, either presently or likely being in danger of extinction.
- Section 5 defines the liability of any offender under this Act.
- Section 7 provides for regulations to be made necessary for environmental prevention and control as regards the purposes of this Act.

1.7.2 State Legislation

Section 20 of the 1999 constitution of the Federal Republic of Nigeria, states that, "The State shall protect and improve the environment and safeguard the water, air and land, forest and wild life of Nigeria". Furthermore, the ESIA Act No. 86 of 1992 recommends the setting up of state environmental agencies to support the efforts of the FMEnv in regulating the consequences of project development on their environment.

1.7.2.1 Cross River State Ministry of Environment

The Cross River State Ministry of Environment was established in accordance with the provisions of Section 24 of the FMEnv (former FEPA) Act 58 of 1988. The Cross River State Environment and Development Planning Authority have the responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of natural resources in the State.

The relevant list of Cross River State Forestry, Biodiversity and Conservation Legislation are shown below;

1. Law for the preservation and control of forests in Eastern Nigeria CAP 55, 1956 (E.R.N. 41 of 1955, 5 of 1957, 3 of 1958, E.N.L.N. 79 of 1961 1955)
2. Cross River State Forest Law Cap. 55
3. Wild Animal Preservation Ordinance Cap. 99
4. Wild Animal Preservation Law Cap.127 of 1916
5. Cross River State Wild Animal Preservation Law CAP. 127
6. Wild Animals Laws (Eastern Nigeria), 1965
7. Cross River State Forestry Commission Law No. 3, 2010

1.7.2.2 Cross River State Urban Development Authority

Edict No. 4 of 1990 established the Cross River State Urban Development Authority, and Bill No. 8 of 2000 amended this edict to reflect that the body holds the responsibility to manage:

- Refuse collection and evacuation;
- Sweeping of the streets and roadways;
- Mowing of grasses in publicly owned parks and open spaces and roadway verges.

The Authority also plants ornamental trees and shrubs along the city streets and highways, conducts house-to-house inspection to ensure the sanitary condition of residential, commercial and industrial areas. The Authority also embarks on public awareness campaign to educate and inform the residents on the essence of good sanitation habits and enforce the urban sanitation laws.

1.7.2.3 Cross River State Environmental Protection Agency Cap E5, 1996

The Edict establishing the Cross River State Environmental Protection Agency was signed into law in April 1996. The Edict spells out clearly the functions of the Agency, the authority of the Agency, and acts that are prohibited within the State together with associated penalties for flouting such prohibitions. The functions of the Agency that are relevant to this present study include:

i) To prepare and update periodic master plans for the development of environmental science and technology and advise the Government on the material and financial requirements for the implementation of such plans;
ii) To initiate and promote policies, programmes and research for the development of environmental science and technology;
iii) To liaise routinely and ensure effective harmonization with the Federal Environmental Protection Agency in order to achieve the objective of the National Policy on environmental protection and conservation;
iv) To co-ordinate the activities of ministries, parastatals, local government councils, departments, statutory bodies and research organizations on matters relating to environmental protection and conservation;
v) To identify the ecological problems of the State including the devastating erosion and flood, brief the Government on their causes and effects and find solutions to them;
vi) To establish mechanisms to prevent ecological disasters, identify the problems of drainage and sewage systems and carry out measures to improve, protect and remedy their ecosystems;
vii) To monitor and determine degradations of coastlines, river basins and estuaries and carry out measures to protect and remedy their ecosystems;
viii) To identify water, air and soil pollution and their sources and carry out measures to prevent them;
ix) To monitor the implementation of Environmental and Social Impact Assessment (ESIA);

x) Environmental Audit Report Guidelines and Procedures on all policies and projects within the State;
xi) To organize and carry out public enlightenment and environmental education for the protection and promotion of a healthy environment;
xii) To protect the general ecosystems including flora and fauna by the encouragement of proper agricultural practice and forest conservation; and
xiii) To carry out other activities that are necessary or expedient for the protection and sustainable development of the environment and for the full discharge of functions of the Agency.

1.7.2.4 Cross River State Environmental Sanitation Enforcement (urban area) law Cap E6

Law to provide for the Enforcement of Environmental Sanitation Laws within Urban Development Authority Areas in Cross River State and for other matters connected:

Appointment of sanitation officers

The Urban Development Authorities established by section 1 of the Urban Development Authority Law shall designate within their operational areas some of their officers of suitable grades as sanitation officers for the purpose of implementing this Law.

Functions of sanitation officer

The functions of a sanitation officer shall be –

i) To enforce the provisions of all laws relating to Environmental Sanitation within the area of the respective Urban Development Authorities; and
a) To carry out any other duties as may be directed by their respective Urban Development Authorities towards the maintenance of a clean and well developed Urban Environment.

1.7.3 Non-Governmental Organisations for the Conservation of Nature

There are some NGOs whose core mandate is the preservation/conservation of nature for the purpose fostering environmental sustainability. A few of these include:

1.7.3.1 Nature Conservation and Environmental Development Organization (NACEDO)

NACEDO is a non-profit, non-governmental organization established in 2001 in an effort to reduce wasteful exploitation and consumption of natural resources in Nigeria. In order to curb deforestation NACEDO promotes the planting of fast-growing, nitrogen-fixing trees species in Nigeria. NACEDO provides free training, aids, tree seeds, technical assistance and educational materials, vital for proper successful reforestation projects to farmers, individuals, groups, students, communities, organizations, governmental ministries, etc. NACEDO also empower the local dwellers to improve their own agricultural production by training farmers to adopt improve farming system and techniques. NACEDO shares and disseminate information and knowledge to the general public on sustainable use and conservation of bio-diversity.

1.7.3.2 The Wildlife Conservation Society

The Wildlife Conservation Society (WCS) was founded in 1895 as the New York Zoological Society (NYZS) and currently works to conserve more than two million square miles of wild places around the world. Today WCS is at work on some 500 projects in more than 60 nations around the world that are intended to help protect both wildlife and the wild places in which they live. The organization endeavours to protect 25 percent of the world's biodiversity - from the gorillas of Africa and the tigers of Asia to macaws in South America and the sharks, whales and turtles traveling through the planet's seas. In recent years WCS has actively worked in conflict areas like Afghanistan, South Sudan and Myanmar, where agreements on wildlife resource have contributed to peace and stability.

1.7.4 International Guidelines and Conventions

In addition to the national and state legislation, there are also international laws, conventions and agreements to which Nigeria subscribes that will be affected by the proposed development. The proposed OCPA project will be developed to comply with the relevant international laws. Among those that will be reviewed and incorporated into the ESIA include the following:

1.7.4.1 International Civil Aviation Authority (ICAO)

ICAO is a specialized agency of the United Nations created in 1944, with the signing of the convention in international civil Aviation, to promote the safe and orderly/development of the global air transport. ICAO has been in the forefront of aviation environmental issues since late 1960s. The organization's work on the environment focuses primarily on these problem that benefit most from a common and coordinated approach on a worldwide basis namely aircraft and engine emissions.

Standards and recommended practices (SACPs) for the certification of aircraft noise and aircraft engine emissions are covered by Annex 16 of the convention ICAO has a membership of 190 contracting states and works closely with others UN bodies and international organizations with an interest in aviation. ICAO has established three environmental goals to limit or reduce the number of people affected by significant aircraft noise; to limit or reduce the adverse impact of aviation emission on local air quality; and to limit or reduce the impact of aviation greenhouse gas emissions on the global climate.

ICAOs committee on Aviation Environmental Protection (CAEP) is a technical committee of the ICAO council and undertakes most of the organizations work in this area. It is the international forum of expertise for the study and development of proposals to minimize the impact of aviation on the environment. Every proposal in CAEP is analyzed according to four criteria: technical – feasibility, environmental benefit; economic reasonableness and in terms of the interrelationship between measures. The ICAO council receives and adopts the CAEP recommendations. It then reports to ICAO Assembly; the highest body of the organization; where the main policies on aviation environmental protection are defined and translated into Assembly

Resolutions. The organization also produces studies, reports, manuals and circulars on the subject of aviation and environment.

1.7.4.2 Montreal Protocol on Substances that Deplete the Ozone Layer

The protocol was adopted in 1987 as an international treaty to eliminate ozone depleting chemical production and consumption. The protocol also called on industrialized countries to provide technical and financial assistance to developing countries and hence led to the Multilateral Fund for the Implementation of Montreal Protocol (MFMP).

1.7.4.3 United Nations Convention on Climate Change

The convention on the climate change was signed in 1992 during the Rio Earth summit but put into force in 1994. The convention calls on developed countries and economies in transition to limit her emissions of the greenhouse gases which cause global warming, although it does not impose mandatory emissions on developing countries.

1.7.4.4 Convention to Regulate International Trade in Endangered Species of Fauna and Flora

This convention was signed into law in 1973 during the Washington summit and restricts the trade of fauna and flora species termed as endangered organisms.

1.7.4.5 Convention on Conservation of Migratory species of Wild Animals

This convention also known as the Bonn Convention of 1979 stipulates actions for the conversation and management of migratory species including habitat conservation.

1.7.4.6 Vienna Convention for the Protection of the Ozone Layer

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

1.7.4.7 International Labour Organisation (ILO) Health and Safety Laws

ILO standards on occupational safety and health provide essential tools for governments, employers, and workers to establish such practices and to provide for maximum safety at work. In 2003 the ILO adopted a global strategy to improve occupational safety and health which included the introduction of a preventive safety and health culture, the promotion and development of relevant instruments, and technical assistance. Having adopted more than 40 standards specifically dealing with occupational safety and health, as well as over 40 Codes of Practice with nearly half of the instruments dealing directly or indirectly with occupational safety and health issues, the ILO commits itself fully to fundamental principles of occupational safety and health. Below are some specific ILO international conventions on health and safety.

1.7.4.8 Occupational Safety and Health Convention, 1981 (No. 155)

The convention provides for the adoption of a coherent national occupational safety and health policy, as well as action to be taken by governments and within enterprises to promote occupational safety and health and to improve working conditions. This policy shall be developed by taking into consideration national conditions and practice. The Protocol calls for the establishment and the periodic review of requirements and procedures for the recording and notification of occupational accidents and diseases, and for the publication of related annual statistics.

1.7.4.9 Occupational Health Services Convention, 1985 (No. 161)

This convention provides for the establishment of enterprise-level occupational health services which are entrusted with essentially preventive functions and which are responsible for advising the employer, the workers and their representatives in the enterprise on maintaining a safe and healthy working environment.

1.7.4.10 Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187)

This Convention aims at promoting a preventative safety and health culture and progressively achieving a safe and healthy working environment. It requires ratifying States to develop, in consultation with the most representative organizations of employers and workers, a national policy, national system, and national programme on occupational safety and health. The national policy shall be developed in accordance with the principles of Article 4 of the Occupational Safety and Health Convention, 1981 (No. 155), and the national systems and programmes shall be developed taking into account the principles set out in relevant ILO instruments. A list of relevant instruments is contained in the Annex to the Promotional Framework for Occupational Safety and Health Recommendation, 2006 (No. 197). National systems shall provide the infrastructure for implementing national policy and programmes on occupational safety and health, such as laws and regulations, authorities or bodies, compliance mechanisms including systems of inspection, and arrangements at the level of the undertaking. National programmes shall include time-bound measures to promote occupational safety and health, enabling a measuring of progress.

1.7.4.11 Kyoto Protocol

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets. Recognizing that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities."

The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords." Its first commitment period started in 2008 and ended in 2012.

In Doha, Qatar, on 8 December 2012, the "Doha Amendment to the Kyoto Protocol" was adopted. The amendment includes:

- New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1st January 2013 to 31st December 2020;
- A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period; and
- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

On 21 December 2012, the amendment was circulated by the Secretary-General of the United Nations, acting in his capacity as depositary, to all parties to the Kyoto Protocol in accordance with Articles 20 and 21 of the Protocol.

1.7.4.12 World Bank OP/BP 4.01; Environmental Assessment (EA)

This is one of the Environmental and Social Safeguard Policies of the World Bank. It is used in the Bank to examine the potential environmental risks and benefits associated with Bank lending operations. Under OP/BP 4.01, Bank lending operations are broadly defined to include investment lending, sector lending, rehabilitation lending through financial intermediaries, and investment components of hybrid lending. Prototype Carbon Fund (PCF) and Global Environmental Facility (GEF) co-financed projects are also subject to the provisions of OP/BP 4.01.

Under this guideline, The Bank requires Environmental Assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. EA evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. The Bank favours preventive measures over mitigatory or compensatory measures, whenever feasible.

EA is initiated as early as possible in project processing and is integrated closely with the economic, financial, institutional, social, and technical analyses of a proposed project. The Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of EA. The Bank classifies the proposed project into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts.

Depending on the project, a range of instruments can be used to satisfy the Bank's EA requirement: environmental and social impact assessment (ESIA), regional or sectoral

EA, environmental audit, hazard or risk assessment, and environmental management plan (EMP). EA applies one or more of these instruments, or elements of them, as appropriate. When the project is likely to have sectoral or regional impacts, sectoral or regional EA is required. Other Banks guidelines and procedures that were considered in this study include the following:

- OP/BP 4.02, Environmental Action Plans;
- OP/BP 4.04, Natural Habitats;
- OP 4.07, Water Resources Management; and
- OP/BP 4.36, Forests;

1.7.4.13 International Finance Corporation (IFC) Performance Standards (PS)

IFC is a member of the World Bank Group which provides investment assistance to private sectors in developing countries. IFC applies its PSs to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. The PSs may also be applied by other financial institutions electing to apply them to projects in emerging markets. Out of the eight IFC's Performance Standards established to enable the clients ensure sustainability in projects throughout the life of an investment by IFC or other relevant financial institution, the following were considered in this ESIA:

Performance Standard 1: Social and Environmental Assessment and Management System

This PS underscores the importance of managing social and environmental performance throughout the life of a project (or business activity that is subject to assessment and management). An effective social and environmental management system is a dynamic, continuous process initiated by management and involving communication between the client, its workers, and the local communities directly affected by the project. Drawing on the elements of the established business management process of "plan, implement, check, and act," the system entails the thorough assessment of potential social and environmental impacts and risks from the early stages of project development, and provides order and consistency for mitigating and managing these on an on-going basis. A good management system appropriate to the size and nature of a project promotes sound and sustainable social and environmental performance, and can lead to improved financial, social and environmental project outcomes. PS1 has the following objectives:

- To identify and assess social and environment impacts, both adverse and beneficial, in the project's area of influence;
- To avoid, or where avoidance is not possible, minimize, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment;
- To ensure that affected communities are appropriately engaged on issues that could potentially affect them;
- To promote improved social and environment performance of companies through the effective use of management systems.

Performance Standard 2: Labour and Working Conditions

Performance Standard 2 recognizes that the pursuit of economic growth through employment creation and income generation should be balanced with protection for basic rights of workers. For any business, the workforce is a valuable asset, and a sound worker-management relationship is a key ingredient to the sustainability of the enterprise. Failure to establish and foster a sound worker management relationship can undermine worker commitment and retention, and can jeopardize a project. Conversely, through a constructive worker-management relationship, and by treating the workers fairly and providing them with safe and healthy working conditions, clients may create tangible benefits, such as enhancement of the efficiency and productivity of their operations.

Performance Standard 3: Pollution Prevention and Abatement

This PS recognizes that increased industrial activity and urbanization often generate increased levels of pollution to air, water, and land that may threaten people and the environment at the local, regional, and global level. On the other hand, along with international trade, pollution prevention and control technologies and practices have become more accessible and achievable in virtually all parts of the world. This Performance Standard outlines a project approach to pollution prevention and abatement in line with these internationally disseminated technologies and practices. In addition, this Performance Standard promotes the private sector's ability to integrate such technologies and practices as far as their use is technically and financially feasible and cost-effective in the context of a project that relies on commercially available skills and resources. The PS3 has the following objectives;

- ❖ To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;
- ❖ To promote the reduction of emissions that contributes to climate change.

Performance Standard 4: Community Health, Safety and Security

This PS recognizes that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development. However, projects can also increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failures, and releases of hazardous materials. Communities may also be affected by impacts on their natural resources, exposure to diseases, and the use of security personnel. While acknowledging the public authorities' role in promoting the health, safety and security of the public, this Performance Standard addresses the client's responsibility to avoid or minimize the risks and impacts to community health, safety and security that may arise from project activities. The level of risks and impacts described in this Performance Standard may be greater in projects located in conflict and post-conflict areas.

- ❖ To avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances;

- ❖ To ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.

Performance Standard 5: Land Acquisition and Involuntary Resettlement

Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or means of livelihood) as a result of project-related land acquisition. Resettlement is considered involuntary when affected individuals or communities do not have the right to refuse land acquisition that result in displacement. This occurs in cases of: (i) lawful expropriation or restrictions on land use based on eminent domain; and (ii) negotiated settlements in which the buyer can resort to expropriation or impose legal restrictions on land use if negotiations with the seller fail.

The objectives of this standard are:

- ❖ To avoid or at least minimize involuntary resettlement wherever feasible by exploring alternative project designs;
- ❖ To mitigate adverse social and economic impacts from land acquisition or restrictions on affected persons' use of land by: (i) providing compensation for loss of assets at replacement cost; and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected;
- ❖ To improve or at least restore the livelihoods and standards of living of displaced persons; and
- ❖ To improve living conditions among displaced persons through provision of adequate housing with security of tenure4 at resettlement sites.

Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management

This performance Standard recognizes that protecting and conserving biodiversity - the variety of life in all its forms, including genetic, species and ecosystem diversity - and its ability to change and evolve is fundamental to sustainable development. The components of biodiversity, as defined in the Convention on Biological Diversity, include ecosystems and habitats, species and communities, and genes and genomes, all of which have social, economic, cultural and scientific importance. This Performance Standard reflects the objectives of the Convention on Biological Diversity to conserve biological diversity and promote use of renewable natural resources in a sustainable manner. This Performance Standard addresses how clients can avoid or mitigate threats to biodiversity arising from their operations as well as sustainably manage renewable natural resources. PS 6 has the following objectives:

- ❖ To protect and conserve biodiversity; and
- ❖ To promote the sustainable management and use of natural resources through the adoption of practices that integrates conservation needs and development priorities.

Performance Standard 7: Indigenous People

This performance Standard recognizes that Indigenous People, as social groups with identities that are distinct from mainstream groups in national societies, are often among the most marginalized and vulnerable segment of the population. In many cases, their economic, social, and legal status limits their capacity to defend their rights to, and interests in, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development. Indigenous Peoples are particularly vulnerable if their lands and resources are transformed, encroached upon, or significantly degraded. Their languages, cultures, religions, spiritual beliefs, and institutions may also come under threat. As a consequence, Indigenous Peoples may be more vulnerable to the adverse impacts associated with project development than non-indigenous communities. This vulnerability may include loss of identity, culture, and natural resource-based livelihoods, as well as exposure to impoverishment and diseases. This Performance Standard has the following objectives:

- To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples;
- To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts;
- To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner;
- To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life-cycle;
- To ensure the Free, Prior, and Informed Consent (FPIC) of the affected communities of the Indigenous Peoples when the circumstances described in this Performance Standard are present; and
- To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.

Performance Standard 8: Cultural Heritage

This Performance Standard recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to protect irreplaceable cultural heritage and to guide clients on protecting cultural heritage in the course of their business operations. In addition, the requirements of this Performance Standard on a project's use of cultural heritage are based in part on standards set by the Convention on Biological Diversity. The objectives of this PS are as follows:

- To protect cultural heritage from the adverse impacts of project activities and support its preservation; and
- To promote the equitable sharing of benefits from the use of cultural heritage in business activities.

1.8 The Report Structure

The ESIA is structured into nine (9) chapters, viz:

1. Chapter one presents the introduction, study objectives, ESIA terms of reference, scope of work and methodology. It also provides information on the legal and administrative framework for the ESIA in Nigeria as applicable to the proposed project.
2. Chapter two examines the justification for the project and its alternatives.
3. Chapter three describes the technical details of the project. This includes the project processes, location, technological layout and project schedule.
4. Chapter four describes the methods adopted in environmental data acquisition, description of the physical, chemical, biological as well as socio-economic aspect of the proposed project site.
5. Chapter five highlights the impact assessment approach as well as the cumulative impact assessment and presents the potential and associated impacts of proposed development.
6. Chapter six presents the mitigation measures to be applied and highlight the beneficial impacts of the proposed activities.
7. Chapter seven provides the Environmental and Social Management Plan (ESMP) that shall be adopted throughout the project lifecycle. This includes environmental monitoring programme.
8. Chapter eight outlines the decommissioning and abandonment plans of the project.
9. Chapter nine highlights the key findings of the study and the conclusions. The list of the bibliography and appendices are included thereafter.

CHAPTER TWO
PROJECT JUSTIFICATION

2.1 Need for the Project

In Nigeria, demand for air transport service has been on the increase within the past three decades. Forecasting air passenger demand is of great importance for future developmental planning and management purposes. Infact, the Murtala Mohammed Airport (MMA), Lagos State and Port Harcourt Airport, Rivers State have had their runways increased few years back. As future air passenger demand increases, so does the need for investment in aviation infrastructure.

Cross River state has a functional airport in Calabar (Margaret Ekpo International Airport) which unfortunately is well over 200 km from the northern part of the state. This has partly affected patronage of tourist sites like the Obudu mountain resort as well as the many other tourist locations in the northern and central part of Cross River State. Asides from tourism, agricultural produce such as cocoa, oil plam, cassava, kolanut, maize, plaintain, banana, yam etc, are massively cultivated in the state especially in the northern part of the state covering local government areas including Yala, Ogoja, Bekawara, Obanliku and Obudu. To provide efficient transportation access, other than road, for tourism and agriculture, the government of Cross River State have proposed to set up the Obudu Cargo and Passenger Airport.

2.2 Project Benefits

On completion, the proposed project will bring about quite a number of socio-economic benefits. The project offers a number of benefits at the national and local community level. Some of the envisaged benefits are outlined below:

2.2.1 Creation of Jobs and Employment

Primarily, various jobs will be created at various stages of the proposed project. While jobs during pre-construction, construction and commissioning may be temporary, jobs during operation and maintenance will be more permanent.

2.2.2 Enhancement of Tourism

The tourist potentials of northern and central senatorial districts of Cross River State are very rich and diverse. Unfortunately, the distance of these sites from major airports as well as long bumpy road drives occasioned by roads which are in certain cases not in the best of condition, have greatly limited patronage of these tourist locations. The proposed OCPA project will help address this transport challenge to a very large extent and therefore boost tourism.

2.2.3 Improved Revenue Generation and Cash Flow

As a result of the planned project, there will be an overall increase in revenue generation at the local, state and national level. Various taxes and charges will be paid by passengers, freight and airline operators to the local, state and federal government, while personnel employed by the proposed OCPA project will earn salaries and emoluments, which will increase their purchasing power and lead to improved economic conditions within and around the project area.

2.2.4 Skill Acquisition and Technology Transfer

As part of project implementation, local personnel will be trained in the operation and maintenance of the proposed OCPA project, thus, this will lead to the acquisition of new skills by local technicians and engineers, and the eventual transfer of advanced technology. This will improve Nigeria's pool of skilled personnel and prompt development in the country.

2.2.5 Value Added Developments

As a result of the proposed OCPA project, several value added developments are likely to spring up in the immediate project area. Banks, schools, hospitals, recreational and hospitality facilities etc, will spring up among within and around the project area. In addition, other ancillary facilities that deal in materials that are routinely used in the civil construction sector, including stationeries, household items that are required by project workers, clients etc. will spring up and engender an economic boom within host communities.

2.3 Value of the Project

The total investment cost estimate for the proposed project works out to One Hundred Million United States Dollars (USD 100,000,000.00). The estimated Investment Cost for the project is based on the requirement of fixed and non-fixed assets.

2.4 Envisaged Sustainability

The envisaged sustainability of the proposed OCPA project is discussed under Technical sustainability, Social sustainability, Economic sustainability and Environmental sustainability.

2.4.1 Technical Sustainability

Cross River State Government have technically sustainable plan for operating the OCPA project. The use and adoption of Best Available Technology (BAT) in the design, construction and operational phases of the project will ensure technical sustainability of the proposed project. The OCPA project shall equally be managed by experienced experts who are well vast in the aviation technology. The installation of equipments will be done following internationally approved standards such that the proposed project not have much negative effect on the host community.

2.4.2 Social Sustainability

The proposed OCPA project will achieve social sustainability in that the project will not only provide employment for the indigenes of the host communities at the pre-construction, contruction and operation phase, but will create room for the training and retraining of the poject personnel. Furthermore, the proposed project will result in the provision of certain social infrastructures and amenities such as road, water, healthcare and educational support etc.

2.4.3 Economic Sustainability

Air travel in Nigeria is currently experiencing a boom owing to the bad nature of most of the federal roads in Nigeria as well as security concerns in the country. Investment in air transportation infrastructure, especially for an area with huge tourism potentials, will yield high return on investment for the government of Cross River State.

2.4.4 Environmental Sustainability

The project will be implemented and operated in accordance with guidelines and recommended best practices of the Federal Ministry of Environment (FMEnv), Federal Ministry of Aviation, and that of other international environmental organizations such as United Nations Environment Programme (UNEP), Intergovernmental Panel on Climate Change (IPCC), Global Environment Facility (GEF) and so on. The environmental aspects of the project shall be given accurate attention to ensure the environment is protected during the project implementation and operation. The integration of the findings and recommendations of this ESIA study into the various phases of the project will to a very large extent see to its environmental sustainability.

2.5 Project Options/Alternatives

The OCPA project is to be sited at the proposed location after due consideration of all environmental and social factors. However, three options were considered before a decision was reached on the implementation of this project, these options are:

2.5.1 No Project Option

This option implies that the proposed project should not be implemented. This option would be typically considered if the proposed project lacks benefits to society such that its negative impacts outweigh the benefits. Essentially, the proposed project is expected to contribute immense benefits particularly on socio-economic growth and other benefits outlined in **Section 2.2**.

Preliminary environmental assessment shows that the proposed project is most likely going to have significant environmental impact. Identified impacts which could be major, moderate or minor during pre-construction, construction, and operation phases can be effectively mitigated by proper environmental management plan. Hence, the No Project option was therefore considered non-favorable and disregarded.

2.5.2 Delayed Project Option

This alternative implies postponement of the implementation period of the proposed project. Delay of project implementation becomes necessary under certain circumstances such as; war, civil unrest, antagonistic public opinion, government policy, prevailing economic conditions, or other force majeure. Presently, none of these circumstances that would warrant the postponement of the proposed project exists. Preliminary planning activities for the proposed project including consultations with stakeholders during the scoping workshop held in Obudu show that the project is highly desirable. Any delay would result in several negative effects, including possible inflation in project implementation costs, which could render the project non-viable in the future.

2.5.3 Go Ahead Project Option

This option involves the implementation of the project as planned. Although preliminary environmental assessment indicates that there may be a number of adverse effects associated with various project phases, especially during construction and operation phases, these impacts are either major, moderate or minor, and with adequate mitigation and environmental management plans, these impacts can be further reduced, or completely eliminated. Therefore, the go-ahead project option, as planned, is the most attractive and is being adopted.

2.6 Project Alternatives

A number of alternatives have/are being considered alongside this proposed project. Some of the project alternatives contemplated as asides the proposed project include.

2.6.1 Donald Duke Airstrip

Donald Duke Airstrip formerly known as Bebi Airstrip is located in Bebi, Cross River State of Nigeria. The airstrip was established primarily to serve the Obudu mountain resort and is located at about 18 km east of Obudu town. By road, the Donald Duke airstrip is about 45 km from the Obudu mountain resort. A major reason why this infrastructure is not considered as a viable project alternative is the history of mishaps that are associated with the airstrip on account of poor air traffic control service, lack of international standard aviation safety equipments among other factors.

Plate 2.1: Donald Duke Airstrip

2.6.2 Calabar Airport

The Calabar airport also known as the Margaret Ekpo International airport is located in Calabar, the capital of Cross River State. The airport is well over 200 km by road from the northern part of Cross River State. Distance is therefore the major challenge in having the Calabar airport serve as a viable project alternative.

Plate 2.2: Margaret Ekpo International Airport, Calabar

2.6.3 Helipad

A helipad is a landing area or platform for helicopters and powered lift aircraft. This is yet another alternative for the proposed project. Infact it is the most cost effective option. However, it is unfortunately not suited as a viable alternative considering the fact that it cannot accommodate the targeted freight and passage volume anticipated.

Plate 2.3: A typical helipad

CHAPTER THREE
PROJECT DESCRIPTION

3.1 Projection Initiation

Cross River State Government proposes to set up a Passenger and Cargo Airport in Obudu Local Government Area (LGA) of Cross River State. The proposed airport is to be hosted by Atiekpe, Ikwomikwu, Okambi and Igwo communities on a land take of 1,842.316 Hectares.

The State government is desirous of setting up the proposed Obudu Cargo and Passenger Airport (OCPA) project to boost the State economy by increasing its internally generated revenue, create jobs for the teaming unemployed youths in the State, establish a transportation link between farmers in the State and the markets, enhance the States' tourism potentials and make it more accessible to both local and international tourists etc.

In fulfilment of the environmental standards and regulations in Nigeria, Cross River State Government commissioned the conduct of this **Environmental and Social Impact Assessment** (**ESIA**) study so as to be able to evaluate the prospective impacts of the project on the environment and people of the immediate communities and proffer mitigation measures for the identified negative impacts. Also, this study is aimed at establishing the baseline environmental and social data for the project area.

3.2 Project Size and Location

The proposed OCPA project traverses four (4) communities in Obudu Local Government Area of Cross River State within the geographic coordinates of 6^0 39' 32.4''N, 9^0 8' 40.8''E, 6^0 39' 43.3''N, 9^0 8' 35.2''E, 6^0 40' 8.9.4''N, 9^0 8' 28.5''E and 6^0 48' 56.4''N, 9^0 7' 21.6''E Below are the proposed airport project host communities.

- Atiekpe
- Ikwomikwu
- Okambi and
- Igwo

The proposed project will occupy a total land area of 1,842.316 hectares with a dimension of 3km by 5km. The landing/runway length spans 3.6km.

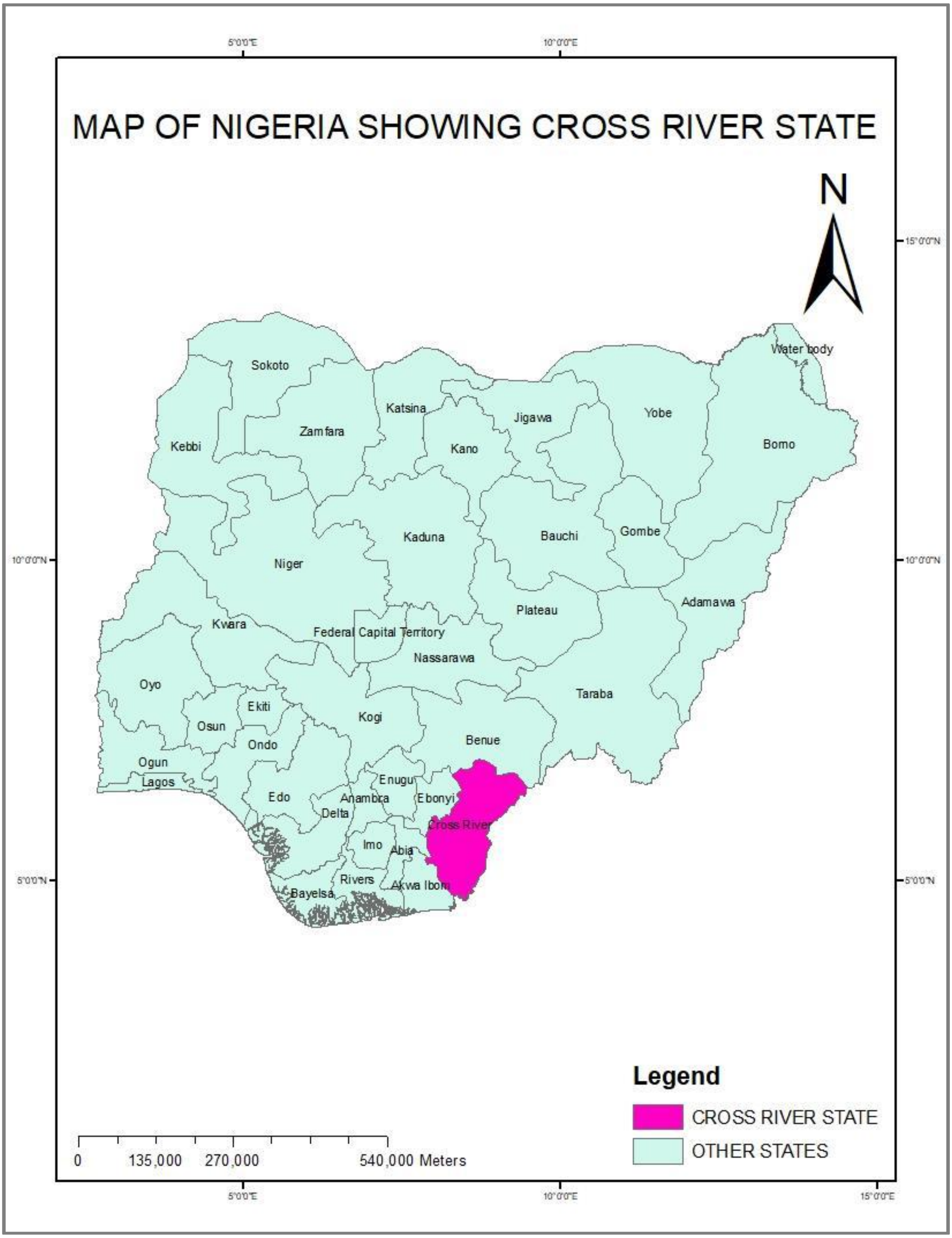

Figure 3.1: Administrative Map of Nigeria highlighting Cross River the Project Host State

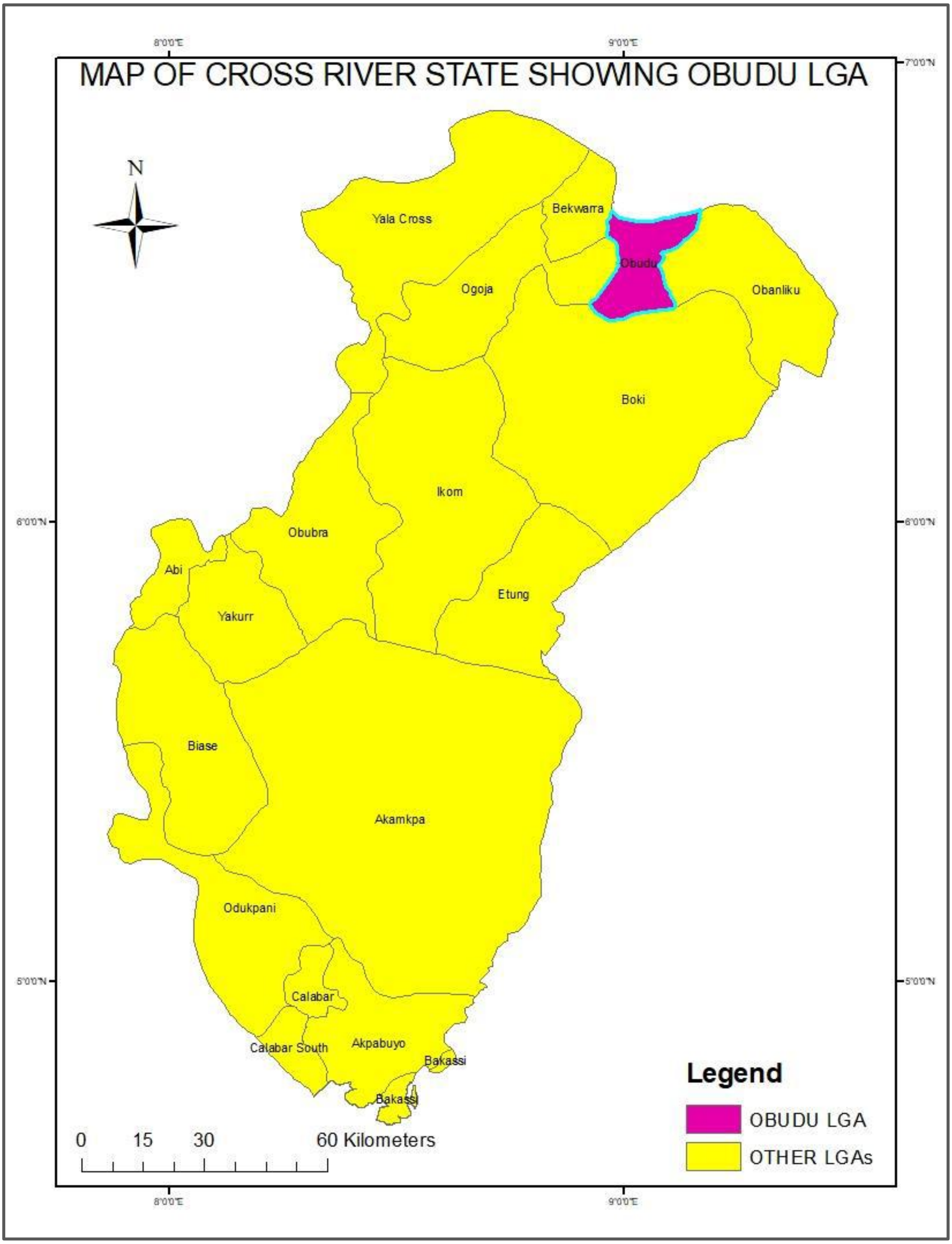

Figure 3.2: Administrative Map of Cross River State showing Obudu LGA

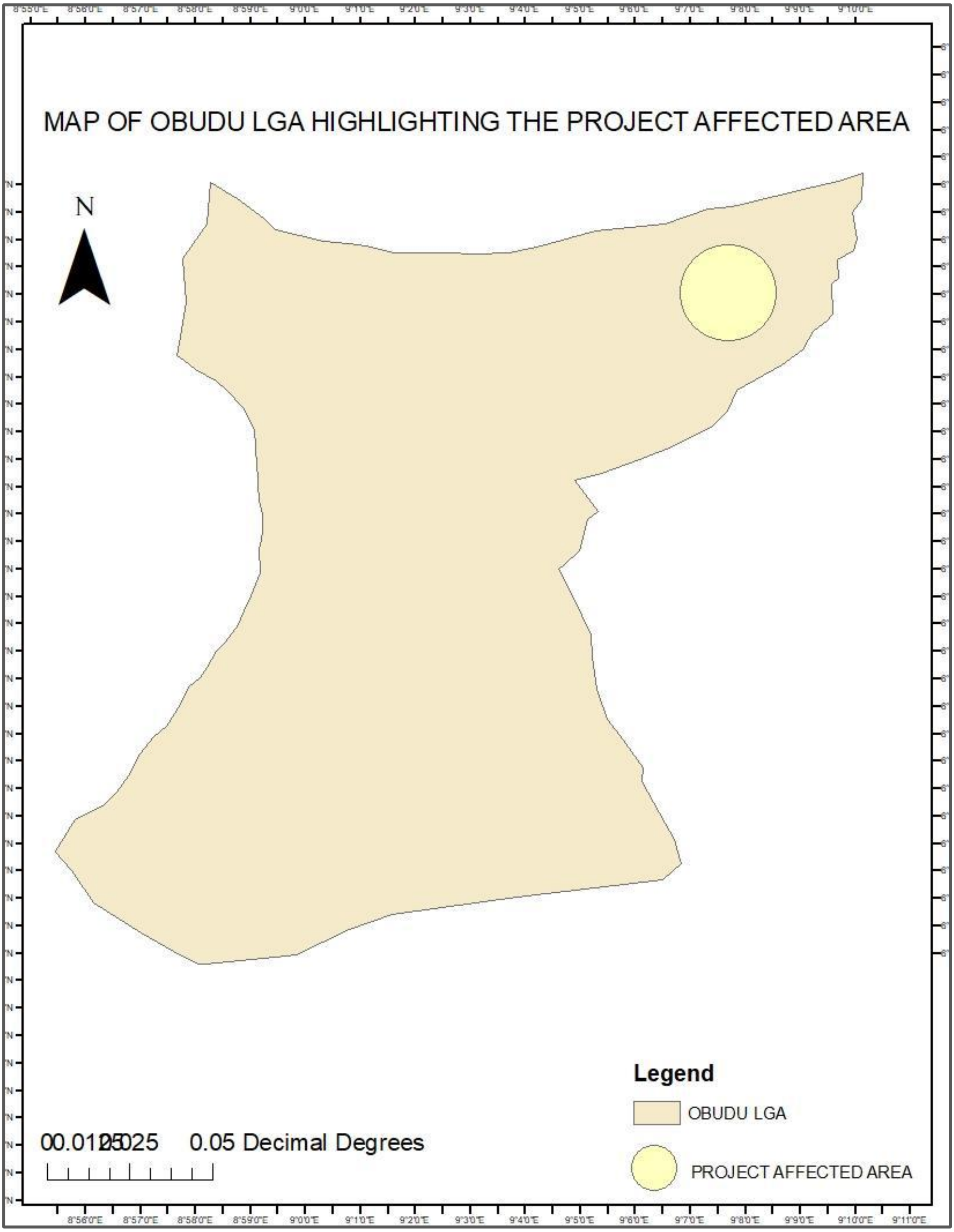

Figure 3.3: Administrative Map of Obudu LGA highlighting the project affected area

3.3 Description of Proposed Project Facility

3.3.1 Background to Air Transport in Nigeria

Air Transportation entails the movement of passengers and cargo by aircraft and helicopters. It is a transport system that involves the carriage by air of persons or goods using airplanes and helicopters (WIE, 2011).

Air Travel in Nigeria commenced during World War II (1939-1945) when it became necessary to move troops and supplies fast across the country. Several air strips were built then which were converted after the war, to Civilian use (Ileoje, 2003). Nigerian Airways was established in October, 1958 as a Joint Venture between the Nigerian Government, Elder Dempster Lines and the British Overseas Airways Corporation (BOAC). The Airways took over the operations of domestic flights from the disbanded West African Airways Corporation (WAAC) which had been operating commercial operations within the country since 1946 (Filani, 1983).

In 1963, the Nigerian Federal Government bought out the other shareholders and Nigeria Airways became wholly-owned by the Nigerian government. The airline had a monopoly for providing domestic air services in Nigeria. It was also the national carrier for international services along the West African Coast, Europe and the United States of America.

In 1976, Nigeria Airways operated a fleet of nineteen (19) aircraft consisting of two each of Boeings 707 and 737 and one DC 10-30 aircraft used mainly for international flights. There were Seven F.28 Jets and Seven Folder F.27 propeller aircrafts used mainly on domestic routes (Filani, 1983). There were also other major international airlines which operated flights to Nigeria, thereby linking Nigeria with the World's major socio-economic and political centres. Within Nigeria itself, several charter companies operate additional flight in small aircraft from Lagos to the main economic centres in the Southern parts of the country.

The Nigerian Federal Government realizing the role of air transport in the nation's development made significant attempts to develop the country's air transport system. The most gigantic was the 1975-1980 Airport development programme in which the Murtala Mohammed airport complex was constructed costing about N240 million (Filani, 1983). Six other airports in Kano, Ilorin, Kaduna, Sokoto, Port Harcourt and Maiduguri were developed to accommodate the largest intercontinental aircraft. Apart from these airports development programmes, the Federal Government also intensified manpower development in the aviation industry. The Nigerian Civil Aviation Training Centres provides a substantial number of trained air personnel. This is in the areas of piloting, maintenance engineers, air traffic controllers, aeronautics teleprompter operators and communications personnel. These personnel were reinforced with those from the Nigerian College of Aviation Technology, Zaria.

During the 1980s and 1990s, many airports were built, existing ones were upgraded and more services and facilities added, all under the management of Nigerian Airports

Authority. Ileoje, 2003, states that it is estimated that by the year 2003, over four million Nigerians fly and use the airports each year. However, private domestic air carriers began to win business at the expense of Nigeria Airways, the government-owned national airline and it was declared bankrupt in 2004.

According to Wikipedia (2011), there are a total of thirty eight (38) airports with paved runways and sixteen (16) airports with unpaved runways. The figure below shows some of the airports and air routes in Nigeria.

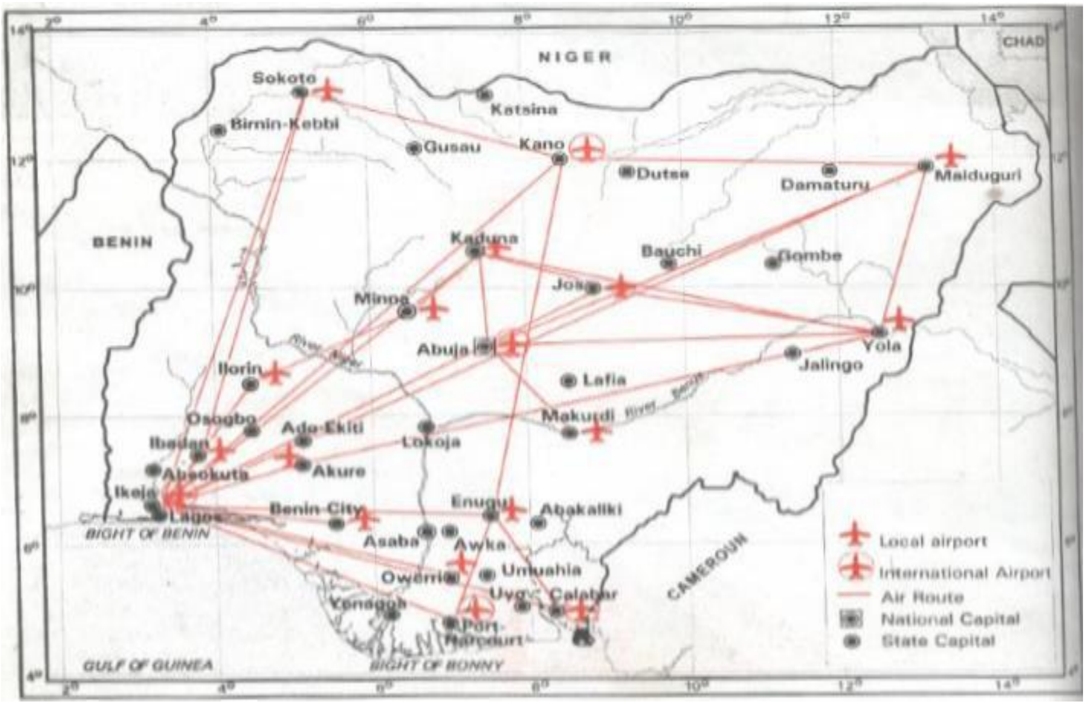

Figure 3.4: Airports and air routes in Nigeria

3.4 Components of the Proposed Project/Facility Layout

The project shall entail extended facilities, mostly for commercial air transport. The facilities will include: Landing/Runway, Terminal (Airline Booking/Ticketing, Aquarium, Arrival Hall, Arrival Immigration, ATM Stand, Atrium, Baggage Reclaim, Custom Channel Departure Exit, Emergency Exit, Fire Hydrant, General Waiting Room, International Departure Hall, Luggage Platform, Male/Female Toilet, Medical Hall, National Departure Hall, Offices, Passport Control Room, Security Room, Control Tower), Maintenance Building, Aircraft Stand, Taxiway, Parking Lot, Cargo Buildings, Fuel Station & Fire Station.

Other components shall include Walkway, Access Road, Car Rental, Air Traffic Control Centre, Fire Station and Entrance Gate.

3.4.1 Runway

As only one runway is proposed, it shall be oriented to take maximum advantage of the prevailing wind. Alignment with built-up and planted areas shall been avoided, hence the takeoff and landing paths shall not positioned over built-up areas in order to avoid complaints from inhabitants of the neighbouring communities. Essentially, no built up areas or communities are located within **1km** horizontal distance during takeoffs, approaches and landings.

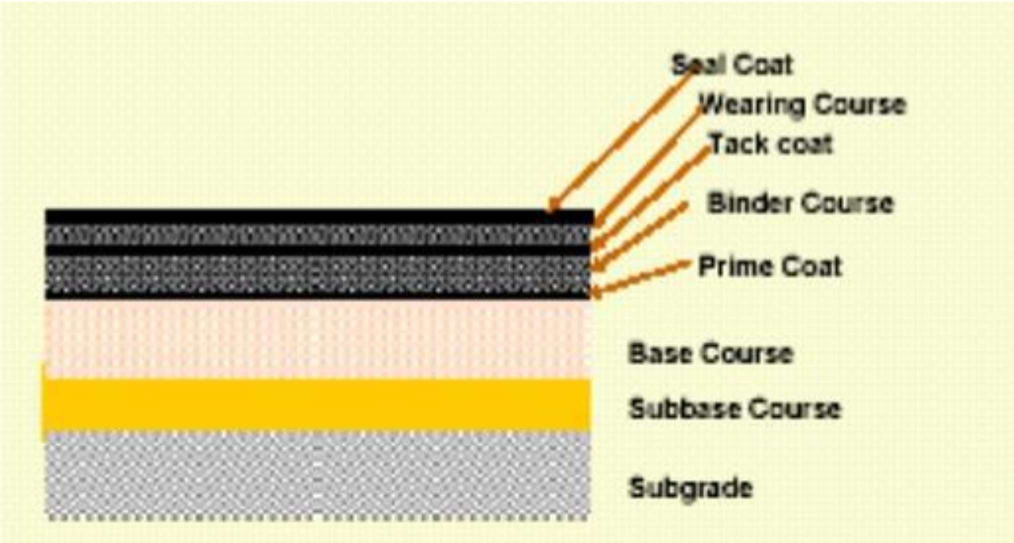

Figure 3.5: Typical Section of Runway

- **Runway Surface**

The runway shall be man made surface (Asphalt) capable of supporting the weight of any aircraft likely to make use of the Airport. The runway will be constructed to have a maximum end-to-end slope of two and a half per cent (2.5%) with no abrupt changes. For drainage purposes the runway will be crowned with two per cent (2%) slopes down to the runway edges. Care shall be taken to avoid areas where water pooling could create soft spots that will hamper aircraft directional control.

- **Runway Dimensions**

The runway length will be adequate to meet the operational requirements for the aircraft intended. The runway will have a minimum width of 25m and length of 3,400m with allowance for expansion possibilities.

Section of a Runway

The following are the sections of the runway;

- The **runway thresholds** are markings across the runway that denote the beginning and end of the designated space for landing and takeoff under non-emergency conditions.
- The **runway safety area** is the cleared, smoothed and graded area around the paved runway. It is kept free from any obstacles that might impede flight or ground roll of aircraft.
- The **runway** is the surface from threshold to threshold, which typically features threshold markings, numbers, and centerlines, but not overrun areas at both ends.

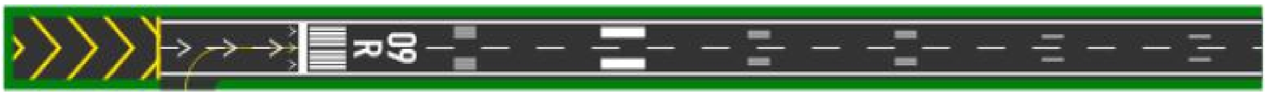

Figure 3.6: Typical Example of Runway

- **Blast pads**, also known as overrun areas or stop ways, are often before the start of a runway where jet blast produced by large planes during the takeoff roll could otherwise erode the ground and eventually damage the runway. Overrun area shall also constructed at the end of runways as emergency space to slowly stop planes that overrun the runway on a landing gone wrong, or to slowly stop a plane on a rejected takeoff or a takeoff gone wrong.

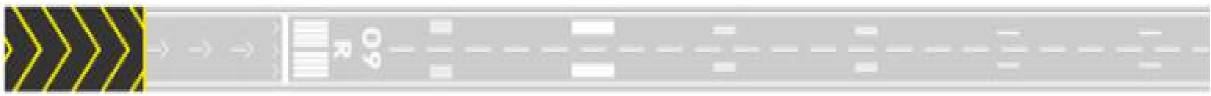

Figure 3.7: Typical Example of a Blast Pad

- **Displaced threshold** shall be used for taxing, takeoff, and landing rollout, but not for touchdown. A displaced threshold often exists because obstacles just before the runway, runway strength, or noise restrictions may make the beginning section of runways unsuitable for landings. It shall be marked with white paint arrows that lea up to the beginning of the landing portion of the runway.

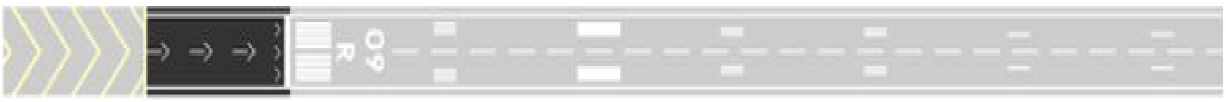

Figure 3.8: Typical Example of a Displaced Threshold

Runway markings

This shall be markings and signs on runways. The runway shall have a distance remaining sign (black box with white numbers). This sign shall use a single number to indicate the thousands of feet remaining, so 7 will indicate 7,000ft (2,134m) remaining. The runway threshold shall be marked by a line of green lights.

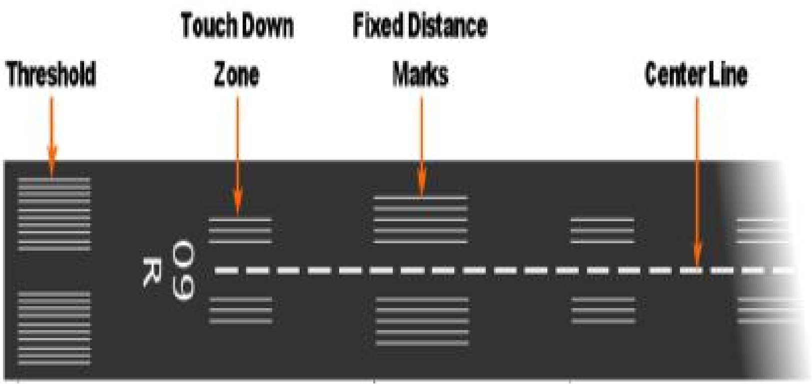

Figure 3.9: Typical Example of Runway Markings

Runway Lighting

Runway lighting is a line of lights on an airfield to guide aircraft in taking off or landing.

3.4.2 Terminal Building

This is a building where passengers shall get on and off aircraft, book ticket, pick up luggages etc. Components of the Obudu Passenger and Cargo Terminal includes: Airline Booking and Ticketing Center, Aquarium, Arrival, Halls, Arrival Immigration, ATM Stand, Atrium, Baggage Reclaim, Car Rental Center, Custom Center, Departure Exit, Emergency Exit, Fire Station, General Waaiting Room, International Departure Hall, Luggage Platform, Male & Female Toilet, National Departure Hall, Off 001 – 006, Passport Control, Rooms, Security, Store.

3.4.3 Maintenance Building

Maintenance building shall be where the performance of task required to ensure the continuing air worthiness of aircraft or aircraft part are done. This includes overhaul, inspection, replacement, defect rectification, embodiment of modifications, compliance with air worthiness directive and repair.

3.4.4 Aircraft Stand

This shall be a vast area inside the airport where aircraft shall be parked. Its landtake is about 200m length and 100m with a capacity to take about twenty (20) aircratfs.

3.4.5 Taxiway

This shall serve as a path connecting runways with aprons, hangars, terminals and other facilities.

3.4.6 Parking Lot

The parking lot will be located infront of the terminal building. Its landtake is about 100m length and 50m width with a capacity to take not less than fifty (50) vehicles.

3.4.7 Cargo Buildings

Cargo building (warehouses) shall provide a holding area for goods awaiting air and road feeder service (RFS) connections to final destination. This facility shall serve as sortation center for cargo carriers. The number of warehouses for cargo operation at Obudu Cargo and Passenger Airport shall be Ten (10) with a total land take of 300m^2.

3.4.8 Fuel Station

Fuel station shall be located at about 200m away from the cargo warehouse. Its proposed land take is about 100m^2.

3.4.9 Fire Station

The Airport Fire Service shall have a total of ten (10) personnel which includes the followimg; Airport Fire Manager, Station/Watch Manager, Crew Manager, Crew Commander, Firefighters etc. and five (5) firefighting trucks and shall be divided into four (4) units ie:

i. Operational Unit;
ii. Training & Development Unit;
iii. Safety & Standard Unit; and

iv. Support & Planning Unit.

3.4.9.1 Function & Responsibilities

- To provide and maintain Fire Protection and Safety Services to aircrafts in accordance with the recommendation and requirements of the International Civil Aviation Organisation (ICAO);
- To provide Rescue and Fire Fighting Services to passengers involved in aircraft accident or incident both on and within the immediate vicinity of the airport;
- To provide a Fire Fighting Service to fight fire in aircrafts and buildings on any part of the airport;
- To provide Fire Protection Services and to give Technical Advices on fire precautions and fire fighting.

3.4.10 Control Tower

This shall be a building from which instructions shall be given to the pilots when they are taking off and landing.

3.4.11 Access Road

Access to the proposed Obudu Passenger and Cargo Air shall be a key component in the efficient operation of the airport. The access road is about 8km dual carriageway by length and 7.4m width

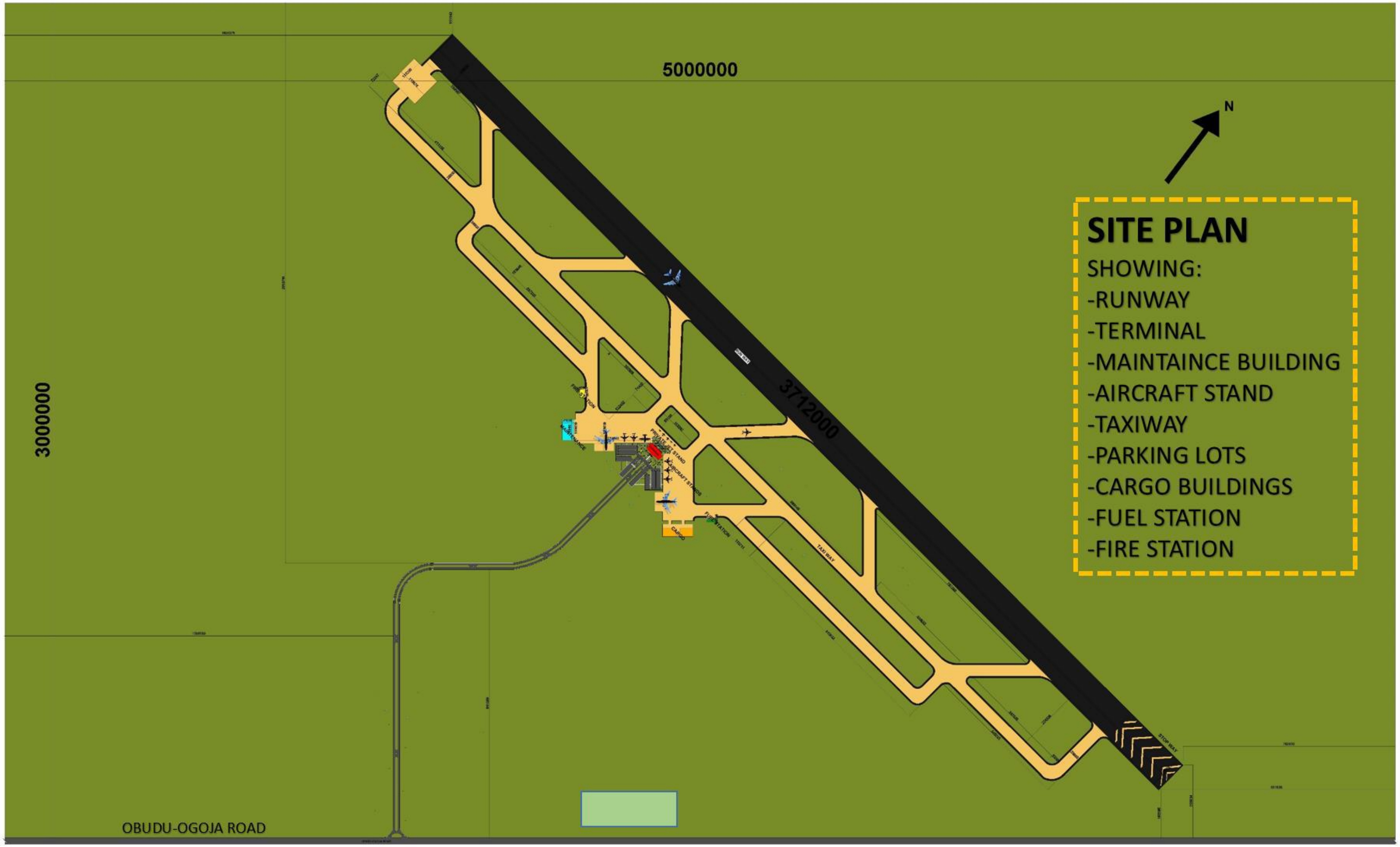

Figure 3.10: Facility Layout of the Proposed Obudu Cargo and Passengers Airport

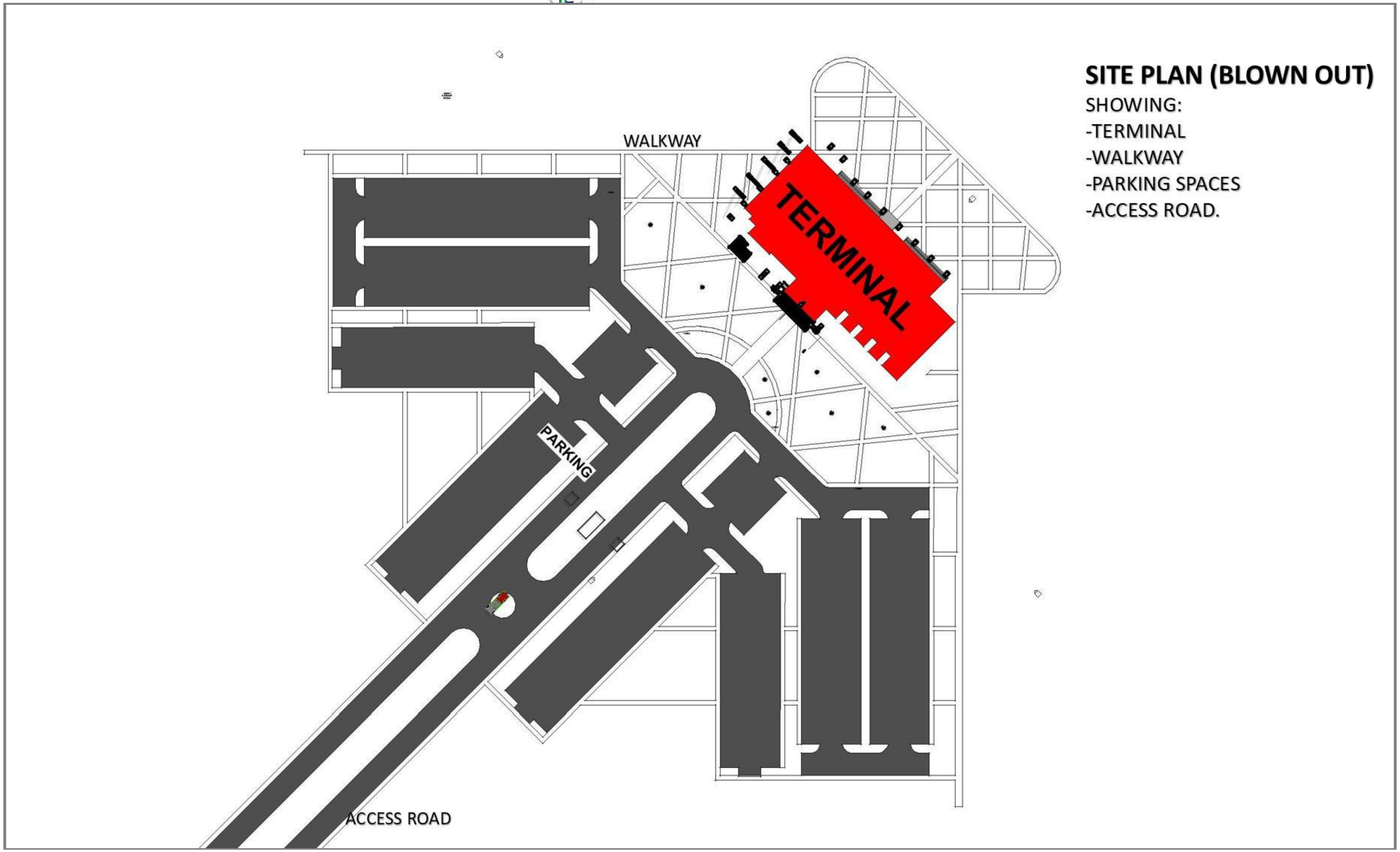

Figure 3.11: Facility Layout of the Proposed Obudu Cargo and Passengers Airport showing Access Road, Parking Lot, Terminal Building & Walkway

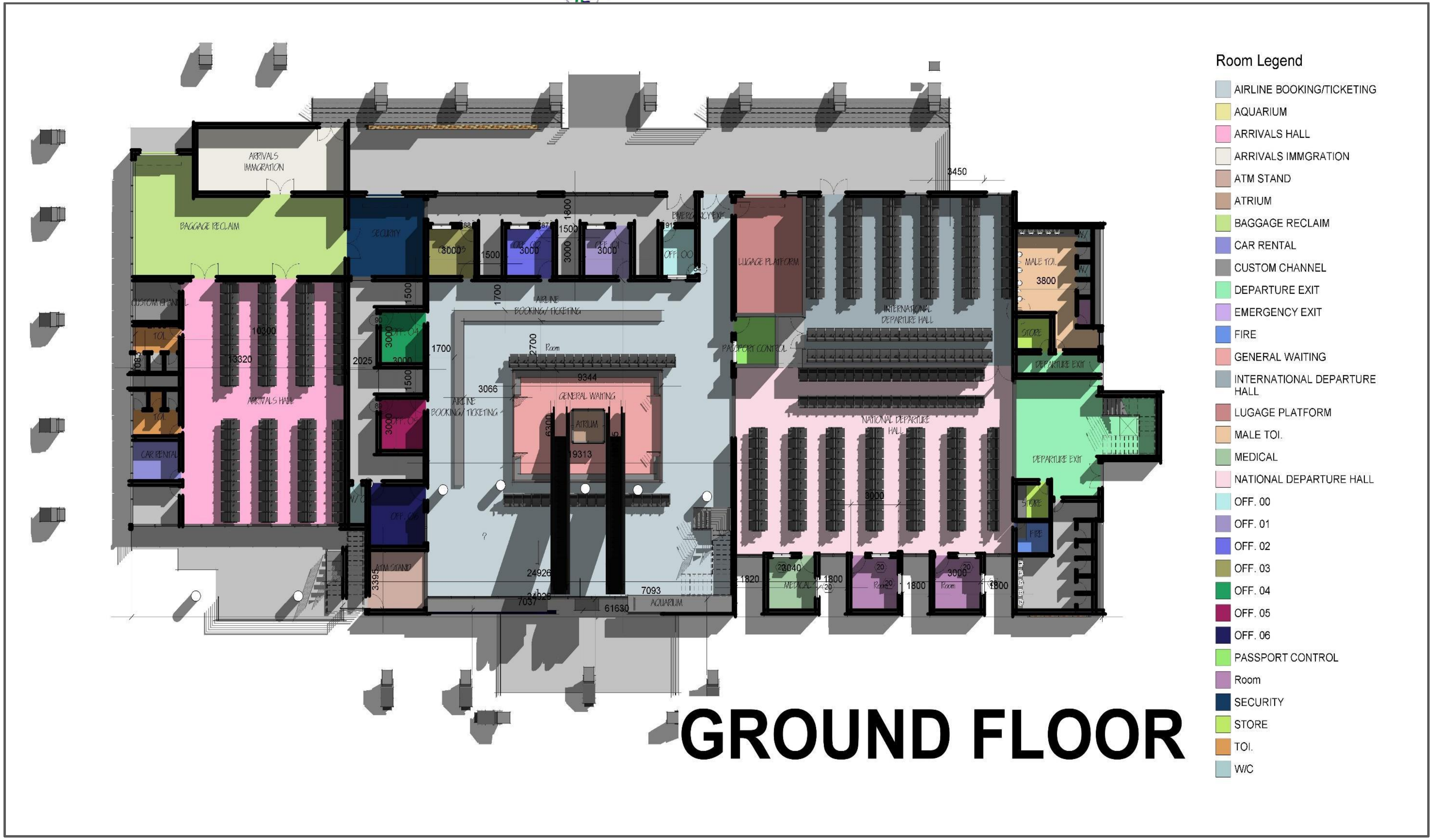

Figure 3.12: Ground Floor of the Proposed Obudu Cargo and Passengers Airport Terminal Building

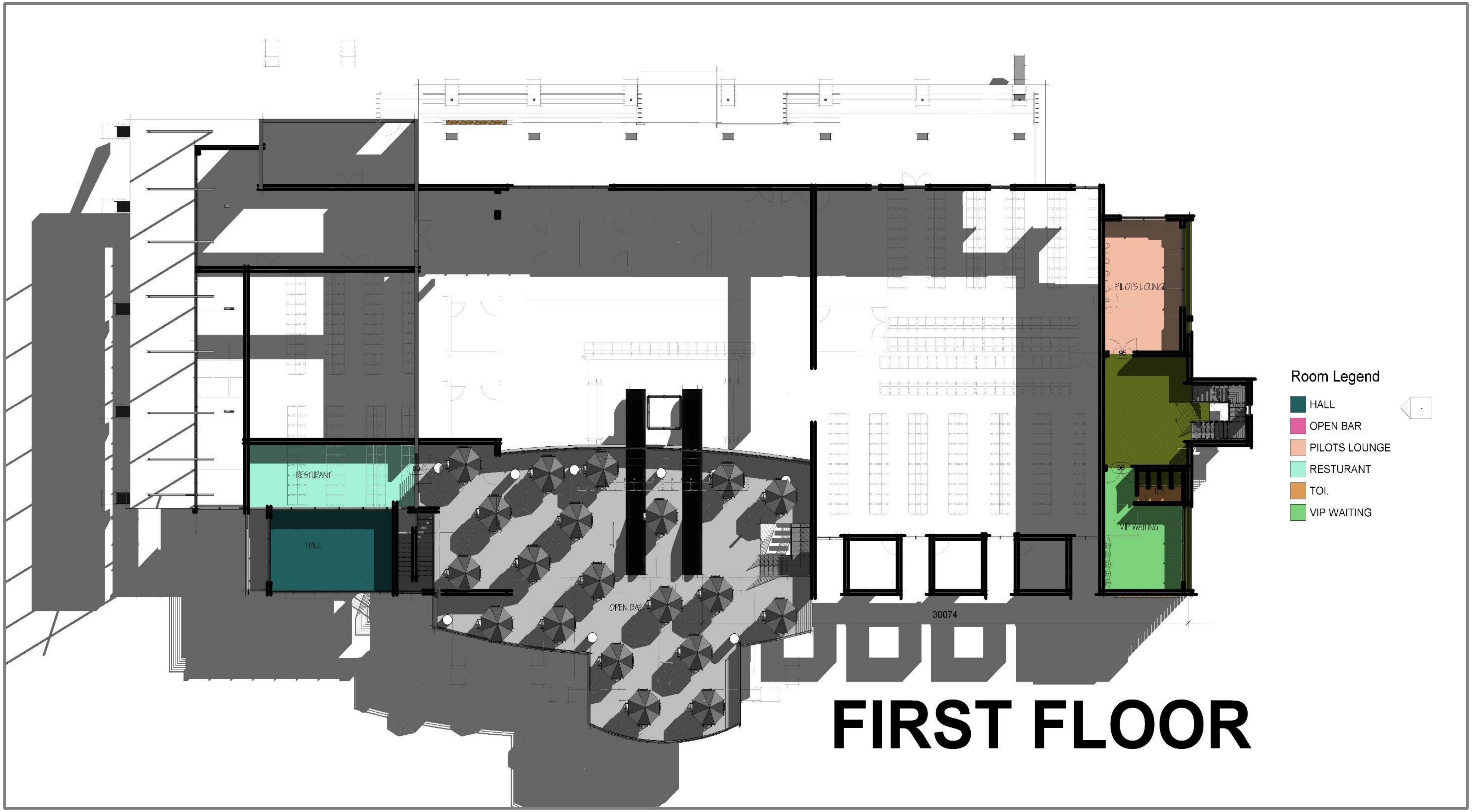

Figure 3.13: First floor of the Proposed Obudu Cargo and Passengers Airport Terminal Building

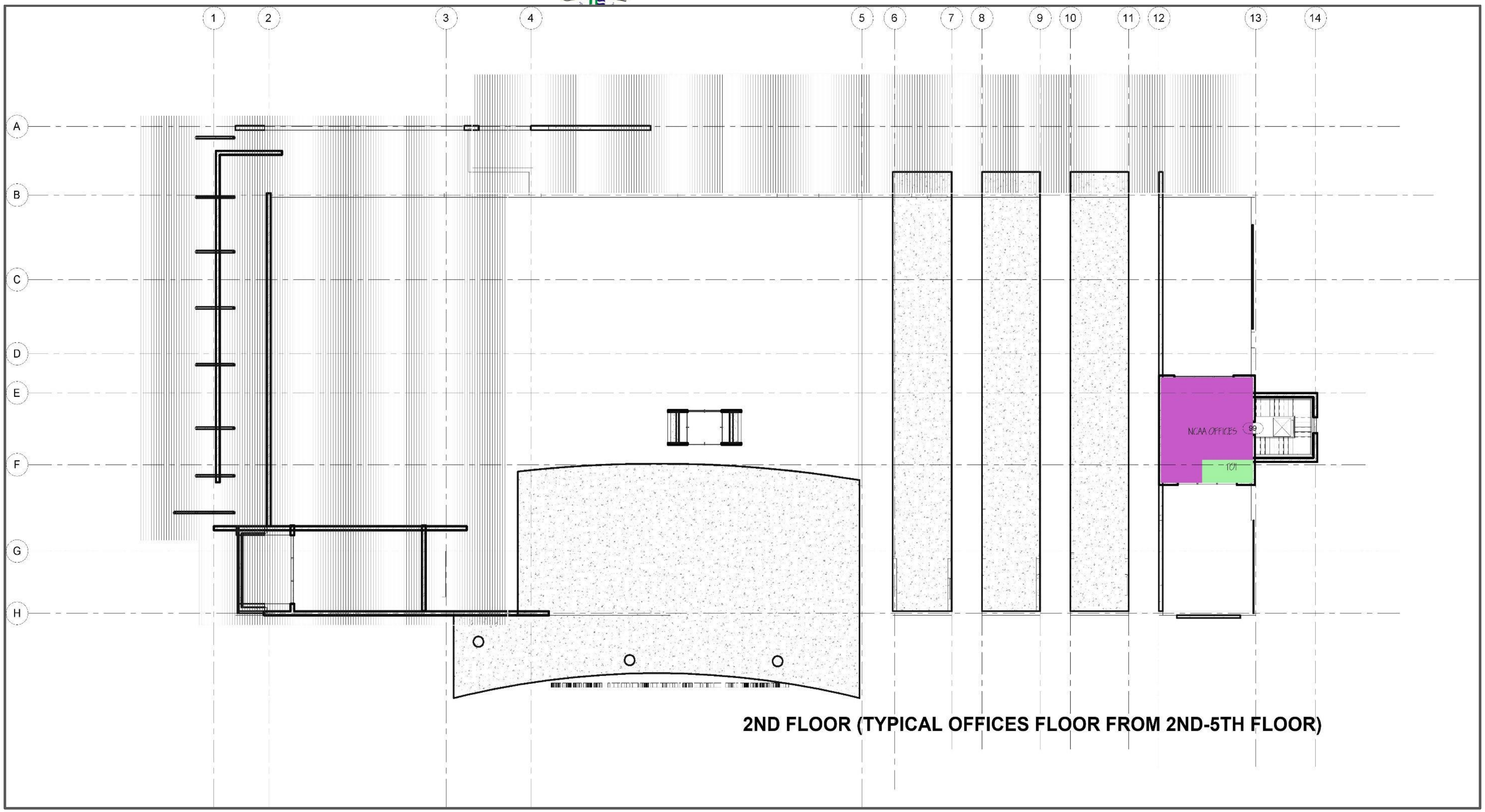

Figure 3.14: Second floor (Typical Offices Floor from 2nd-5th Floor) of the Proposed Obudu Cargo and Passenger Airport Terminal Building

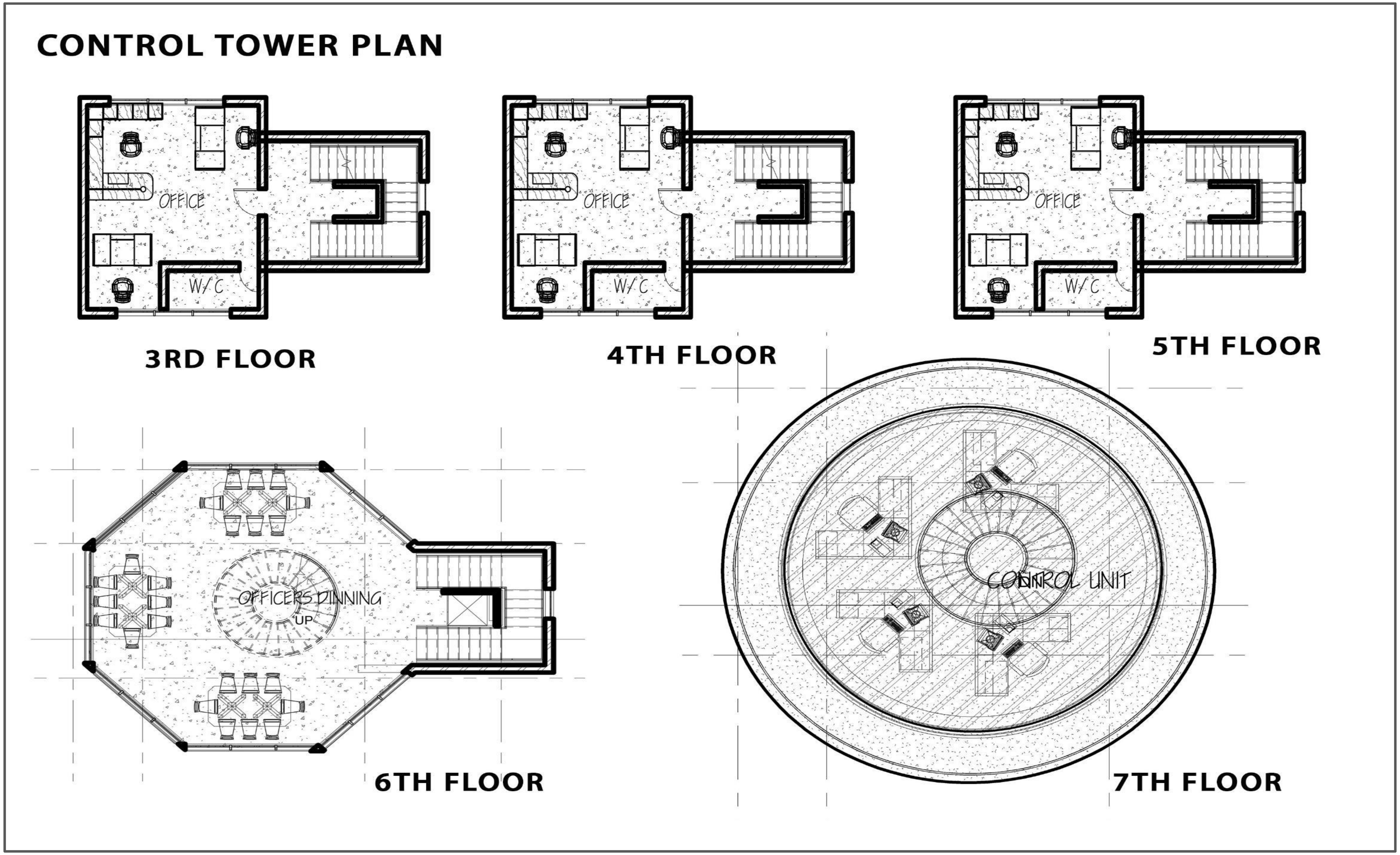

Figure 3.15: Control Tower Plan for the Proposed Obudu Cargo and Passenger Airport

3.5 Mobilization Phase

3.5.1 Site Preparation

The site preparation will cover the following;

- Site clearing,
- Construction of access road,
- Construction of terminal and maintenance buildings, control tower, warehouses, runway, taxiways, airport stand etc.

3.5.2 Mobilization of Construction Materials and Equipment

Sources of Materials

The project will require various standard construction materials including aggregates (granite), sand and water. These construction materials shall be sourced locally.

3.5.3 Equipment and Machinery

The project will employ various standard construction equipment which includes the following;

Table 3.1: Breakdown of equipment, machines and storage/processing facilities

S/No	Name of Machines	No.
1	Excavators	2
2	Wheel loader	1
3	Generators	2
4	Pay loaders	2
5	Tower Crane	1

3.5.4 Personnel

- **Construction Phase**

The construction will be undertaken by an appointed contractor. It is envisaged that the contractor personnel will include skilled and semi-skilled personnel. A good number of labourers will also be employed from the neighbouring communities. For the size of the Obudu Cargo and Passenger Airport, it is estimated that 90% of the construction crew will be Nigerians especially Cross Riverians.

- **Operation Phase**

The project will engage a total of 100 persons (within Cross River State and Nigeria) and in response to the Nigerian Government set minimum local content target of 75%. Cross River State Government shall ensure that preference with respect to employment is given to host and neighboring communities (where requisite skills are available).

3.6 Energy Input

The Obudu Cargo and Passenger Airport shall be connected to the national grid. As alternative source of power, the airport facility shall have installed two (2) 450KVA generators for its power needs.

3.7 Water

The water requirement for the project is relatively high during construction and mininmal during operation. The main consumption of the water during construction is for mixing of cement and concrete. The water requirement during construction is estimated at 10,000 liters per day. During construction, water shall be sourced from water vendors.

Water requirement during the operational phase of Obudu Cargo and Passenger Airport will be minimal. Water will be used for cleaning, it will also be used at the rest rooms. Water shall be sourced from the borehole which will be drilled on site.

3.8 Waste Management

The waste management for the proposed Obudu Cargo and Passenger Airport involves a comprehensive description and analysis of activities at preconstruction, construction, operational and abandonment phases of project. It also involves a review of the existing waste management and environmental management system of the proponent.

3.9 Project Schedule

The project construction is to last from the third quarter of 2020 to the second quarter of 2021. All things being equal, the operation of the project is expected to commence in the fourth quarter of 2021. Details of Cross River State Government implementation schedule both at pre-operation and operation stage is as shown in the Table 3.2.

Table 3.2: Proposed project schedule (Pre-project activities)

Project Activity	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Feasibility Studies												
EIA Process												
Pre-construction; Site clearing and preparation												
Construction; of access road, other structures (such as terminal building, control tower, maintenance building, warehouses, fire station, fuel station, runway, taxiway, aircraft stand, parking lot etc.)												
Commissioning												
Operational Stage												

CHAPTER FOUR

DESCRIPTION OF THE ENVIRONMENT/BASELINE CONDITION

4.1 Introduction

Baseline information on the environment of any particular location is a crucial component of environmental studies. Apart from giving an idea of the existing status of an environment in which a project is to be located, baseline information also serves as a benchmark against which future measurements can be compared.

In this chapter of the report, a general description of the setting of the project host environment is discussed. Also, an overview of the methodology adopted for the collection of baseline information on the environment around the site proposed for the OCPA project is presented. Furthermore, an overview of the findings from the study; the baseline environmental conditions of the project area is aptly captured.

4.2 Data Source

Data presented in this chapter of the report was collected from a combination of sources, including review of literature (previous publications on the project environment and similar environments); previous studies around the project area, maps, satellite imageries, academic study reports, research papers etc. These were obtained from governmental departments including the Federal Ministry of Environment (FMEnv), Cross River State Ministry of Environment, National Environmental Standards and Regulations Enforcement Agency (NESREA), Universities, Research Institutes, and Non-Governmental Organisation (NGOs). Information on the climate of the project area was collected from the Nigerian Meteorological Institute (NIMET). For this purpose, information for a period of 39 years (1980-2018) was obtained.

4.3 Environmental Setting

4.3.1 Geology

The Geology of Cross River State is dominated principally by the basement complex of the Oban massif, which extends from the Central Region to the southeastern part and the Obudu Plateau of the Northeast. The sedimentary terrain comprises rocks of the lower Benue Trough and Calabar Flank. The area has been subjected to periods of tectonism, magmatism and regional metaphorism leading to the development of fractures faults and folds creating favourable sites for mineralization.

Geologically, Cross River State can be subdivided into four units for ease of description. These are:

i. The Oban Massif
ii. The Calabar Flank
iii. The Mamfe Embayment
iv. The Obudu Plateau

The mapping of the rocks of the Oban Massif revealed rocks similar to the well-established occurrences in southwestern Nigeria. According to Ekwueme, (2003) they fall within the already established groupings of the Nigerian Basement Complex namely;

a) Schist belts,
b) The Migmatite – gneiss complex,
c) Charnockitic rocks,
d) Gabbro and doleritic rocks,
e) Older granites with Amphiboles,
f) Syenites, basic and acidic intrusive rocks like granodiorites, pegmatites and quartz veins.

The inaccessibility of the terrains is a major factor hindering exploration. The Obudu Plateau belongs to the Precambrian and include metamorphic rocks as well as intermediate and acidic igneous rocks intruding them. These rocks include the gneisses, Amphiobolites, Schists, Charnockites and meta-ultramafic rocks.

The Calabar Flank represents that part of the Southern Nigerian Continental Margin bounded in the North by the Oban Massif and by the Calabar Hinge line delineating the Niger Delta Basin to the West. It has Early Cretaceous deposits followed by the first marine incursion that resulted in the deposition of the platform, the Mfamosing Limestone during the middle Albian (Petters, 1962). During the Cenomanian and Turonian, subsidence of faulted blocks resulted in widespread deposition of shales with minor Calcarous intercalations. These sediments are uncomformably overlain by a domainantly shale lithology with occasional mudstone and thin gypsum beds during the Campanian to Mastrichtian (Nyong & Ramanthan, 1985).

The Mamfe Embayment situated between the Oban Massif and the Obudu Plateau is predominantly fluviatile clastic sequence that exhibit point bar-fining upward cycles and over bank mud cracks (Ekwueme et al; 1995). This formation belongs to the Asu River Group. Rocks associated with the sedimentary rocks of the Mamfe rift are Basaltic, abundantly found around Ikom bridge.

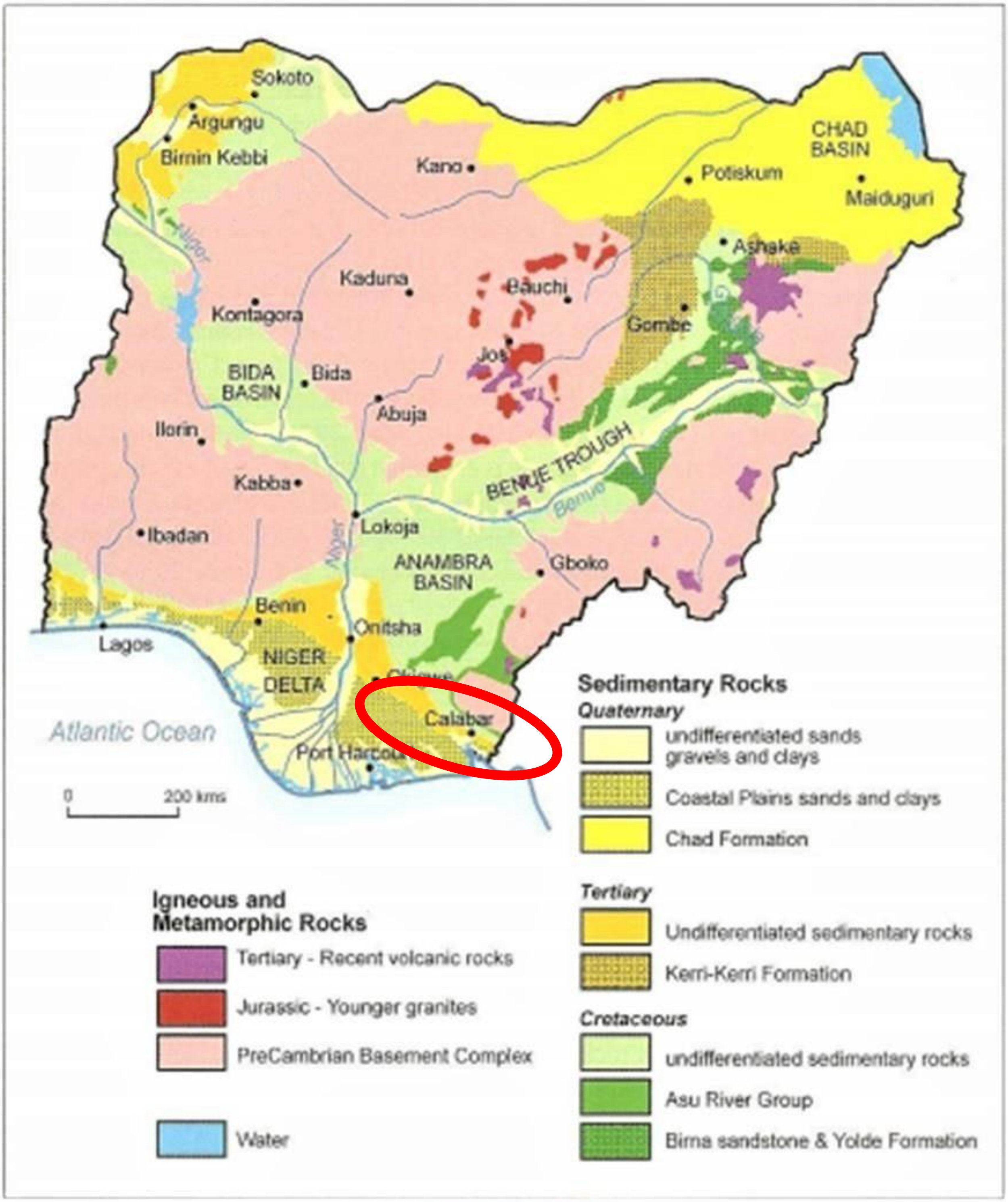

Figure 4.1: Generalized geological map of Nigeria (from Mac Donald *et al.* 2005) highlighting Cross River State

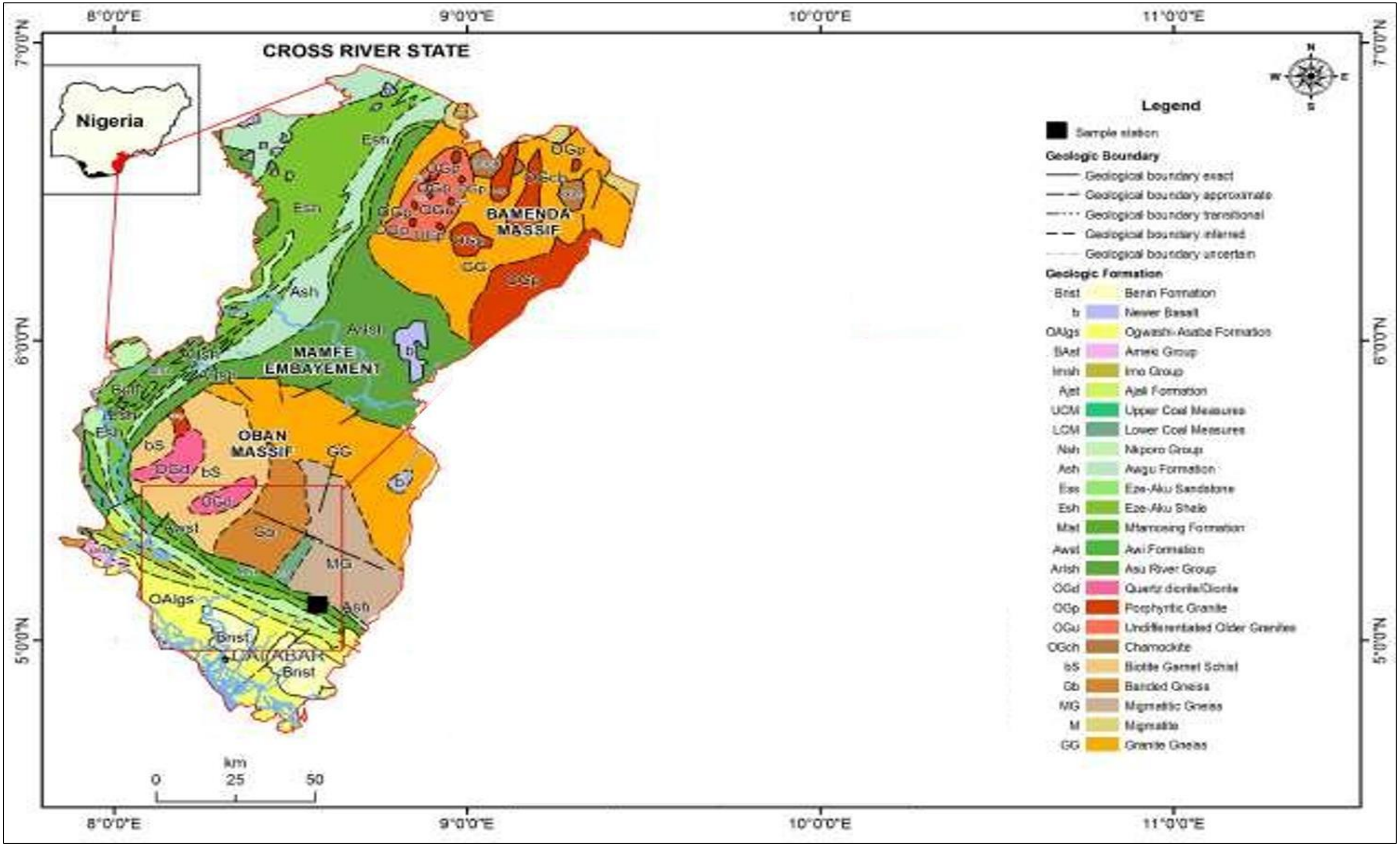

Figure 4.2: Geological and Mineral Resources Map of Cross River State

4.3.2 Soil

Cross River soils are predominantly of five types. These are:

(i) The steep, shallow, yellowish and red gravely soils on the Oban Obudu Hills (the project location);
(ii) The deep lateritic, fertile soils on the Cross River Plain;
(iii) The dark clayey basaltic soils in Ikorn;
(iv) The sandy, heavily leached soils on the older coastal plain which are highly susceptible to gully erosion; and
(v) The swampy hydromorphic soils of the lower deltaic coastal plain that is usually floated during the rains.

4.3.3 Hydrogeology

There are 3 main sources of groundwater in Cross River State:

- The regional aquifer of the Coastal Plain Sands covering 10% of the area of the State,
- The fractured Shale of the Eze- Aku and Asu River Group, (55%),
- The weathered and fractured zone aquifers of the Oban and Obudu Basement complex (35%).

As the shales and basement complex rocks are essentially impermeable, about 85% of the State has poor groundwater resources, accounting for the difficulty in providing safe drinking water through ground.

4.3.4 Biodiversity

a. Flora

The vegetation ranges from mangrove swamps, through rainforest, to derived savanna, and montane parkland. Just as its rocks are diverse, so also are the mineral resource potentials of the State. Cross River State contains the largest amount of Tropical High Forest remaining in Nigeria and largest remaining rainforest in West Africa (0.85 million hectares), although its quality and density varies across the State's three agro-ecological zones. Cross River State also contains 1,000 sq. kilometres of mangrove and swamp forest. The main tree species found here include gmelina, albizia, iroko, ebony, mahogany, cedar, brachystegia and obeche. Cross River State due to her rich biodiversity and ecology remains an ideal biometry resource data base for tropical plant and animal research.

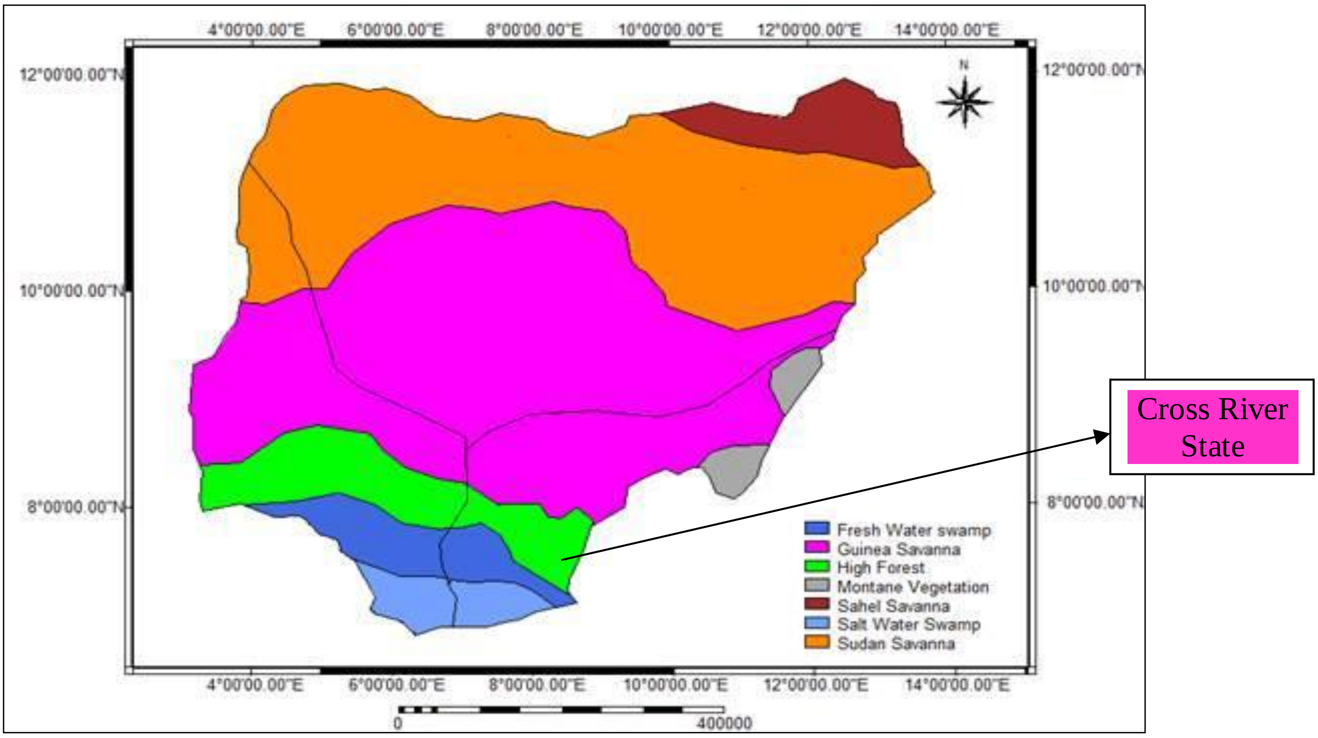

Figure 4.3: Vegetation Map of Nigeria showing the project location
Source: www.wikipedia/maps/nigeria_vegetation

b. Fauna

The fauna composition of the project area like most tropical rain forest areas comprise of mammals such as *Erythrocebus patas* (Patas monkey), *Bos Taurus* (Cow), *Capra hircus* (Goat) etc. There are also reptiles such as *Rana temporaria* (Common frog), etc.

Amphibians such as Toads abound in the project area. Examples of common worms found include *Lumbricus terrestris* (Common earthworm). Obudu has a very diverse collection of birds such as *Buteo platypterus* (Broad winged hawk), *Aegypius monachus* (Black vulture), *Columbidae columbiformes* (Pigeon), *Aquila accipitridae* (Eagles), *Bubulcus ibis* (Cattle egret) etc.

Insects include, *Morpho peleides* (Blue morpho butterfly), *Atta spp* (Leafcutter ant), *Danaus plexippus* (Monarch butterfly), *Stagmomantis sp* (Praying mantis), *Acrocinus longimanus* (Harlequin bettle) etc.

4.3.5 Relief

The topography of Cross River State is low lying landmass rising gradually upwards towards the town of Ugep, Ikom, Bekirana and Obudu (the project host Local Government).

4.3.6 Climate and Meteorology

The climate within Cross River State is tropical-humid with wet and dry seasons and average temperatures ranging between 15°C - 30°C, and the annual rainfall between 1300 – 3000mm. The high plateau of Obudu experience climatic conditions which are markedly different from the generalised dry and wet period in the rest of Cross River State. Temperatures are 4°C - 10°C lower due to high altitude than in the surrounding areas. Similarly, the annual rainfall figures are higher than in areas around them, particularly on the windward side. Cross River State can, thus, be broadly divided into the following sub-climatic regions:

- The moderated sub-temperate within the high plateaus of Obudu; and
- The hot, wet tropical extending from the southern lowlands to the central and northern hinterland parts.

Table 4.1: Average maximum Temperature data for Cross River State from 1980 - 2018

STN	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
Cross River	1980	32.1	33.0	32.5	31.5	30.8	29.1	28.1	26.8	29.0	29.5	30.4	31.8	30.4
Cross River	1981	31.3	33.6	32.7	32.3	31.2	30.5	28.3	27.4	28.9	30.3	31.5	32.0	30.8
Cross River	1982	31.8	33.3	32.1	31.4	30.7	29.0	27.8	27.2	28.4	29.1	30.7	31.6	30.3
Cross River	1983	31.6	35.0	34.8	33.2	30.9	28.5	28.0	26.9	29.0	29.5	30.6	30.9	30.7
Cross River	1984	32.3	34.7	32.8	32.3	31.1	31.2	29.6	30.1	29.1	29.7	31.1	31.8	31.3
Cross River	1985	32.3	33.6	33.0	31.4	31.2	29.6	29.2	28.5	29.3	29.7	30.7	30.7	30.8
Cross River	1986	32.6	33.1	31.8	32.5	31.5	29.9	26.9	28.1	28.5	29.4	30.6	31.4	30.5
Cross River	1987	32.9	33.3	32.4	32.6	31.5	30.0	29.3	28.7	29.1	29.7	31.3	31.7	31.0
Cross River	1988	31.2	33.7	32.5	29.9	30.2	30.3	28.3	27.8	28.5	29.1	30.8	30.1	30.2
Cross River	1989	31.6	33.4	32.4	31.5	30.8	29.7	28.2	27.9	28.5	29.7	30.9	31.7	30.5
Cross River	1990	31.7	33.5	35.2	32.9	31.1	29.7	26.6	27.7	28.5	29.5	30.4	30.8	30.6
Cross River	1991	32.2	33.3	32.6	31.3	30.9	30.5	28.3	28.0	29.0	29.0	30.5	30.8	30.5
Cross River	1992	31.5	34.2	32.3	31.6	30.9	28.8	27.9	26.2	27.8	29.4	30.5	32.2	30.3
Cross River	1993	31.4	33.3	31.7	31.6	31.2	29.7	28.4	28.0	29.4	30.1	30.1	30.9	30.5
Cross River	1994	31.7	33.2	32.6	32.1	31.2	29.8	27.5	27.4	28.8	29.7	30.9	32.5	30.6
Cross River	1995	32.7	34.1	32.6	32.4	31.5	30.9	29.4	29.3	30.3	30.1	30.5	31.5	31.3
Cross River	1996	32.6	33.8	31.7	32.1	31.9	29.8	28.3	27.3	28.1	29.3	31.5	32.5	30.7
Cross River	1997	31.9	33.6	32.7	30.8	31.0	29.4	28.7	28.0	29.9	30.7	31.4	32.3	30.9
Cross River	1998	32.9	35.0	34.2	33.1	32.5	31.1	29.5	28.0	29.2	30.3	31.5	31.1	31.5
Cross River	1999	31.9	32.3	32.3	31.1	30.8	30.1	29.3	29.2	28.7	29.3	30.4	32.3	30.6
Cross River	2000	32.7	33.8	34.3	32.2	31.6	30.5	29.0	28.2	28.7	29.8	31.3	32.0	31.2
Cross River	2001	32.4	34.3	32.5	32.0	31.6	30.1	28.5	27.1	28.2	30.2	31.3	32.2	30.9
Cross River	2002	32.5	34.3	32.0	32.0	31.9	30.2	29.6	28.2	29.6	29.7	31.2	32.1	31.1
Cross River	2003	33.1	34.2	33.3	32.1	31.4	30.2	30.2	28.7	29.8	31.0	31.5	31.6	31.4
Cross River	2004	31.3	33.6	32.7	32.3	31.2	30.5	28.3	27.4	28.9	30.3	31.5	32.0	30.8
Cross River	2005	32.6	34.0	32.4	32.5	31.2	29.1	28.0	26.7	29.0	29.5	31.3	30.8	30.6
Cross River	2006	31.8	32.6	30.2	31.7	30.2	28.2	28.2	27.8	28.2	30.1	30.6	32.0	30.1
Cross River	2007	32.4	34.0	32.0	31.0	30.0	30.0	28.0	30.0	30.2	30.0	32.0	31.9	31.0
Cross River	2008	31.6	33.7	31.9	32.0	31.0	29.0	27.3	27.3	28.0	29.7	30.8	31.4	30.3
Cross River	2009	31.2	32.5	32.1	31.5	31.2	29.9	27.3	27.2	28.3	29.4	31.1	31.9	30.3
Cross River	2010	32.1	33.0	32.5	31.5	30.8	29.1	28.1	26.8	29.0	29.5	30.4	31.8	30.4
Cross River	2011	31.6	35.0	34.8	33.2	30.9	28.5	28.0	26.9	29.0	29.5	30.6	30.9	30.7
Cross River	2012	31.8	33.3	32.1	31.4	30.7	29.0	27.8	27.2	28.4	29.1	30.7	31.6	30.3
Cross River	2013	31.2	32.0	32.2	32.2	31.2	29.7	26.9	27.3	28.4	28.9	30.4	30.9	30.1
Cross River	2014	32.3	34.7	32.8	32.3	31.1	31.2	29.6	30.1	29.1	29.7	31.1	31.8	31.3
Cross River	2015	33.5	33.8	32.6	31.9	31.0	29.9	30.0	31.4	29.6	32.1	31.1	32.0	31.6
Cross River	2016	31.9	32.8	34.9	32.1	27.0	31.0	28.6	32.1	33.0	32.5	31.5	30.8	31.5
Cross River	2017	32.7	32.3	31.2	30.5	28.3	33.6	32.7	32.3	31.2	30.5	31.8	32.6	31.6
Cross River	2018	34.8	33.2	30.9	28.5	28.0	34.0	32.4	32.5	31.2	29.1	32.4	34.0	31.8

Source: NIMET

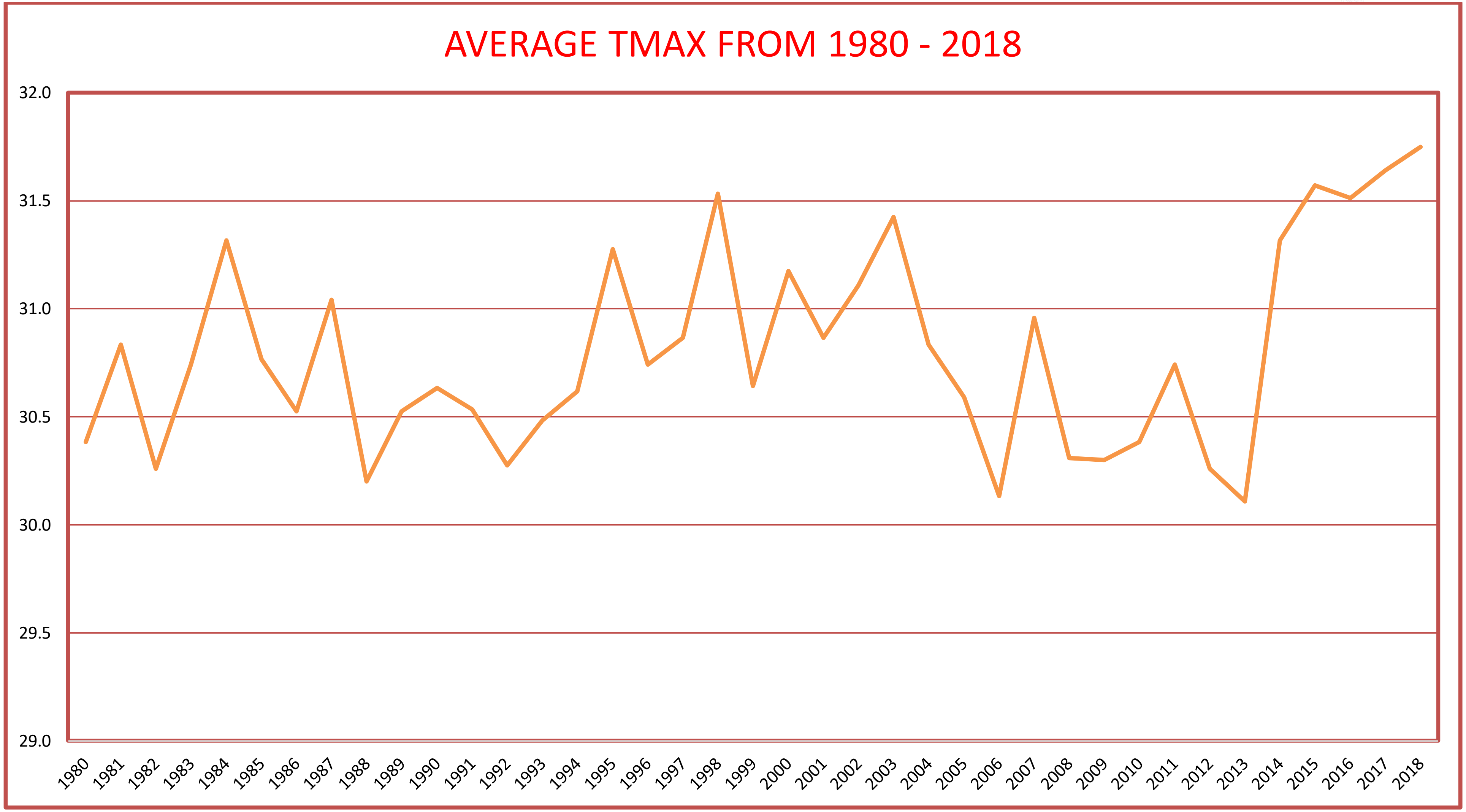

Figure 4.4: Line Graph showing average maximum Temperature for Cross River State from 1980 - 2018

Table 4.2: Minimum Temperature data for Cross River State from 1980 - 2018

STN	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
Cross River	1980	23.4	24.0	24.5	24.6	24.1	23.3	25.0	22.6	23.0	23.2	23.0	22.9	23.6
Cross River	1981	22.0	24.0	24.2	24.0	23.4	23.4	21.9	22.6	22.8	23.0	23.1	23.0	23.1
Cross River	1982	23.5	23.9	23.7	23.0	23.0	22.8	22.6	22.8	22.5	22.8	22.4	23.8	23.1
Cross River	1983	20.7	24.8	25.9	25.0	24.1	23.6	22.9	22.6	22.6	23.0	22.8	23.0	23.4
Cross River	1984	22.2	24.1	23.8	23.6	22.9	22.3	22.1	22.4	22.0	22.5	23.0	21.8	22.7
Cross River	1985	23.8	23.6	24.7	23.5	22.8	22.3	22.3	22.6	22.3	22.7	23.3	22.9	23.1
Cross River	1986	23.3	24.1	23.1	24.0	23.2	22.9	22.6	22.5	22.4	22.5	23.1	21.9	23.0
Cross River	1987	23.0	23.9	24.0	24.4	23.9	23.1	23.2	23.2	23.1	23.0	23.8	23.6	23.5
Cross River	1988	23.1	25.0	24.0	22.1	22.1	22.9	22.5	22.8	22.4	22.7	23.1	22.1	22.9
Cross River	1989	20.4	22.6	23.5	23.2	22.5	22.6	22.1	22.2	22.2	22.4	23.0	22.4	22.4
Cross River	1990	23.5	23.7	25.2	24.7	23.8	23.6	22.9	23.3	23.1	23.2	23.7	24.3	23.8
Cross River	1991	23.5	25.3	24.8	23.9	24.1	24.2	23.3	23.0	23.1	22.7	23.6	22.9	23.7
Cross River	1992	21.5	24.1	24.5	24.5	23.9	22.8	22.7	22.3	22.4	22.7	22.2	22.8	23.0
Cross River	1993	22.2	24.1	23.5	23.9	24.2	23.5	22.9	23.0	22.8	22.9	23.2	23.3	23.3
Cross River	1994	22.6	24.1	23.5	23.0	22.4	21.9	21.5	22.7	22.8	22.6	22.6	21.1	22.6
Cross River	1995	21.9	23.1	22.6	23.1	22.6	22.0	21.6	21.7	21.6	21.0	22.5	21.9	22.1
Cross River	1996	21.9	23.7	23.2	22.6	22.9	22.0	21.5	21.4	21.4	21.1	22.4	22.7	22.2
Cross River	1997	22.5	21.6	22.9	22.1	22.0	21.7	21.1	22.6	23.2	22.8	22.8	22.6	22.3
Cross River	1998	21.5	24.7	24.3	23.8	23.3	23.2	22.6	22.3	22.3	22.3	22.6	21.9	22.9
Cross River	1999	22.0	22.5	22.2	22.3	22.2	21.9	21.1	21.4	22.6	22.7	22.9	22.6	22.2
Cross River	2000	23.9	23.2	24.3	23.6	23.7	23.1	22.8	22.5	23.0	23.0	23.4	22.5	23.3
Cross River	2001	22.4	23.4	23.7	23.7	23.7	23.0	22.8	22.6	22.8	23.2	23.7	24.1	23.3
Cross River	2002	22.5	23.5	24.3	24.0	23.6	23.4	23.5	22.9	23.3	23.1	23.4	23.3	23.4
Cross River	2003	23.4	24.4	24.4	23.6	23.6	23.3	23.0	23.1	22.9	23.4	23.6	23.3	23.5
Cross River	2004	24.0	25.0	24.0	24.0	23.0	23.0	23.0	23.0	22.7	23.0	23.0	23.4	23.4
Cross River	2005	21.7	25.2	24.0	24.6	23.8	23.7	23.0	22.9	23.3	23.1	23.8	23.3	23.5
Cross River	2006	24.6	24.3	23.6	24.3	23.6	23.2	23.2	23.3	23.2	23.3	23.6	23.1	23.6
Cross River	2007	23.4	24.1	24.0	23.7	23.4	22.4	22.5	22.4	22.3	22.4	23.0	22.5	23.0
Cross River	2008	22.7	23.3	23.3	22.7	23.2	22.7	22.4	22.3	22.3	22.4	23.0	21.6	22.7
Cross River	2009	22.8	23.3	23.2	23.1	23.6	22.9	22.8	22.5	22.5	22.7	23.5	23.1	23.0
Cross River	2010	23.4	24.0	24.5	24.6	24.1	23.3	25.0	22.6	23.0	23.2	23.0	22.9	23.6
Cross River	2011	23.7	23.7	23.7	21.7	21.1	22.6	23.0	22.9	21.4	21.1	22.4	23.4	22.6
Cross River	2012	23.5	23.9	23.7	23.0	23.0	22.8	22.6	22.8	22.5	22.8	22.4	23.8	23.1
Cross River	2013	22.0	24.0	24.2	24.0	23.4	23.4	21.9	22.6	22.8	23.0	23.1	23.0	23.1
Cross River	2014	20.7	24.8	25.9	25.0	24.1	23.6	22.9	22.6	22.6	23.0	22.8	23.0	23.4
Cross River	2015	21.6	21.0	22.5	21.9	22.8	22.6	22.8	22.5	22.8	22.4	23.8	22.5	22.4
Cross River	2016	23.9	24.2	23.5	22.9	22.4	23.4	23.7	23.7	24.0	24.5	23.4	24.3	23.7
Cross River	2017	24.1	22.7	23.2	22.7	22.4	22.3	22.3	22.9	23.3	23.1	23.8	22.2	22.9
Cross River	2018	22.8	24.4	23.6	23.6	23.5	22.9	23.3	23.1	23.2	23.7	24.3	22.9	23.4

Source: NIMET

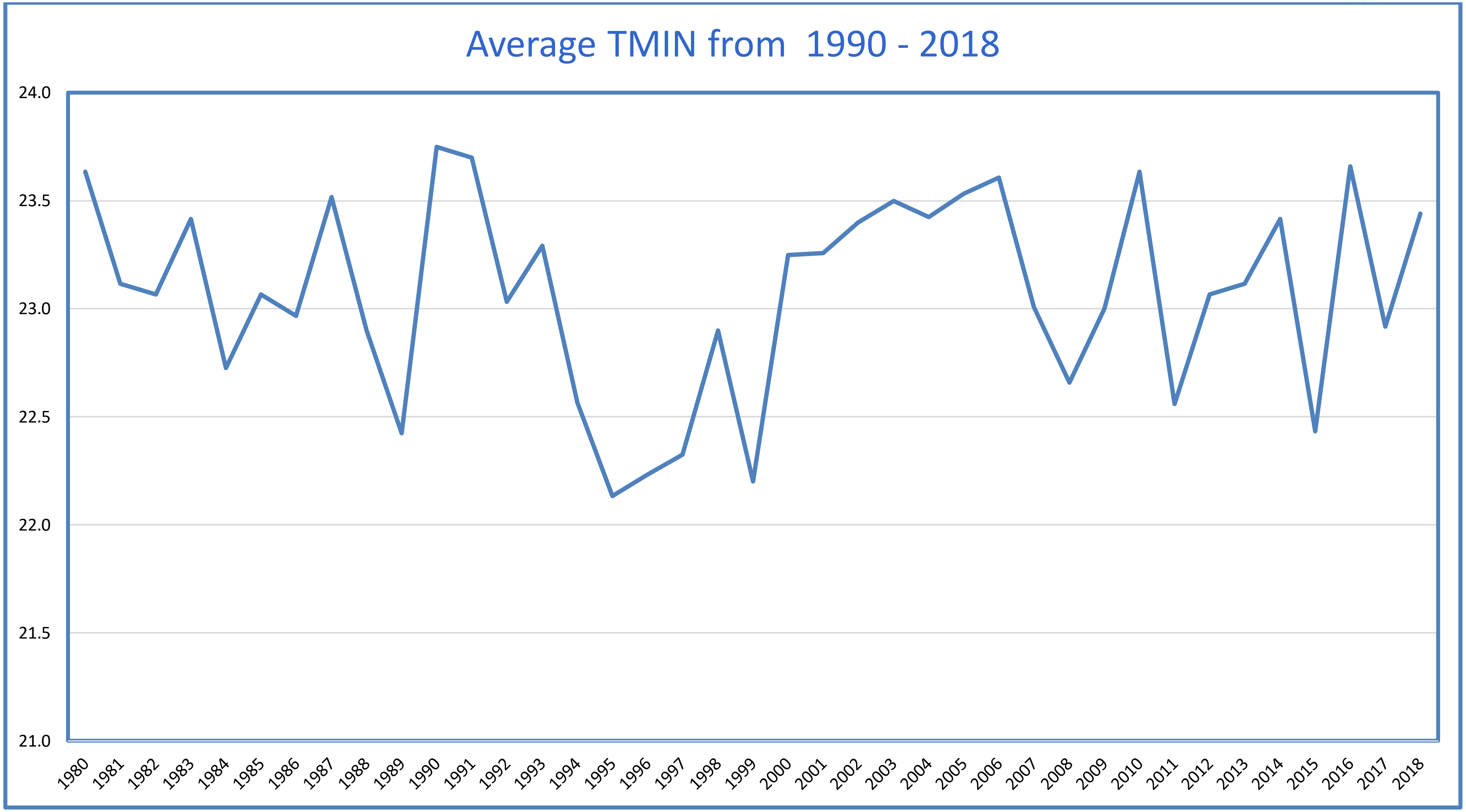

Figure 4.5: Line Graph Showing Average Minimum Temperature for Cross River State from 1980 - 2018

Table 4.3: Average Yearly Rainfall Data from 1980 - 2018

STN	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
Cross River	1980	66.0	10.0	95.9	166.4	217.0	250.6	597.9	392.0	577.6	232.9	153.6	57.5	234.8
Cross River	1981	50.0	10.3	152.6	401.9	523.1	503.1	382.5	516.0	474.8	534.0	230.4	6.8	315.5
Cross River	1982	0.0	15.5	190.4	432.5	423.3	344.6	321.3	734.4	393.4	385.8	212.0	7.4	288.4
Cross River	1983	30.5	109.1	321.2	345.0	315.3	432.0	723.1	433.6	455.4	332.1	168.7	3.8	305.8
Cross River	1984	24.2	257.9	125.1	285.1	302.1	388.4	174.8	266.7	398.8	86.3	6.3	16.7	194.4
Cross River	1985	84.7	323.0	57.1	430.8	166.1	484.9	227.7	273.4	536.3	175.3	134.4	0.1	241.2
Cross River	1986	0.0	154.6	13.5	301.3	383.2	274.1	344.6	623.5	284.3	285.8	126.0	6.8	233.1
Cross River	1987	26.7	226.6	103.2	315.3	283.0	327.4	202.2	398.6	399.2	224.1	148.5	2.9	221.5
Cross River	1988	19.9	278.4	73.5	308.0	270.2	391.9	303.5	335.5	196.4	168.3	0.6	25.6	197.7
Cross River	1989	33.8	295.9	35.3	263.9	299.9	808.2	615.6	624.0	230.4	279.8	182.3	32.9	308.5
Cross River	1990	31.8	63.6	88.2	306.5	130.4	382.6	611.3	406.7	451.3	463.7	27.2	56.7	251.7
Cross River	1991	0.0	181.6	51.1	384.2	265.9	492.2	583.5	415.5	561.7	198.0	262.1	33.1	285.7
Cross River	1992	15.1	184.1	1.0	386.8	216.4	597.7	437.0	510.2	217.9	315.0	102.5	77.1	255.1
Cross River	1993	89.7	87.5		308.9	150.5	577.4	218.3	507.1	273.9	148.1	126.9	0.0	226.2
Cross River	1994	66.0	95.9	0.0	217.0	166.4	597.9	250.6	392.0	577.6	232.9	153.6	57.5	234.0
Cross River	1995	9.5	118.2	1.2	326.9	101.7	330.5	163.8	313.2	276.3	191.2	132.1	39.7	167.0
Cross River	1996	0.0	201.0	5.2	329.6	234.4	203.4	556.3	196.1	248.3	234.6	120.6	3.7	194.4
Cross River	1997	66.0	95.9	0.0	217.0	166.4	597.9	250.6	392.0	577.6	232.9	153.6	57.5	234.0
Cross River	1998	121.0	250.5	111.2	149.3	207.7	274.3	475.0	388.8	191.3	101.3	4.5	0.0	189.6
Cross River	1999	56.0	177.7	27.4	379.0	162.0	240.6	380.2	355.8	284.1	93.4	1.5	2.6	180.0
Cross River	2000	26.7	226.6	103.2	315.3	283.0	327.4	202.2	398.6	399.2	224.1	148.5	2.9	221.5
Cross River	2001	0.0	151.7	11.6	491.4	371.8	268.5	390.5	457.0	455.7	381.0	217.1	5.7	266.8
Cross River	2002	0.0	154.6	13.5	301.3	383.2	274.1	344.6	623.5	284.3	285.8	126.0	6.8	233.1
Cross River	2003	84.7	323.0	57.1	430.8	166.1	484.9	227.7	273.4	536.3	175.3	134.4	0.1	241.2
Cross River	2004	19.9	278.4	73.5	308.0	270.2	391.9	303.5	335.5	196.4	168.3	0.6	25.6	197.7
Cross River	2005	33.8	295.9	35.3	263.9	299.9	808.2	615.6	624.0	230.4	279.8	182.3	32.9	308.5
Cross River	2006	31.8	63.6	88.2	306.5	130.4	382.6	611.3	406.7	451.3	463.7	27.2	56.7	251.7
Cross River	2007	5.4	192.7	62.1	292.9	219.8	269.0	486.1	277.9	276.8	366.4	127.8	1.1	214.8
Cross River	2008	15.1	184.1	1.0	386.8	216.4	597.7	437.0	510.2	217.9	315.0	102.5	77.1	255.1
Cross River	2009	89.7	87.5	0.0	308.9	150.5	577.4	218.3	507.1	273.9	148.1	126.9	0.0	207.4
Cross River	2010	0.0	181.6	51.1	384.2	265.9	492.2	583.5	415.5	561.7	198.0	262.1	33.1	285.7
Cross River	2011	56.0	177.7	27.4	379.0	162.0	240.6	380.2	355.8	284.1	93.4	1.5	2.6	180.0
Cross River	2012	30.7	170.4	83.0	229.6	314.1	552.0	319.5	295.0	268.7	284.1	124.1	0.0	222.6
Cross River	2013	0.0	151.7	11.6	491.4	371.8	268.5	390.5	457.0	455.7	381.0	217.1	5.7	266.8
Cross River	2014	0.0	121.1	17.3	343.5	290.8	267.0	313.3	261.6	395.4	237.7	277.6	0.0	210.4
Cross River	2015	230.4	0.0	182.3	355.8	34.0	451.3	463.7	453.0	379.0	162.0	240.6	380.2	277.7
Cross River	2016	379.0	162.0	240.6	398.6	0.0	276.8	366.4	88.2	315.3	283.0	327.4	202.2	253.3
Cross River	2017	229.6	314.1	552.0	457.0	82.0	5.4	192.7	0.0	491.4	371.8	268.5	390.5	279.6
Cross River	2018	217.9	315.0	102.5	623.5	76.0	15.1	184.1	1.0	301.3	383.2	274.1	0.0	207.8

Source: NIMET

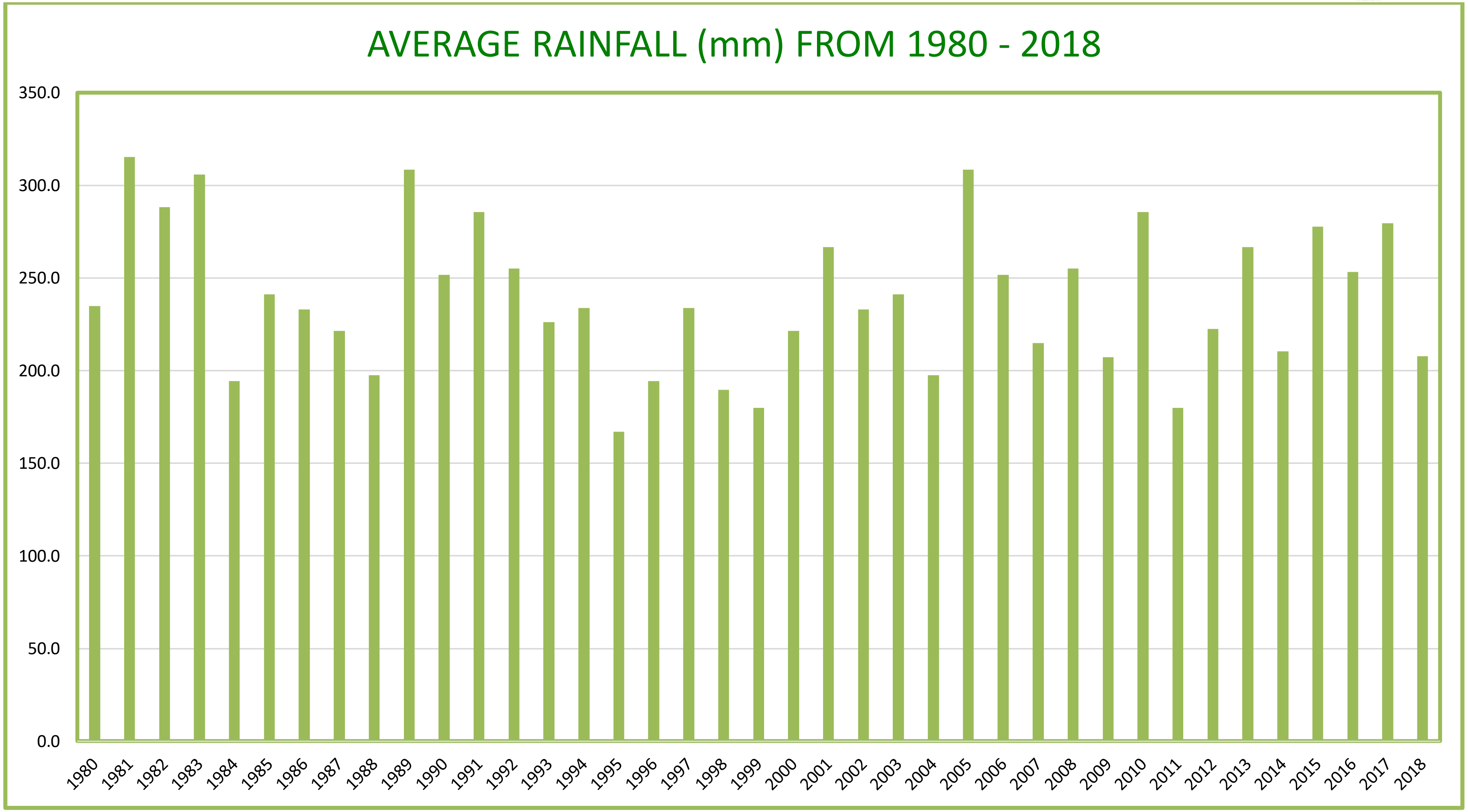

Figure 4.6: Bar Chart Showing Average Annual Rainfall for Cross River State from 1980 – 2018

Table 4.4: Average Yearly Relative Humidity @9 Hours Data for Cross River State from 1980 - 2018

STN	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
Cross River	1980	87.0	82.0	84.0	86.0	86.0	91.0	91.0	94.0	89.0	89.0	87.0	75.0	86.8
Cross River	1981	78.0	80.0	83.0	84.0	86.0	88.0	90.0	92.0	89.0	86.0	83.0	81.0	85.0
Cross River	1982	81.0	75.0	84.0	83.0	85.0	89.0	92.0	92.0	90.0	86.0	86.0	84.0	85.6
Cross River	1983	50.0	75.0	77.0	82.0	88.0	88.0	90.0	92.0	89.0	87.0	85.0	86.0	82.4
Cross River	1984	79.0	75.0	82.0	83.0	84.0	84.0	87.0	86.0	88.0	87.0	85.0	76.0	83.0
Cross River	1985	79.0	75.0	82.0	83.0	84.0	84.0	87.0	86.0	88.0	87.0	85.0	76.0	83.0
Cross River	1986	78.0	82.0	83.0	82.0	84.0	85.0	92.0	89.0	89.0	88.0	85.0	73.0	84.2
Cross River	1987	80.0	83.0	81.0	82.0	85.0	83.0	88.0	91.0	88.0	89.0	84.0	83.0	84.8
Cross River	1988	82.0	82.0	82.0	78.0	79.0	87.0	88.0	90.0	88.0	88.0	85.0	80.0	84.1
Cross River	1989	65.0	66.0	82.0	84.0	84.0	88.0	90.0	91.0	89.0	86.0	85.0	80.0	82.5
Cross River	1990	84.0	76.0	81.0	84.0	84.0	87.0	87.0	89.0	88.0	87.0	87.0	76.0	84.2
Cross River	1991	77.0	80.0	83.0	85.0	84.0	87.0	91.0	92.0	87.0	88.0	86.0	79.0	84.9
Cross River	1992	68.0	75.0	85.0	86.0	85.0	89.0	91.0	94.0	91.0	87.0	84.0	75.0	84.2
Cross River	1993	71.0	78.0	83.0	84.0	85.0	88.0	89.0	92.0	88.0	87.0	88.0	81.0	84.5
Cross River	1994	84.0	76.0	75.0	78.0	84.0	87.0	93.0	91.0	88.0	87.0	87.0	87.0	84.8
Cross River	1995	72.0	78.0	84.0	85.0	85.0	88.0	90.0	90.0	88.0	87.0	82.0	86.0	84.6
Cross River	1996	85.0	81.0	86.0	84.0	82.0	86.0	91.0	92.0	91.0	86.0	83.0	84.0	85.9
Cross River	1997	76.0	80.0	84.0	85.0	85.0	87.0	94.0	94.0	90.0	87.0	84.0	69.0	84.6
Cross River	1998	73.0	77.0	78.0	82.0	82.0	85.0	88.0	90.0	89.0	87.0	86.0	83.0	83.3
Cross River	1999	81.0	86.0	83.0	87.0	84.0	85.0	88.0	89.0	89.0	89.0	88.0	80.0	85.8
Cross River	2000	84.0	71.0	80.0	84.0	84.0	89.0	90.0	91.0	86.0	85.0	86.0	82.0	84.3
Cross River	2001	82.0	70.0	83.0	85.0	84.0	87.0	90.0	93.0	89.0	87.0	86.0	85.0	85.1
Cross River	2002	67.0	75.0	85.0	84.0	84.0	86.0	88.0	91.0	87.0	87.0	85.0	81.0	83.3
Cross River	2003	81.0	82.0	82.0	84.0	86.0	86.0	87.0	92.0	90.0	85.0	86.0	82.0	85.3
Cross River	2004	87.0	80.0	76.0	85.0	82.0	90.0	90.0	86.0	87.0	87.0	86.0	81.0	84.8
Cross River	2005	81.0	70.0	78.0	81.0	84.0	85.0	91.0	92.0	91.0	88.0	86.0	79.0	83.8
Cross River	2006	86.0	85.0	81.0	84.0	84.0	84.0	88.0	90.0	87.0	84.0	84.0	87.0	85.3
Cross River	2007	87.0	82.0	80.0	85.0	86.0	87.0	89.0	84.0	90.0	87.0	86.0	86.0	85.8
Cross River	2008	89.0	86.0	84.0	82.0	84.0	88.0	92.0	91.0	89.0	86.0	86.0	85.0	86.8
Cross River	2009	86.0	85.0	82.0	85.0	84.0	87.0	89.0	91.0	88.0	89.0	86.0	85.0	86.4
Cross River	2010	79.0	78.0	86.0	82.0	85.0	90.0	89.0	90.0	89.0	87.0	84.0	85.0	85.3
Cross River	2011	80.0	78.0	83.0	84.0	86.0	88.0	90.0	92.0	89.0	86.0	81.0	83.0	85.0
Cross River	2012	75.0	81.0	84.0	83.0	85.0	89.0	92.0	92.0	90.0	86.0	84.0	86.0	85.6
Cross River	2013	75.0	50.0	77.0	82.0	88.0	88.0	90.0	92.0	89.0	87.0	86.0	85.0	82.4
Cross River	2014	82.0	87.0	84.0	86.0	86.0	91.0	91.0	94.0	89.0	89.0	75.0	87.0	86.8
Cross River	2015	86.0	79.0	85.0	91.0	71.0	80.0	84.0	84.0	89.0	90.0	84.0	87.0	84.2
Cross River	2016	87.0	86.0	81.0	91.0	92.0	87.0	88.0	86.0	79.0	91.0	86.0	83.0	86.4
Cross River	2017	71.0	80.0	84.0	84.0	89.0	90.0	91.0	86.0	86.0	67.0	75.0	89.0	82.7
Cross River	2018	82.0	84.0	87.0	82.0	84.0	86.0	86.0	87.0	85.0	94.0	82.0	86.0	85.4

Source: NIMET

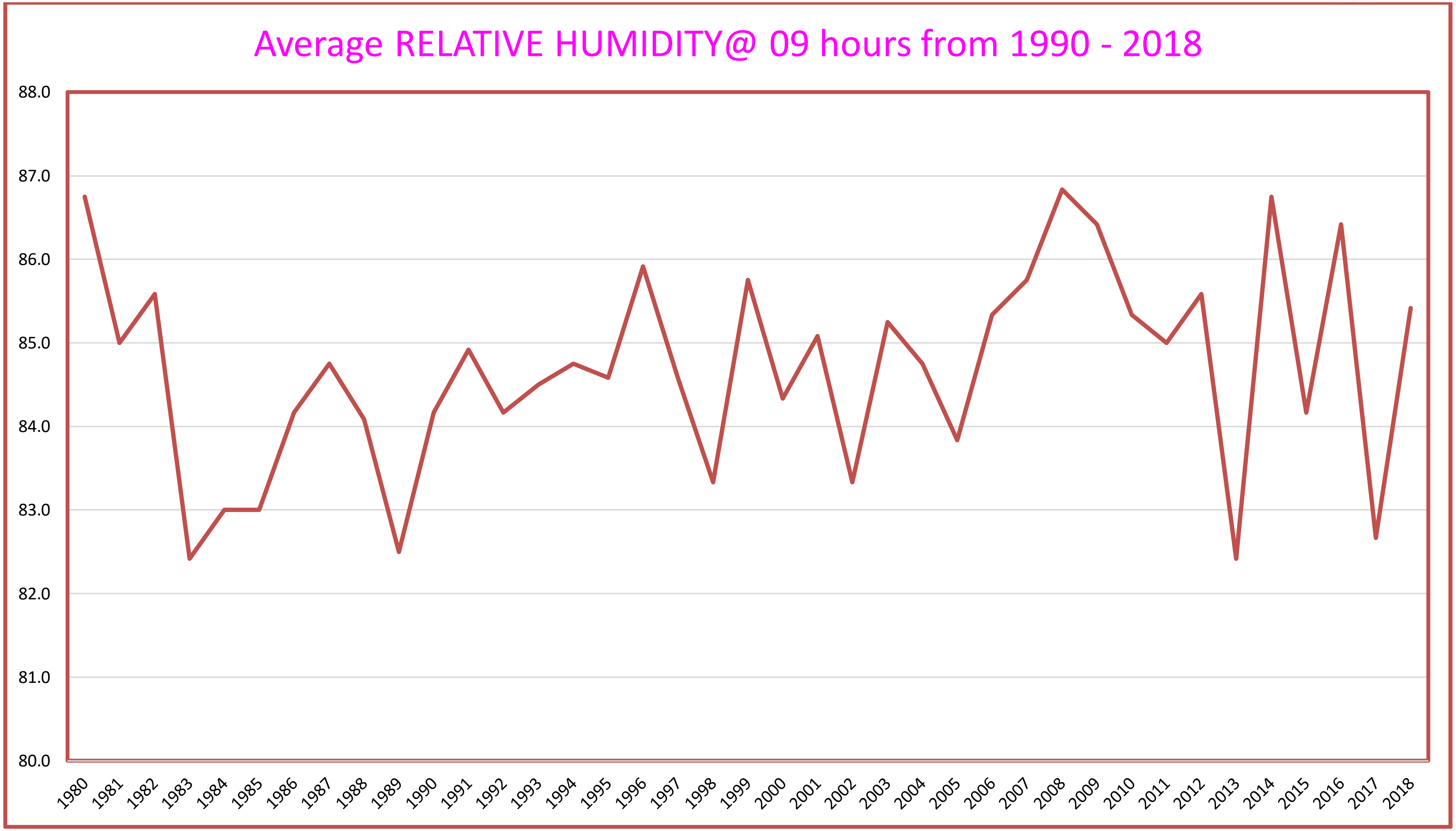

Figure 4.7: Line Graph Showing Average Yearly Relative Humidity @9 Hours for Cross River State from 1980 - 2018

Table 4.5: Average Yearly Relative Humidity @15 Hours Data for Cross River State from 1980 - 2018

STN	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
Cross River	1980	62.0	62.0	64.0	75.0	77.0	83.0	84.0	88.0	82.0	80.0	73.0	58.0	74.0
Cross River	1981	56.0	55.0	67.0	43.0	62.0	71.0	74.0	79.0	81.0	84.0	68.0	59.0	66.6
Cross River	1982	64.0	57.0	66.0	60.0	62.0	72.0	76.0	82.0	88.0	84.0	71.0	63.0	70.4
Cross River	1983	42.0	51.0	57.0	67.0	80.0	83.0	85.0	88.0	82.0	79.0	72.0	67.0	71.1
Cross River	1984	63.0	54.0	63.0	63.0	68.0	71.0	71.0	74.0	73.0	76.0	70.0	57.0	66.9
Cross River	1985	63.0	47.0	63.0	70.0	72.0	78.0	78.0	81.0	77.0	77.0	72.0	61.0	69.9
Cross River	1986	55.0	53.0	56.0	69.0	69.0	73.0	79.0	82.0	83.0	72.0	73.0	57.0	68.4
Cross River	1987	51.0	60.0	66.0	67.0	71.0	75.0	77.0	82.0	77.0	77.0	71.0	61.0	69.6
Cross River	1988	61.0	57.0	65.0	67.0	66.0	74.0	80.0	83.0	80.0	77.0	70.0	65.0	70.4
Cross River	1989	55.0	62.0	67.0	68.0	68.0	75.0	85.0	81.0	80.0	78.0	73.0	55.0	70.6
Cross River	1990	42.0	51.0	57.0	67.0	80.0	83.0	85.0	81.0	80.0	78.0	73.0	55.0	69.3
Cross River	1991	55.0	61.0	67.0	70.0	75.0	75.0	82.0	86.0	77.0	77.0	72.0	60.0	71.4
Cross River	1992	50.0	45.0	65.0	71.0	70.0	78.0	84.0	90.0	83.0	75.0	67.0	56.0	69.5
Cross River	1993	45.0	43.0	64.0	69.0	72.0	78.0	80.0	83.0	81.0	74.0	70.0	57.0	68.0
Cross River	1994	59.0	56.0	64.0	68.0	72.0	76.0	98.0	83.0	80.0	77.0	70.0	65.0	72.3
Cross River	1995	49.0	62.0	67.0	68.0	68.0	75.0	85.0	81.0	80.0	78.0	73.0	55.0	70.1
Cross River	1996	55.0	56.0	65.0	68.0	72.0	78.0	81.0	83.0	78.0	72.0	75.0	65.0	70.7
Cross River	1997	59.0	43.0	62.0	71.0	74.0	79.0	81.0	84.0	77.0	73.0	72.0	55.0	69.2
Cross River	1998	60.0	60.0	62.0	72.0	76.0	82.0	88.0	84.0	85.0	75.0	75.0	67.0	73.8
Cross River	1999	59.0	56.0	65.0	72.0	71.0	75.0	77.0	76.0	79.0	79.0	76.0	56.0	70.1
Cross River	2000	58.0	59.0	69.0	70.0	70.0	78.0	78.0	85.0	82.0	76.0	63.0	58.0	70.5
Cross River	2001	52.0	45.0	68.0	70.0	71.0	75.0	80.0	90.0	84.0	74.0	71.0	61.0	70.1
Cross River	2002	52.0	68.0	69.0	71.0	75.0	80.0	87.0	77.0	78.0	73.0	63.0	60.0	71.1
Cross River	2003	60.0	64.0	71.0	74.0	76.0	78.0	83.0	79.0	77.0	73.0	62.0	56.0	71.1
Cross River	2004	63.0	54.0	63.0	63.0	68.0	71.0	71.0	74.0	73.0	76.0	70.0	57.0	66.9
Cross River	2005	61.0	62.0	66.0	75.0	78.0	77.0	81.0	87.0	83.0	78.0	77.0	70.0	74.6
Cross River	2006	61.0	57.0	72.0	71.0	75.0	82.0	88.0	88.0	85.0	76.0	69.0	66.0	74.2
Cross River	2007	61.0	46.0	55.0	68.0	70.0	72.0	79.0	83.0	81.0	77.0	71.0	59.0	68.5
Cross River	2008	60.0	59.0	70.0	71.0	71.0	75.0	82.0	84.0	80.0	77.0	71.0	66.0	72.2
Cross River	2009	57.0	63.0	68.0	72.0	76.0	79.0	83.0	87.0	81.0	80.0	65.0	65.0	73.0
Cross River	2010	66.0	60.0	70.0	72.0	72.0	75.0	86.0	88.0	84.0	77.0	72.0	61.0	73.6
Cross River	2011	56.0	55.0	67.0	80.0	75.0	80.0	84.0	86.0	82.0	75.0	68.0	59.0	72.3
Cross River	2012	64.0	57.0	66.0	75.0	79.0	82.0	85.0	87.0	83.0	78.0	71.0	63.0	74.2
Cross River	2013	42.0	51.0	57.0	67.0	80.0	83.0	85.0	88.0	82.0	79.0	72.0	67.0	71.1
Cross River	2014	62.0	62.0	64.0	75.0	77.0	83.0	84.0	88.0	82.0	80.0	73.0	58.0	74.0
Cross River	2015	70.0	78.0	83.0	79.0	77.0	70.0	71.0	71.0	84.0	86.0	82.0	75.0	77.2
Cross River	2016	66.0	71.0	71.0	74.0	73.0	80.0	75.0	80.0	84.0	86.0	82.0	66.0	75.7
Cross River	2017	68.0	72.0	76.0	79.0	82.0	85.0	87.0	83.0	78.0	80.0	75.0	56.0	76.8
Cross River	2018	42.0	52.0	68.0	69.0	71.0	75.0	80.0	87.0	77.0	55.0	68.0	64.0	67.3

Source: NIMET

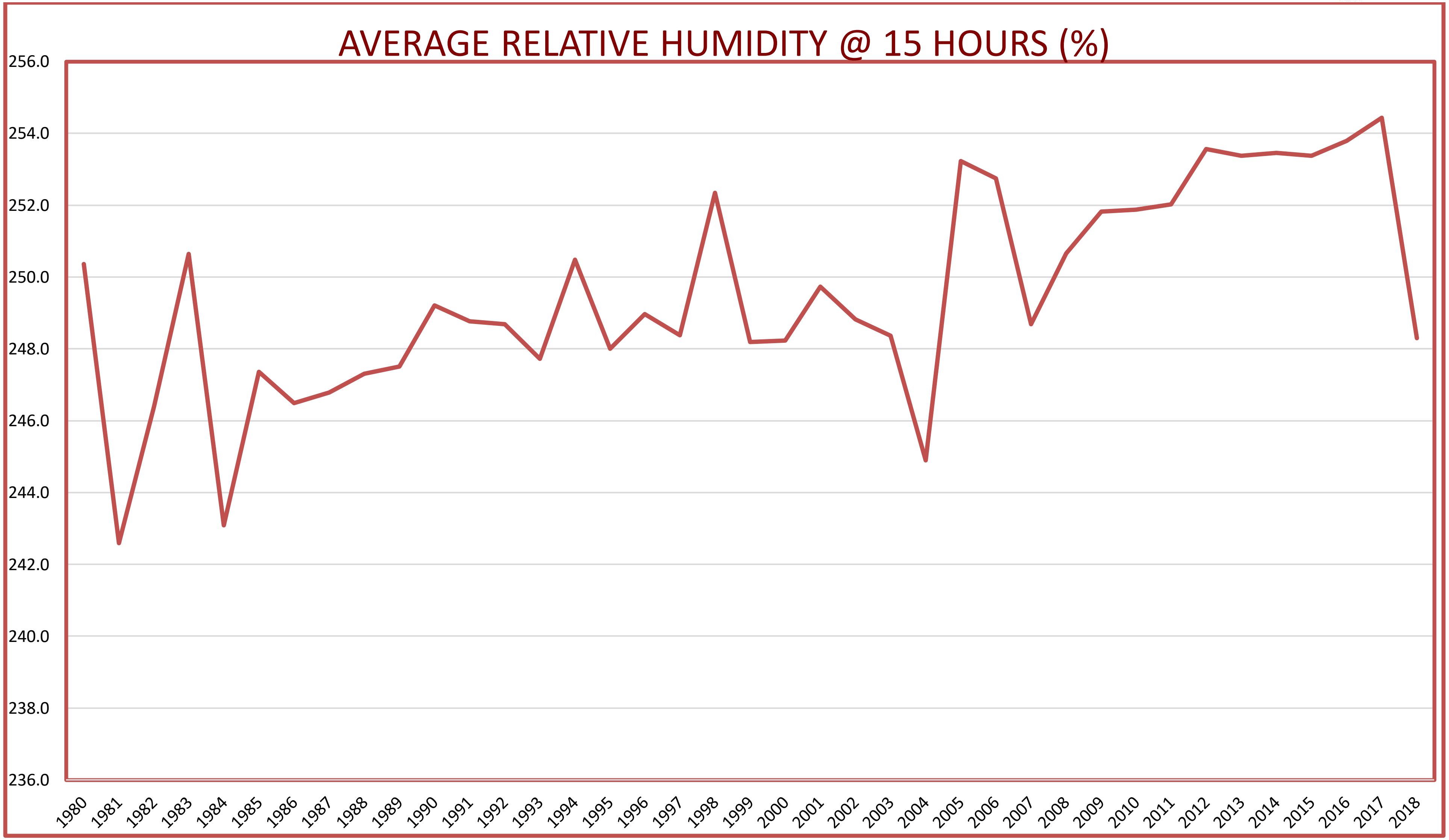

Figure 4.8: Line Graph Showing Average Yearly Relative Humidity @15 Hours for Cross River State from 1980 - 2018

Table 4.6: Average Yearly Wind Speed Data for Cross River State from 1980 - 2018

STN	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
Cross River	1980	6.0	3.8	4.8	4.6	5.0	4.2	5.0	6.3	4.7	3.7	5.0	3.8	4.7
Cross River	1981	5.8	3.8	7.0	5.5	5.7	3.9	4.2	4.7	3.8	4.6	4.5	3.9	4.8
Cross River	1982	4.9	4.1	5.3	4.7	5.9	3.4	3.9	3.2	4.5	3.8	3.9	4.1	4.3
Cross River	1983	3.8	4.3	4.9	4.1	3.7	3.6	4.2	3.9	4.2	3.6	3.3	3.5	3.9
Cross River	1984	4.4	3.6	4.1	4.4	5.3	2.9	3.8	4.8	3.7	3.7	2.9	3.2	3.9
Cross River	1985	5.0	4.9	4.9	5.1	5.1	4.4	4.8	4.3	3.9	4.3	4.4	3.8	4.6
Cross River	1986	4.1	3.5	3.2	5.2	4.0	3.1	2.9	4.1	4.0	3.2	3.1	2.4	3.6
Cross River	1987	3.4	3.8	3.8	4.2	3.9	3.2	3.4	3.8	3.8	3.8	3.2	3.5	3.7
Cross River	1988	4.6	4.1	3.6	3.9	3.3	3.5	3.3	3.9	4.0	3.3	3.5	3.5	3.7
Cross River	1989	4.0	4.1	4.2	4.4	4.1	3.5	4.1	3.8	3.9	4.1	3.5	3.3	3.9
Cross River	1990	4.4	3.6	4.1	4.4	5.3	2.9	3.8	4.8	3.7	3.7	2.9	3.2	3.9
Cross River	1991	4.5	6.0	3.3	4.4	3.9	3.2	3.3	3.5	3.7	3.8	3.2	3.4	3.9
Cross River	1992	5.0	4.9	4.8	5.3	4.5	4.1	4.8	3.5	3.9	5.5	4.1	4.0	4.5
Cross River	1993	4.2	4.6	4.2	5.1	5.3	3.9	4.4	3.9	4.2	4.2	3.9	4.4	4.4
Cross River	1994	3.7	4.7	4.0	4.3	5.0	3.7	4.8	4.5	4.2	3.7	3.7	4.1	4.2
Cross River	1995	4.0	4.1	3.3	3.9	3.9	2.9	2.8	4.0	3.7	3.1	2.9	2.7	3.4
Cross River	1996	4.9	4.9	3.8	4.8	3.9	3.7	4.0	4.0	4.0	4.0	3.7	3.7	4.1
Cross River	1997	4.2	3.3	3.4	5.1	4.5	3.4	2.5	2.9	2.2	3.1	3.4	2.5	3.4
Cross River	1998	3.9	3.7	2.8	5.4	3.6	3.4	2.7	2.8	2.9	3.1	3.4	2.4	3.3
Cross River	1999	3.0	3.7	3.9	3.2	3.7	3.3	2.6	4.0	2.9	3.4	3.3	3.0	3.3
Cross River	2000	4.9	4.2	3.8	4.4	3.9	3.7	3.9	4.0	4.0	4.0	3.7	3.7	4.0
Cross River	2001	5.0	4.9	4.9	5.1	5.1	4.4	4.8	4.3	3.9	4.3	4.4	3.8	4.6
Cross River	2002	4.0	4.1	4.2	4.4	4.1	3.5	4.1	3.8	3.9	4.1	3.5	3.3	3.9
Cross River	2003	3.4	3.8	3.8	4.2	3.9	3.2	3.4	3.8	3.8	3.8	3.2	3.5	3.7
Cross River	2004	4.6	4.1	3.6	3.9	3.3	3.5	3.3	3.9	4.0	3.3	3.5	3.5	3.7
Cross River	2005	4.3	4.4	4.1	4.2	3.9	3.0	3.5	6.5	3.5	3.8	3.0	3.6	4.0
Cross River	2006	4.3	4.4	4.1	4.2	3.9	3.0	3.5	6.5	3.5	3.8	3.0	3.6	4.0
Cross River	2007	4.5	6.0	3.3	4.4	3.9	3.2	3.3	3.5	3.7	3.8	3.2	3.4	3.9
Cross River	2008	5.0	4.9	4.8	5.3	4.5	4.1	4.8	3.5	3.9	5.5	4.1	4.0	4.5
Cross River	2009	4.2	4.6	4.2	5.1	5.3	3.9	4.4	3.9	4.2	4.2	3.9	4.4	4.4
Cross River	2010	3.7	4.7	4.0	4.3	5.0	3.7	4.8	4.5	4.2	3.7	3.7	4.1	4.2
Cross River	2011	3.3	2.9	2.9	3.2	3.3	2.4	3.2	2.8	2.4	2.5	2.4	2.8	2.8
Cross River	2012	4.0	3.2	3.3	3.8	2.9	2.8	2.8	2.7	3.3	3.0	2.8	3.1	3.1
Cross River	2013	3.7	3.9	3.4	3.7	3.7	2.5	2.9	3.1	3.6	2.9	2.5	2.7	3.2
Cross River	2014	4.8	3.9	3.7	4.0	4.0	5.0	4.0	3.5	3.2	3.1	3.2	3.3	3.8
Cross River	2015	5.1	4.5	3.4	2.5	2.9	2.2	3.1	4.1	3.8	3.9	4.1	3.5	3.6
Cross River	2016	5.4	3.6	3.4	2.7	2.8	2.9	3.1	3.4	3.8	3.8	3.8	3.2	3.5
Cross River	2017	4.2	5.1	5.3	3.9	4.4	3.9	4.2	3.3	3.9	4.0	3.3	3.5	4.1
Cross River	2018	4.0	4.3	5.0	3.7	4.8	4.5	4.2	3.5	6.5	3.5	3.8	3.0	4.2

Source: NIMET

Table 4.7: Wind Direction Data for Cross River State from 1980 - 2018

STN	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Cross River	1980	W	NW	S	SW	SW	SW	SW	W	W	NW	W	NW
Cross River	1981	W	W	S	S	S	W	SW	W	W	W	W	NW
Cross River	1982	NW	N	SW	SW	W	W	W	W	W	S	S	NW
Cross River	1983	W	NE	W	SW	SW	S	SW	SW	SW	SW	SW	E
Cross River	1984	W	W	S	S	S	W	SW	W	W	W	W	NW
Cross River	1985	W	NE	S	W	SW	SW	W	W	W	NW	W	NW
Cross River	1986	W	NW	S	SW	SW	SW	SW	W	W	NW	W	NW
Cross River	1987	W	W	S	S	S	W	SW	W	W	W	W	NW
Cross River	1988	W	NE	S	W	SW	SW	W	W	W	NW	W	NW
Cross River	1989	W	NW	S	SW	SW	SW	SW	W	W	NW	W	NW
Cross River	1990	W	N	S	SW	W	W	SW	W	W	NW	S	NW
Cross River	1991	S	W	W	W	S	SW	W	SW	W	SW	SW	SW
Cross River	1992	SW	NE	SW	SW	SW	S	W	SW	SW	W	SW	E
Cross River	1993	SW	NE	SW	SW	SW	SW	W	SW	SW	NE	SW	W
Cross River	1994	W	SW	W	SW	S	SW	SW	SW	SW	NE	SW	W
Cross River	1995	SW	W	W	S	S	W	SW	W	W	W	W	NE
Cross River	1996	SW	NE	SW	SW	SW	S	W	SW	SW	W	SW	E
Cross River	1997	SW	NE	SW	SW	SW	SW	W	SW	SW	NE	SW	W
Cross River	1998	W	SW	W	SW	S	SW	SW	SW	SW	NE	SW	W
Cross River	1999	SW	SW	SW	SW	SW	SW	SW	SW	SW	NE	SW	NE
Cross River	2000	SW	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	W
Cross River	2001	SW	NE	SW	SW	SW	SW	SW	SW	SW	NE	SW	E
Cross River	2002	W	NE	SW	SW	W	SW	SW	W	SW	NE	SW	E
Cross River	2003	SW	NE	SW	SW	SW	SW	W	SW	SW	NE	SW	W
Cross River	2004	W	SW	S	SW	S	SW	S	S	W	S	W	S
Cross River	2005	NW	NW	SW	SW	SW	SW	W	W	W	W	S	NW
Cross River	2006	NW	N	SW	SW	W	W	W	W	W	S	S	NW
Cross River	2007	S	S	S	S	S	S	S	S	W	W	S	S
Cross River	2008	W	NE	W	SW	SW	S	SW	SW	SW	SW	SW	E
Cross River	2009	NE	NE	W	SW	SW	SW	SW	SW	SW	SW	SW	W
Cross River	2010	NE	SW	SW	SW	S	SW	W	SW	SW	SW	W	W
Cross River	2011	W	W	SW	S	S	W	W	W	W	W	S	NW
Cross River	2012	NW	NE	W	W	SW	SW	W	W	W	W	S	NW
Cross River	2013	NW	NW	SW	SW	SW	SW	W	W	W	W	S	NW
Cross River	2014	W	W	SW	S	S	W	W	W	W	W	S	NW
Cross River	2015	S	NE	SW	S	SW	SW	SW	S	SW	NE	SW	S
Cross River	2016	W	SW	SW	SW	SW	W	W	S	W	NE	S	E
Cross River	2017	W	NE	WS	SW	S	SW	W	W	SW	S	SW	NW
Cross River	2018	W	NE	WS	SW	S	SW	W	W	SW	S	SW	NW

Source: NIMET

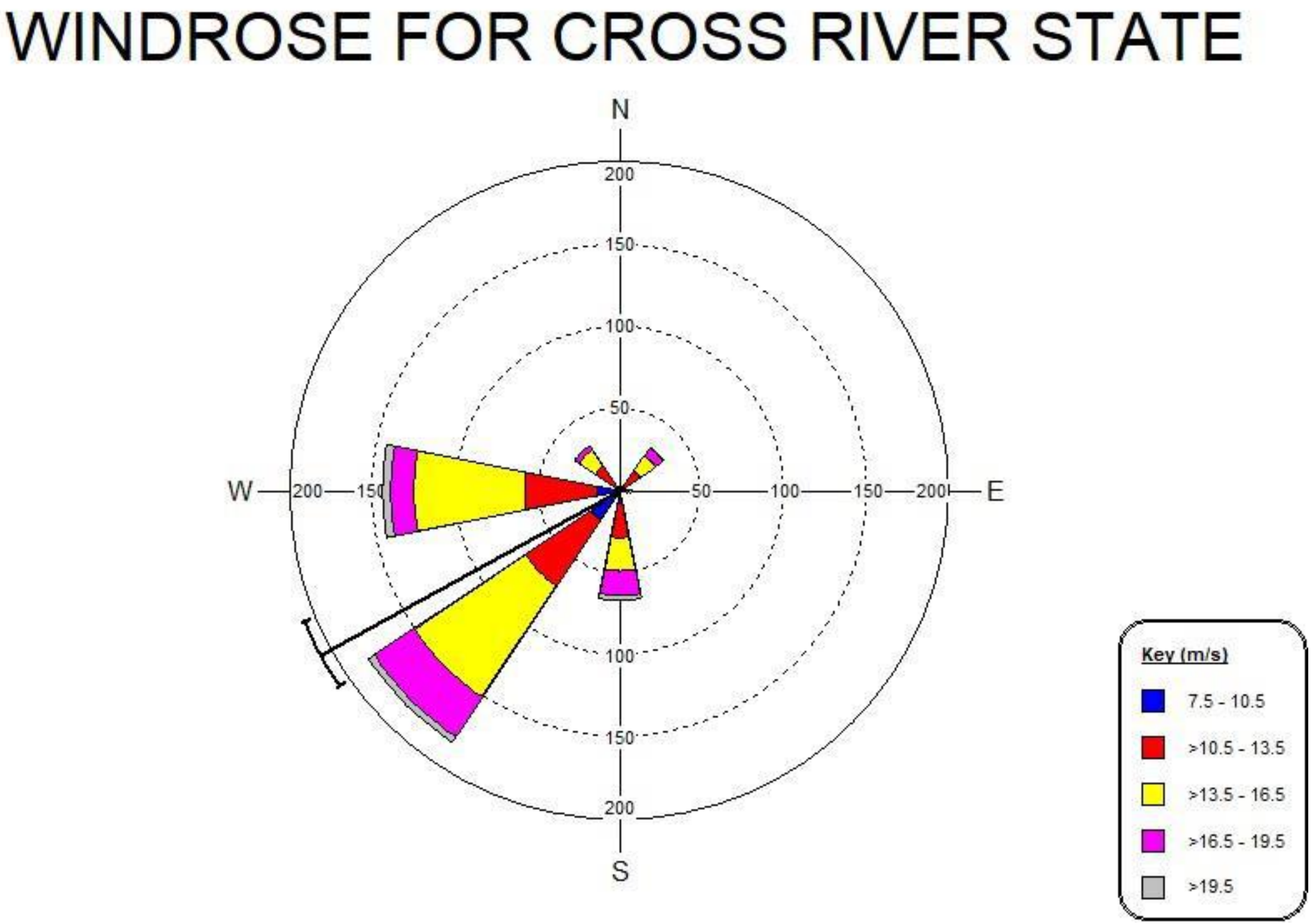

Figure 4.9: Wind Rose for Cross River State (1980 – 2018)

Table 4.8: Average Yearly Sunshine Hours Data for Cross River State from 1980 - 2018

STN	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
Cross River	1980	5.6	4.7	6.1	5.4	5.5	4.8	3.8	3.2	3.3	4.6	5.4	6.8	4.9
Cross River	1981	6.4	5.8	6.3	6.3	5.8	5.8	3.7	3.9	4.1	4.6	5.5	6.3	5.4
Cross River	1982	6.1	4.5	6.2	6.1	6.4	5.3	3.4	2.3	3.2	4.3	6.2	6.4	5.0
Cross River	1983	5.6	4.7	6.1	5.4	5.5	4.8	3.8	3.2	3.3	4.6	5.4	6.8	4.9
Cross River	1984	7.6	6	6	7	6.4	5.1	4.1	2.7	4.1	5.4	7	7	5.7
Cross River	1985	5.5	5.3	5.4	5.4	5.1	4.9	3.9	3.2	3.1	5.3	6.1	6.8	5
Cross River	1986	6.1	4.5	6.2	6.1	6.4	5.3	3.4	2.3	3.2	4.3	6.2	6.4	5.0
Cross River	1987	6.2	5.2	5.7	5.5	5.5	5	4.2	3.5	3.1	4.3	5.8	6.6	5.1
Cross River	1988	5.8	6.2	5.8	5.8	6.4	5.1	4.2	4.2	3.6	4.2	6.3	5.8	5.3
Cross River	1989	5.1	5.8	6.2	5.8	5.8	6.4	5.1	4.2	4.2	3.6	4.2	6.3	5.2
Cross River	1990	6.8	6.1	5.8	6.6	6.6	5.2	4.1	2.6	3.9	4.9	6.9	6.6	5.5
Cross River	1991	6.1	6.3	6.8	6.3	6.8	5.1	4.1	4.6	4	4.1	5.4	5.1	5.4
Cross River	1992	6.3	5.7	5.4	6.1	6.9	5.7	3.6	3.5	3.3	5.8	5.8	5.3	5.3
Cross River	1993	6	6.2	5.5	6.6	6.6	5.4	3.7	1.4	3.3	4.8	7.8	7.4	5.4
Cross River	1994	6.2	6.2	5.2	6.4	6.7	5.3	4.2	3.8	4.2	5.3	7	6.6	5.6
Cross River	1995	7.2	5.9	6.1	7	6.3	5.3	4.4	3.2	4.2	4.8	6.9	6.9	5.7
Cross River	1996	5.9	5.5	5.9	6.8	6.4	5.2	3.6	4.1	3.8	5.6	6.2	6.5	5.5
Cross River	1997	5.8	6.3	5.5	6.3	5.8	4.8	3.4	3.3	3.7	5.5	6.1	6.7	5.3
Cross River	1998	6.2	5.2	5.7	5.5	5.5	5	4.2	3.5	3.1	4.3	5.8	6.6	5.1
Cross River	1999	6.1	4.5	6.2	6.1	6.4	5.3	3.4	2.3	3.2	4.3	6.2	6.4	5
Cross River	2000	7.6	6	6	7	6.4	5.1	4.1	2.7	4.1	5.4	7	6.8	5.7
Cross River	2001	5.6	5.2	6	7	6.5	5.4	2.7	2.5	3.7	4.9	6.3	6.4	5.2
Cross River	2002	5.6	6.5	5.8	5.9	5.5	5.8	3.7	2.5	3.9	4.8	6.1	5.8	5.2
Cross River	2003	5.5	5.3	5.4	5.4	5.1	4.9	3.9	3.2	3.1	5.3	6.1	6.8	5
Cross River	2004	5.7	3.9	5.9	5.9	6.8	5.2	3.4	2.3	3.2	4.1	5.9	5.7	4.8
Cross River	2005	6	6.2	5.5	6.6	6.6	5.4	3.7	1.4	3.3	4.8	7.8	7.4	5.4
Cross River	2006	6.6	5.6	5.3	6.5	6.6	5.5	3.8	2.8	4.1	4	5.4	5.1	5.1
Cross River	2007	5.9	5.9	4.9	6.6	6.9	5.9	3.9	3.9	3.8	4.1	5.9	5.7	5.3
Cross River	2008	6.2	6.2	5.2	6.4	6.7	5.3	4.2	3.8	4.2	5.3	7	6.6	5.6
Cross River	2009	6.1	6.3	6.8	6.3	6.8	5.1	4.1	4.6	4	4.1	5.4	5.1	5.4
Cross River	2010	7.3	5.3	6.3	6.9	6.6	5.8	4.7	2.4	4.1	5.3	6.1	4.4	5.4
Cross River	2011	5.6	4.7	6.1	5.4	5.5	4.8	3.8	3.2	3.3	4.6	5.4	6.8	4.9
Cross River	2012	5.5	4.2	6	7.1	6.2	5.2	3.9	3.2	3.5	4.4	6.1	5.9	5.1
Cross River	2013	6.8	6.1	5.8	6.6	6.6	5.2	4.1	2.6	3.9	4.9	6.9	6.6	5.5
Cross River	2014	7.2	5.5	5.6	6.9	6.4	5.5	2.8	3.9	3.1	4.1	6.3	6.1	5.3
Cross River	2015	6.4	5.8	6.3	6.3	5.8	5.8	3.7	3.9	4.1	4.6	5.5	6.3	5.4
Cross River	2016	5.8	6.2	5.8	5.8	6.4	5.1	4.2	4.2	3.6	4.2	6.3	5.8	5.3
Cross River	2017	6.3	5.7	5.4	6.1	6.9	5.7	3.6	3.5	3.3	5.8	5.8	5.3	5.3
Cross River	2018	7	5.8	5.2	6.5	6.9	5.1	5.2	4.6	4.2	4.9	5.3	5.6	5.5

Source: NIMET

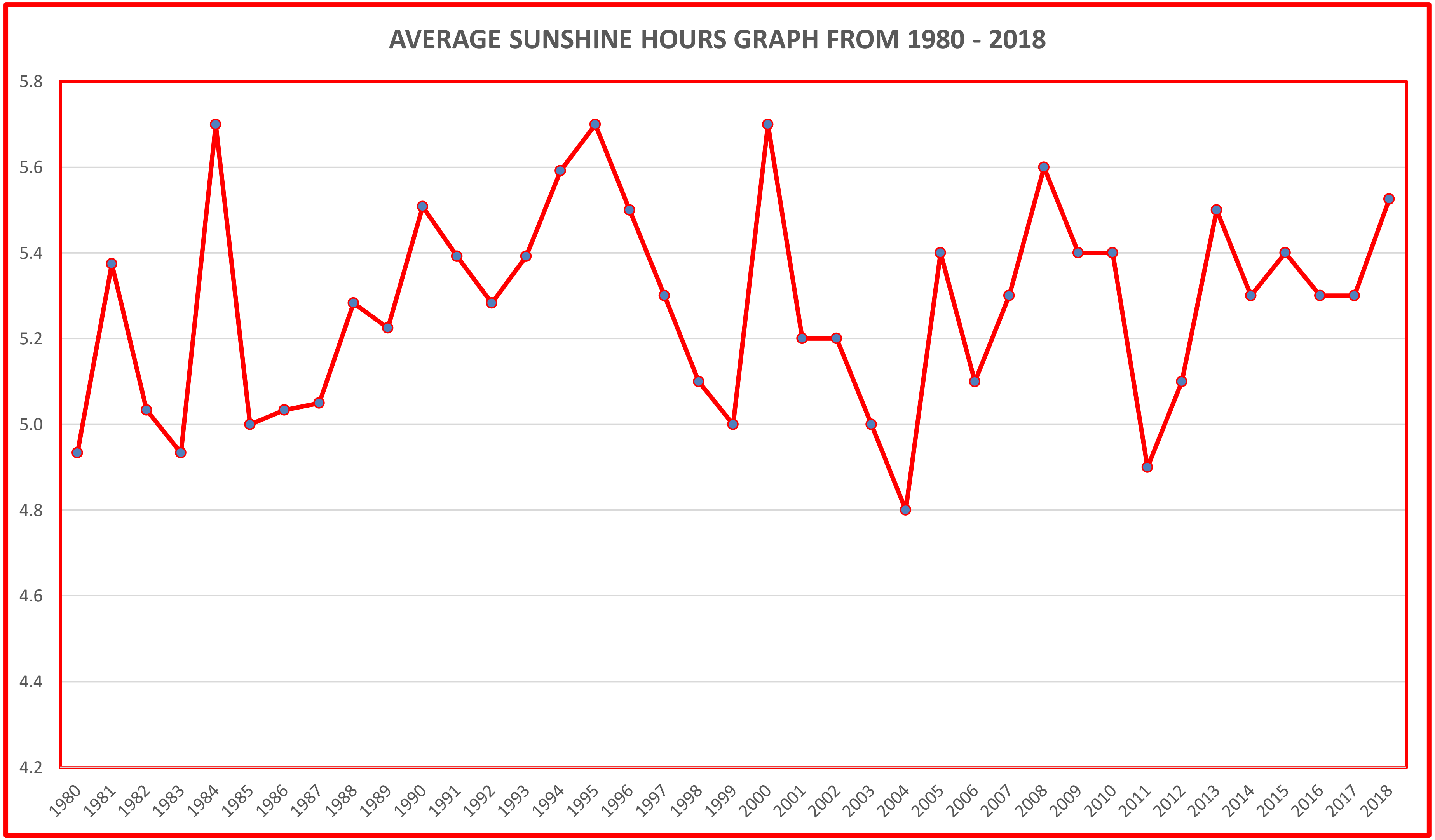

Figure 4.10: Line Graph Showing Average Sunshine Hours for Cross River State from 1980 - 2018

4.4 Baseline Data Acquisition Methods

Baseline data for the study area was generated using a combination of field studies; analysis of maps, plans, aerial photos; review of background project documents (feasibility studies); structured interviews; social surveys and internet searches were carried out. Below are the various study approaches and data acquisition methodologies adopted.

4.4.1 Baseline Study Team

Considering the inter-disciplinary need for conducting the ESIA, Geo Environmental Resources Limited (GERL) ensured that relevant and well experienced team were assembled to deliver on the set objectives. To achieve this, a multi-disciplinary team of experienced scientists and environmental professionals were assembled to carry out the required resource assessment, generation and analysis of baseline data, determination of potential impacts and recommendation of mitigation measures. An interactive approach among the environmental team members and other project professionals was adopted and facilitated by team meetings as required.

4.4.2 Sampling Design & Distribution

Sampling design and distribution was adopted in order to adequately characterise the study area. A comprehensive study was carried out for all environmental and social components as presented in Table 4.9.

Table 4.9: Environmental components and sampling methodologies

S/No.	Environmental component	Methodology
1.	Air Quality/ Climatology	• 4 in 1 Multi-function environment meter. • BW Technologies GAXT-A2-DL Gas Alert Extreme High Range Ammonia (NH3) Single Gas Detector, 0-400 ppm Measuring Range, • AS8905 high-precision portable industrial sulfur dioxide gas detector tester meter SO2 Monitor analyzer, • NO2 Gas Detector Nitrogen Dioxide Gas Analyzer with Alarm System Gas Leak Detector Portable NO2 Industrial Gas Monitor Sensor, • BH-4S 4 in 1 Combustible Gas Detector Oxygen O2 Carbon Monoxide Hydrogen Sulfide Toxic And Harmful Gas Concentration Detector Leak Detector COD, • Temtop M2000 Air Quality Monitor for PM2.5 PM10 Particles CO2 HCHO Temperature Humidity; and • AcuRite 01512 Wireless Weather Station with 5-in-1 Weather Sensor: Temperature and Humidity Gauge, Rainfall, Wind Speed and Wind Direction.
2.	Surface water (surface water bodies within the project influence)	HANNA HI 93414 in situ meter was used to determine dissolved oxygen (DO), pH, electrical conductivity (EC), total dissolved solids (TDS) and water temperature (T). Other water parameters with long holding analytical time will be preserved and analysed in a laboratory.

S/No.	Environmental component	Methodology
3.	Groundwater (groundwater bodies within the project influence)	HANNA HI 93414 in situ meter was used to determine dissolved oxygen (DO), pH, electrical conductivity (EC), total dissolved solids (TDS) and water temperature (T). Other water parameters with long holding analytical time will be preserved and analysed in a laboratory.
4.	Sediment	Sediment samples was collected into aluminium foil using Eckman Grab
5.	Soil	Stainless steel screw-type soil auger. A composite sample was collected from 0-15cm and 16-30cm to represent top soil and bottom soil respectively.
6.	Plankton	Phytoplankton and zooplankton species was collected with a plankton net. In situ visual identification and lab analysis methods was used.
7.	Benthos	Sediment samples was collected wide mouth glass bottles using stainless steel Eckman Grab.
8.	Vegetation and wildlife	The area was divided into transects for sampling. Both in situ identification and ex situ herbarium analysis was carried out on the vegetation samples.
9.	Noise and other Nuisances	4 in 1 Multi-function environment meter was used for measuring noise level in-situ.
10.	Geology and Erosion	Field survey and desktop review.
11.	Socio-economics and health survey	Semi structured interviews, focus group discussion, consultations and grievance procedures.
12.	Transport study	Visual assessment and desktop review.

4.4.3 Air Quality Assessment Method

The spatial boundary for the air quality assessment of this project was limited to 5 km radius; this is so chiefly because of the land take for the project. For sampling of the air quality, the duration was between the hours of 8.00am and 6.00pm.

The following specific air quality assessment were carried out:

- Micro and macro-climatology: Ambient temperature, relative humidity, rainfall, wind speed, wind direction, etc.
- Toxic gases: SOx, NOx, COx, H_2S, etc.
- Greenhouse gases: NOx, etc.
- Dust and particulates: Dust and SPM
- Noise and other Nuisances: Ambient Noise level, vibration, visual impact, odour, flies, heat, etc.

The following ambient air quality monitoring equipments were deployed for air quality assessment:

a) 4 in 1 Multi-function environment meter.

b) BW Technologies GAXT-A2-DL Gas Alert Extreme High Range Ammonia (NH_3) Single Gas Detector, 0-400 ppm Measuring Range,
c) AS8905 high-precision portable industrial sulfur dioxide gas detector tester meter SO_2 Monitor analyzer,
d) NO_2 Gas Detector Nitrogen Dioxide Gas Analyzer with Alarm System Gas Leak Detector Portable NO_2 Industrial Gas Monitor Sensor,
e) BH-4S 4 in 1 Combustible Gas Detector Oxygen O_2 Carbon Monoxide Hydrogen Sulfide Toxic And Harmful Gas Concentration Detector Leak Detector COD,
f) Temtop M2000 Air Quality Monitor for PM2.5 PM10 Particles CO_2 HCHO Temperature Humidity; and
g) AcuRite 01512 Wireless Weather Station with 5-in-1 Weather Sensor: Temperature and Humidity Gauge, Rainfall, Wind Speed and Wind Direction.

Table 4.10: Effects of air pollutants

S/No.	Chemicals/Substance	Effects
1	Carbon dioxide (CO_2)	Respiratory effects, asphyxiation
2	Carbon monoxide (CO)	Chemical asphyxiation
3	Hydrogen Sulfide (H_2S)	Irritation; CNS and respiratory toxicant
4	Chromium (Cr)	Toxic; skin and lung cancer
5	Nitrogen oxide (NO_X)	Airway effects
6	Sulfur oxide (SO_2)	Respiratory and skin irritation bronchitis and emphysema


Plate 4.1: Environmental consultant team explaining how its in-situ digital air quality equipment work to the regulators on site

Plate 4.2: In-situ digital air quality assessment meters with GPS and wireless weather station

4.4.4 Vegetation Characterization Method

The spatial boundary for the vegetation studies is 5 km radius of the project site. Quadrant count method was adopted. 5 quadrants 100 m x 100 m was taken, one within the proposed airport site, another at the Okambi community, the third at Atiekpe community, the fourth at Ikwomikwu community and the last one at Igwo community. Samples were identified at the herbarium by a taxonomist. The general characterization of the vegetation of the study area includes the common name, botanical name, life forms, level of abundance, family, uses and IUCN conservation status.

4.4.5 Method of Soil Studies

The spatial boundary for soil quality assessment is 5 km radius of the proposed project site. Sampling locations for soil samples at the project site were chosen in a way that enhances mapping. At each sampling point, soil samples were collected from two depths, representing surface (0-15 cm) and subsurface soil (16 – 30 cm), these two were uniformly mixed in the laboratory to obtain composite samples. These composite samples were then tested for physico-chemical and microbial parameters. In all, 75 samples were collected from the proposed project site with soil auger while 5 control samples were collected outside the proposed project site. The samples were stored in labeled polythene bags.

The soil samples collected were tested analysed for the following:

a) Soil textural description (particle sizes, % composition, bulk density, etc.)
b) Physico-chemistry (pH, bio-oxygen demand (BOD), chemical oxygen demand (COD), electrical conductivity (EC), alkalinity, Cation exchangeable capacity (CEC), oil & grease (O&G), etc.)
c) Cations and anions (Na^+, K^+, Mg^{2+}, Ca^{2+}, CO_3^{2-}, SO_4^{2-}, Cl^{-1}, PO_4^{2-}, NO_3^- etc.)
d) Heavy metals concentration (Zn, Pb, Mn, Cr, Al, Fe, Hg, etc.)
e) Total organic contents (TPH, Aliphatics, BTEX, etc.)
f) Microbial composition (HUB, HUF, Faecal coliform, etc.)

The Table below shows the methods used for physicochemical analysis of collected samples.

Table 4.11: Test methods for physico-chemical parameters

Parameters	Analytical Methods
pH	Corning pH meter
Temperature (°C)	Mercury Thermometer
Turbidity (NTU)	Turbidimeter
TDS (mg/kg)	Gravimetric method
TSS (mg/kg)	Gravimetric method
DO (mg/kg)	Alkali-iodide-azide method
Oil and Grease Content (mg/kg)	Xylene extraction followed by spectrophometry
Salinity (Cl^-) mg/kg	Salinometer
Ammonia (NH_4^+)	Nesslerization method
Conductivity (µS/cm)	Conductivity meter
TOC (mg/kg)	Potassium dichromate digestion followed by ferrous ammonium sulphate titration
ANIONS	
Nitrate (mg/kg)	Phenoldisulphonic acid method
Sulphate (mg/kg)	Turbidimetric meter
Phosphate (mg/kg)	Ascorbic acid method
Nitrite (mg/kg)	Colorimetric method
CATIONS	
Sodium (mg/kg)	Flame photometric method
Potassium (mg/kg)	Flame photometric method
Calcium (mg/kg)	Titration with ethylenediamine tetra acetic acid (EDTA) method
Magnesium (mg/kg)	Titration with ethylenediamine tetra acetic acid (EDTA) method

4.4.6 Method of Water Sampling

The spatial boundary for water quality assessment is 5 km. Surface water sources are Litam River, Liwhan River, Adima Stream. Control samples for surface water were collected at Abeb River and Dam. Ground water samples were collected at a borehole in Ikwomikwu and Well in Okambi communities respectively. Control samples of ground water were collected in Okwortug and Atiekpe respectively. The water quality study of the project environment was undertaken to provide baseline information on the water resources of the project site environment.

Primary water sources were identified using existing topographical maps, drainage maps, aerial photos and on-the-spot field assessment were carried out. Water quality assessments were carried out:

(a) To give an inventory of the general water resources i.e surface and ground water
(b) To obtain water quality of surface water (river and stream) and ground water (borehole and well water) in the area, notably the physicochemical parameters of water quality.

In-situ measurements shall be carried out for parameters with short holding analytical time such as pH, temperature, conductivity, dissolved oxygen. The analytes and the laboratory analysis methods is summarised in Table 4.12.

Table 4.12: Laboratory analytical method summary

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

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

4.4.6.1 Groundwater Analysis

Five (5) groundwater samples were collected and analysed for the following:

a) Groundwater hydrology (water table, flow direction, seasonal fluctuations, etc.)
b) Physico-chemistry (pH, colour, appearance, temperature, turbidity, bio-oxygen demand (BOD), chemical oxygen demand (COD), electrical conductivity (EC), alkalinity, oil & grease (O&G), etc.)
c) Cations and anions (Na^+, K^+, Mg^{2+}, Ca^{2+}, $CO3^{2-}$, $SO4^{2-}$, CL^{-1}, $PO4^{2-}$,NO^{3-} etc.)
d) Heavy metals concentration (Zn, Pb, Mn, Cr, Al, Fe, Hg, etc.)
e) Total organic contents (TPH, Aliphatics, BTEX, etc.)
f) Microbial composition (HUB, HUF, Faecal coliform, etc.)

4.4.6.2 Surface Water Analysis

Four (4) surface water samples were collected from pre-determined sampling locations and were analysed for the following:

a) Surface water hydrology (water level, flow direction, seasonal fluctuation, source, first & final destination waters, etc.)
b) Physico-chemistry (pH, colour, appearance, temperature, turbidity, bio-oxygen demand (BOD), chemical oxygen demand (COD), electrical conductivity (EC), alkalinity, oil & grease (O&G), etc.)
i. Cations and anions (Na^+, K^+, Mg^{2+}, Ca^{2+}, $CO3^{2-}$, $SO4^{2-}$, CL^{-1}, $PO4^{2-}$,NO^{3-} etc.)

ii. Heavy metals concentration (Zn, Pb, Mn, Cr, Al, Fe, Hg, etc.)
iii. Total organic contents (TPH, Aliphatics, BTEX, etc.)
iv. Microbial composition (HUB, HUF, Faecal coliform, etc.)

4.4.6.3 Microbial Parameters

The Microbial parameters that were measured include Total Heterotrophic Bacteria (THB), Total and Faecal coliform Count and E- coli.

4.4.7 Method of Socio Economic Assessment

The survey was undertaken with respect to demography, occupational pattern, land holding, literacy rate and other important socio-economic indicators of the project host and neighbouring communities to decipher the socio-economic nature of the entire project area. 10 km spatial boundary was maintained to able to capture Okambi, Atiekpe, Ikwomikwu and Igwo communities.

A multi-method approach was used in gathering socio-economic data and information, namely, (1) Focus Group Discussion (FGD), (2) In-Depth Interview (IDI) with questionnaire administration, and (3) Field observation.

1) **Focus Group Discussion (FGD)** - Here, consultations and engagements were held with the project host community traditional heads, community chiefs, community youth groups, other interest groups as well as individuals. Public consultation/forum with the communities represented by all social strata/groups was equally carried out.

2) **In-Depth Interviews (IDI)** - In order to gather information and opinion of residents of Okambi, Atiekpe, Ikwomikwu and Igwo communities, personal interviews were conducted. Households were sampled for interview using probability sampling method. At 95% confidence level with 5% margin error using an estimate population of about 24,500 people, 420 population sample size was used (Denscombe, 2010). A comprehensive questionnaire for data collection was developed, wherein certain information were requested such as: household bio-data, livelihoods, infrastructural facilities currently available. These included road/access, water, electricity, education and healthcare infrastructures available. A total of 420 questionnaires were administered and 400 copies were retrieved for analysis of the socio economic baseline for the project area. (See attached questionnaire in Appendix One).

Plate 4.3: Consultation with Atiekpe, Ikwomikwu, Okambi and Igwo Communities

3) Field Observation - The socio-economic study team also physically inspected major facilities and landmarks, such as water supply points, school buildings, health care facilities, markets, town halls, occupational activities, informal sector activities and conditions of roads and houses. Other areas of interest studied include cultural heritage/artefact and other historical/cultural patrimony of the communities. Demography was yet another area that wasn't left out. The size, land use, economic activities (with emphasis on low income groups highly dependent on primary activities), community structure, employment, markets, labour supply, income distribution, consumption, and migration pattern of the host and neighboring communities was also studied.

4.4.8 Health Impact Assessment

Under the health impact assessment, the existing health facilities with the prevalent health issues/cases within the study area were assessed to generate baseline data on the health status of the people within the project area before the commencement of the proposed project.

4.4.9 Traffic Impact Assessment

The baseline transport data of the study area including volume, peak period, predominant type, safety condition, existing road infrastructure, etc. were studied and documented.

4.5 Quality Assurance and Quality Control Measures

A quality control programme was established at the beginning of the fieldwork in order to ensure the validity of results and comparability of acquired biological data. This involved detailed procedural guidelines for sampling, preservation, labeling, and storage and laboratory analysis. To ensure the accuracy and reliability of in-situ field measurements, field instruments were calibrated prior to use and cross checked from time to time. Field data sheets were carefully kept and inspected at the end of the day's fieldwork to make sure that no samples were missed out. Other Quality Control measures adopted in the field included:

a) Representativeness of samples and repeatability of data,
b) Samples collection and labelling, preservation and storage,
c) Minimizing laboratory sampling error or bias and
d) Data verification

Data sheets for relevant environmental and ecological observations as well as laboratory logbook for laboratory-based aspects of the study were kept throughout the duration of the field work. To ensure that results obtained during analysis compare favourably with the in-situ environment, all samples were analyzed soon after collection. Standard laboratory quality control procedures were adhered to.

4.6 Baseline Studies

4.6.1 Air Quality

4.6.1.1 Results of Air Quality Assessment

The potential air contaminants addressed in this study are nitrogen oxides, sulphur oxides, hydrogen sulphide, carbon monoxide and particulate matter. The results of the air quality of the project site at pre-operation stage are presented in Tables 4.13. Figure 4.11 shows the satellite imagery of spatial distribution of the air quality sampling points of the proposed project site.

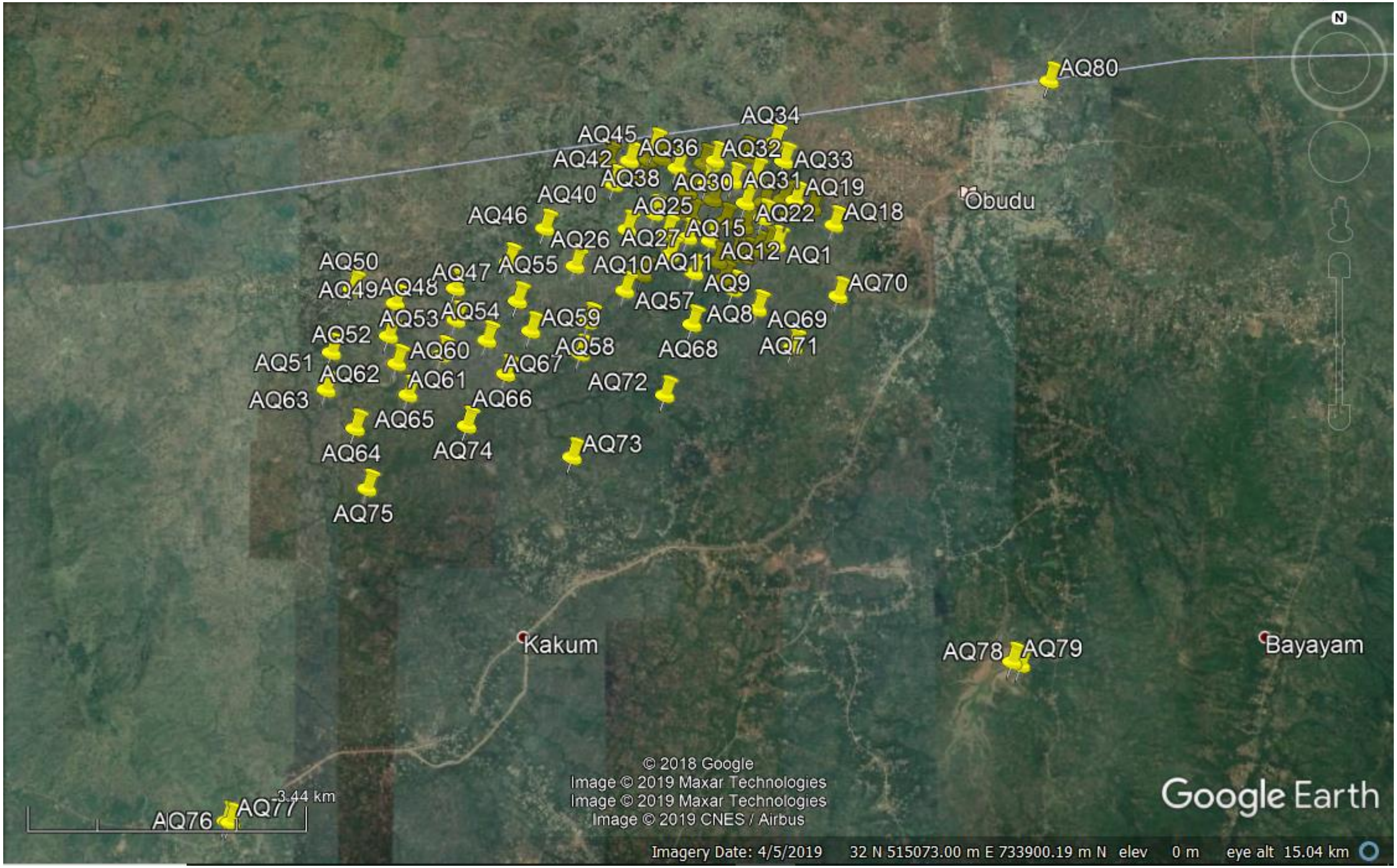

Figure 4.11: Google Map of Air Quality Sampling Points

Table 4.13: Result of air quality sampling at the project site during wet season

Points	Easting	Northing	Elev. (m)	Wind Dire	Temp. °C	RH (%)		Noise (dB)		NO_2 (ppm)	SO_2 (ppm)	NO (ppm)	CO (ppm)	CO_2 (ppm)	NH_3 (pm)	H_2S (ppm)	O_2 %	PM10 µg/m³	PM2.5 µg/m³
						Min	Max	Min	Max										
AQ1	0515990	0736054	185	S	32.2	20.3	20.4	30.4	50.6	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.6	6.8	5.0
AQ2	0515892	0736039	178	N	33.1	17.6	17.7	35.3	46.4	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.5	10.5	8.3
AQ3	0515748	0735989	180	N	32.9	17.5	17.6	28.3	40.2	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	5.3	4.2
AQ4	0515627	0735901	177	N	33.5	17.3	17.4	28.7	48.4	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.6	12.5	9.0
AQ5	0515475	0735920	178	N	35.1	14.8	14.9	35.1	40.3	<0.01	<0.01	<0.01	<0.01	491	<0.01	<0.01	21.7	10.2	8.7
AQ6	0515252	0735840	190	N	33.8	17.1	17.2	29.3	42.8	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.6	6.4	5.1
AQ7	0515318	0735619	194	N	34.4	17.0	17.3	28.1	43.4	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	7.1	4.2
AQ8	0515447	0735493	197	N	33.1	17.0	17.2	28.2	44.1	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	7.8	5.3
AQ9	0514954	0735698	192	N	34.2	17.2	17.3	29.2	43.2	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.5	8.4	6.2
AQ10	0514652	0735929	177	N	32.1	17.1	17.4	29.3	45.1	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.3	9.3	6.4
AQ11	0514874	0736145	173	N	33.1	17.2	17.5	31.1	46.2	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.6	9.4	7.2
AQ12	0515161	0736101	173	N	34.2	17.1	17.6	29.4	41.2	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	10.3	8.3
AQ13	0515334	0736338	182	NW	33.6	17.6	17.7	27.4	42.3	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.8	10.4	9.4
AQ14	0515585	0736289	186	NW	33.1	17.1	17.8	23.1	42.1	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	11.1	10.2
AQ15	0515817	0736390	183	NW	34.2	17.2	17.4	24.1	44.2	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	11.4	9.3
AQ16	0516141	0736425	196	NW	35.2	17.1	17.5	25.2	41.3	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	12.1	10.3
AQ17	0516438	0736515	193	NW	35.3	17.1	17.2	25.2	42.1	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	9.3	9.4
AQ18	0516715	0736303	189	NW	35.4	17.1	17.3	23.7	42.3	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.3	9.4	7.4
AQ19	0516226	0736613	202	NW	36.1	17.3	17.4	24.1	44.4	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	9.3	6.3
AQ20	0516070	0736624	185	NW	37.1	17.2	17.5	25.1	44.5	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.8	13.4	9.4
AQ21	0515830	0736592	191	NW	38.1	17.2	17.3	22.1	45.6	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	14.1	10.1
AQ22	0515600	0736578	192	NW	31.2	17.3	17.4	23.1	46.1	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.6	11.0	9.3
AQ23	0515189	0736621	187	NW	32.1	17.4	17.5	24.1	47.1	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.7	9.4	6.4
AQ24	0514907	0736401	183	N	33.2	17.5	17.6	21.3	48.1	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.8	9.5	5.3
AQ25	0514611	0736196	173	NW	34.1	17.1	17.6	21.4	48.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	9.6	4.3
AQ26	0514112	0736246	175	E	32.1	20.3	21.4	28.1	41.3	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.6	10.1	9.3
AQ27	0514455	0736446	174	E	32.4	21.4	25.6	29.2	43.2	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.7	12.3	10.6
AQ28	0514770	0736493	180	E	33.1	22.3	26.1	24.3	42.3	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.9	12.4	9.3
AQ29	0514872	0736716	186	E	33.0	22.4	27.3	25.4	44.4	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.4	10.4	9.1
AQ30	0515116	0736820	199	E	32.0	21.3	24.3	26.3	51.3	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.5	9.8	7.3
AQ31	0515444	0736849	201	E	33.0	21.04	24.0	27.4	51.1	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.6	12.8	10.1
AQ32	0515722	0736920	202	E	32.1	22.4	23.2	28.1	52.1	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	22.1	13.1	11.2
AQ33	0516086	0737107	206	NW	32.4	22.4	24.0	25.2	42.1	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	22.0	9.1	8.3
AQ34	0515967	0737343	196	N	32.0	23.0	24.1	26.2	43.2	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.7	13.0	9.4

Points	Easting	Northing	Elev. (m)	Wind Dire	Temp. ^{o}C	RH (%)		Noise (dB)		NO_2 (ppm)	SO_2 (ppm)	NO (ppm)	CO (ppm)	CO_2 (ppm)	NH_3 (pm)	H_2S (ppm)	O_2 %	PM10 $\mu g/m^3$	PM2.5 $\mu g/m^3$
						Min	Max	Min	Max										
AQ35	0515613	0737177	198	E	34.1	24.1	22.2	27.3	44.1	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.8	9.4	7.1
AQ36	0515221	0737113	202	E	34.1	25.1	23.1	24.1	43.1	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.9	10.3	9.0
AQ37	0515074	0737082	201	E	33.2	26.1	24.0	25.2	44.2	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.4	11.1	8.4
AQ38	0514741	0737021	198	E	34.0	27.0	25.0	26.1	43.2	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.6	10.3	8.3
AQ39	0514306	0736923	177	E	30.5	20.3	20.4	47.3	49.3	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.7	11.4	9.0
AQ40	0513946	0736817	182	E	30.4	20.4	20.6	42.2	48.4	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.8	10.4	7.1
AQ41	0513867	0737113	221	E	30.3	20.3	21.2	44.3	47.3	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.9	9.5	7.0
AQ42	0514140	0737114	188	E	30.1	20.4	22.1	40.3	49.4	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.8	10.1	8.1
AQ43	0514380	0737129	183	E	30.3	20.5	21.6	40.2	48.4	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.4	11.2	10.3
AQ44	0514546	0737142	192	E	30.4	20.6	22.1	40.4	50.3	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.5	10.1	9.0
AQ45	0514450	0737282	190	E	30.3	20.7	21.6	41.4	51.4	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.6	9.8	8.4
AQ46	0513079	0736258	172	E	30.1	20.1	21.7	46.3	52.4	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.7	9.1	7.1
AQ47	0512624	0735832	170	E	30.2	20.3	23.1	43.2	57.0	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	22.8	10.3	8.1
AQ48	0511962	0735503	166	E	30.4	20.4	24.1	44.3	48.4	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	23.9	10.4	7.8
AQ49	0511207	0735317	162	E	30.5	20.5	21.6	41.3	49.3	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	22.8	10.6	7.1
AQ50	0510668	0735493	171	E	30.3	20.6	26.1	42.4	46.7	<0.01	<0.01	<0.01	<0.01	400	<0.01	<0.01	21.7	11.0	9.3
AQ 51	0510415	0734700	155	W	29.7	23.3	23.4	48.6	59.6	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	11.8	10.4
AQ 52	0511127	0734905	170	N	32.9	19.6	19.8	43.7	65.4	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.8	12.1	11.5
AQ 53	0511972	0735104	173	W	32.4	19.4	19.5	29.8	42.9	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.6	10.2	8.4
AQ 54	0512740	0735345	175	W	31.9	19.8	20.1	27.6	42.4	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	11.6	9.3
AQ 55	0513461	0735783	187	W	32.1	19.7	20.1	27.1	43.1	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.7	9.1	6.4
AQ 56	0514309	0735676	179	W	32.2	19.6	20.3	26.3	44.0	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	10.2	7.5
AQ 57	0514087	0735476	185	W	33.2	19.4	20.2	25.4	45.0	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	9.1	6.2
AQ 58	0513632	0735085	191	W	33.1	19.1	19.8	27.6	46.0	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	9.0	6.3
AQ 59	0512910	0734970	173	W	32.3	19.3	19.7	29.9	45.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.5	9.6	7.4
AQ 60	0512361	0734853	180	W	34.1	19.2	19.5	30.1	47.1	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.4	9.7	7.1
AQ 61	0511792	0734669	181	N	31.6	19.8	20.0	27.6	55.5	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.4	10.1	7.2
AQ 62	0511234	0734562	162	N	32.0	19.7	19.8	28.3	44.6	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.5	10.3	8.3
AQ 63	0510354	0734234	164	N	31.3	18.3	19.5	27.2	47.5	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.4	11.2	9.4
AQ 64	0510721	0733751	179	N	32.3	19.3	20.1	28.2	48.6	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.5	9.8	7.2
AQ 65	0511378	0734173	169	N	32.4	19.6	19.7	28.0	48.0	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.6	9.6	8.1
AQ 66	0513568	0733948	190	N	32.1	19.4	19.8	28.1	47.0	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.3	9.7	7.3
AQ 67	0513569	0733947	191	N	33.2	19.5	19.9	28.3	48.3	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.6	9.6	8.0
AQ 68	0513572	0733953	192	N	31.2	19.3	19.5	28.4	48.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.6	10.1	9.1
AQ 69	0513582	0733949	193	N	32.3	19.4	19.6	28.3	49.5	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	10.1	8.3
AQ 70	0513573	0733951	194	N	33.2	19.5	19.7	27.4	43.5	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.8	10.8	9.4

Points	**Easting**	**Northing**	**Elev. (m)**	**Wind Dire**	**Temp. °C**	**RH (%)**		**Noise (dB)**		**NO_2 (ppm)**	**SO_2 (ppm)**	**NO (ppm)**	**CO (ppm)**	**CO_2 (ppm)**	**NH_3 (pm)**	**H_2S (ppm)**	**O_2 %**	**PM10 µg/m³**	**PM2.5 µg/m³**
						Min	**Max**	**Min**	**Max**										
AQ 71	0513574	0733933	195	N	33.1	19.3	19.6	28.1	44.0	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	11.5	10.1
AQ 72	0513577	0753392	194	N	33.2	19.4	19.8	28.2	44.4	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.7	10.1	9.3
AQ 73	0513563	0753372	195	N	33.3	19.5	19.9	29.3	45.6	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.8	9.3	9.4
AQ 74	0513554	0753372	194	N	33.4	19.4	19.8	28.4	46.2	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	22.9	8.4	7.3
AQ 75	0513555	0753383	194	N	33.5	19.4	19.7	28.3	43.4	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	23.2	10.2	8.4
AQ 76	0509234	0728909	184	N	27.8	24.4	24.6	50.7	55.5	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.2	10.3	8.4
AQ 77	0509188	0728926	189	N	28.1	23.6	23.8	36.2	61.1	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.3	9.4	7.3
AQ 78	0519005	0730836	212	S	27.9	24.5	24.8	27.9	47.4	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	22.3	10.2	8.2
AQ 79	0518900	0730874	220	N	27.6	23.4	24.4	27.7	28.3	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	21.9	12.1	8.4
AQ 80	0519441	0738128	220	W	27.2	21.5	25.5	28.2	42.8	<0.01	<0.01	<0.01	<0.01	399	<0.01	<0.01	22.8	10.2	7.5
Average					**32.4**	**19.8**	**20.5**	**30.5**	**46.4**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**400**	**<0.01**	**<0.01**	**21.8**	**10.2**	**8.1**
FMEnv Limits					**<40**	**90 - 100**		**90**		**0.01**	**26.0**	**0.4**	**10**	**-**	**2.0**	**0.9**	**-**	**150**	**112.5**

Source: Field Work, 2019

Table 4.14: Result of air quality sampling at the project site during dry season

Points	Easting	Northing	Elev. (m)	Wind Dire	Temp. ^oC	RH (%)		Noise (dB)		NO_2 (ppm)	SO_2 (ppm)	NO (ppm)	CO (ppm)	CO_2 (ppm)	NH_3 (pm)	H_2S (ppm)	O_2 %	PM10 µg/m³	PM2.5 µg/m³
						Min	Max	Min	Max										
AQ1	0515990	0736054	185	N	31.2	20.2	20.4	46.6	51.9	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.5	67.4	49.2
AQ2	0515892	0736039	178	N	32.1	19.6	19.8	27.7	49.4	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	98.7	58.7
AQ3	0515748	0735989	180	N	33.2	20.3	22.1	30.1	38.3	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.7	66.7	31.0
AQ4	0515627	0735901	177	NE	31.3	21.4	22.3	38.3	40.4	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	71.4	44.4
AQ5	0515475	0735920	178	N	30.0	22.5	22.8	21.1	37.2	<0.01	<0.01	<0.01	<0.01	498	<0.01	<0.01	21.3	73.8	50.3
AQ6	0515252	0735840	190	S	32.1	21.6	21.8	27.6	51.3	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	69.8	61.8
AQ7	0515318	0735619	194	N	31.2	21.3	22.3	20.3	28.4	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.7	67.6	60.9
AQ8	0515447	0735493	197	NE	30.3	26.6	26.8	19.0	20.3	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.8	66.4	63.8
AQ9	0514954	0735698	192	N	30.1	22.1	22.3	20.7	38.8	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.7	70.1	69.1
AQ10	0514652	0735929	177	N	32.1	18.3	20.8	30.3	41.1	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	91.3	73.4
AQ11	0514874	0736145	173	N	31.4	20.2	21.1	27.7	38.8	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.7	94.2	81.4
AQ12	0515161	0736101	173	N	30.5	21.2	21.8	20.1	29.8	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.8	70.3	66.6
AQ13	0515334	0736338	182	N	29.8	21.4	21.9	27.7	30.4	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.3	73.1	69.3
AQ14	0515585	0736289	186	NE	31.1	21.5	21.7	26.6	32.3	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.4	81.3	71.4
AQ15	0515817	0736390	183	N	32.1	22.6	22.8	27.6	50.1	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	77.8	70.3
AQ16	0516141	0736425	196	N	31.7	20.3	21.1	30.1	44.3	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.5	71.8	69.9
AQ17	0516438	0736515	193	N	32.1	22.6	22.7	31.2	36.3	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	76.3	71.1
AQ18	0516715	0736303	189	N	30.8	22.1	22.3	18.2	21.1	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	70.4	68.3
AQ19	0516226	0736613	202	N	31.7	21.1	21.2	20.1	22.8	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.7	76.5	71.3
AQ20	0516070	0736624	185	NE	32.1	21.0	21.1	22.2	34.4	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	77.6	73.4
AQ21	0515830	0736592	191	NE	30.3	21.7	21.8	20.3	29.9	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.5	71.7	70.1
AQ22	0515600	0736578	192	N	31.1	22.0	22.1	25.7	50.1	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.6	70.8	68.3
AQ23	0515189	0736621	187	N	30.7	21.7	21.8	26.7	51.0	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.4	71.4	50.3
AQ24	0514907	0736401	183	N	30.6	22.0	22.3	30.2	46.0	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.7	77.8	63.7
AQ25	0514611	0736196	173	N	31.3	21.0	21.4	31.1	38.8	<0.01	<0.01	<0.01	<0.01	398	<0.01	<0.01	21.8	76.8	60.7
AQ26	0514112	0736246	175	N	30.2	15.6	15.7	55.4	59.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	58.9	44.0
AQ27	0514455	0736446	174	N	32.3	15.6	15.9	56.6	60.8	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	57.7	43.1
AQ28	0514770	0736493	180	N	30.4	15.7	15.9	57.8	62.9	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	61.4	38.3
AQ29	0514872	0736716	186	NE	31.3	15.6	15.7	59.8	64.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	59.6	37.1
AQ30	0515116	0736820	199	NE	30.3	15.7	15.8	60.1	62.9	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.6	61.3	38.3
AQ31	0515444	0736849	201	N	30.4	15.5	15.7	57.1	60.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.5	59.6	37.1
AQ32	0515722	0736920	202	N	31.3	15.6	15.8	51.8	57.8	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.4	60.3	42.2
AQ33	0516086	0737107	206	N	31.0	15.5	15.7	60.4	62.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.3	68.2	38.4
AQ34	0515967	0737343	196	N	32.4	15.6	15.8	63.4	63.9	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.4	59.1	37.3

Points	Easting	Northing	Elev. (m)	Wind Dire	Temp. ^{o}C	RH (%)		Noise (dB)		NO_2 (ppm)	SO_2 (ppm)	NO (ppm)	CO (ppm)	CO_2 (ppm)	NH_3 (pm)	H_2S (ppm)	O_2 %	PM10 $\mu g/m^3$	PM2.5 $\mu g/m^3$
						Min	Max	Min	Max										
AQ35	0515613	0737177	198	N	31.4	15.5	15.6	62.2	64.5	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.6	60.2	41.4
AQ36	0515221	0737113	202	NE	31.0	15.4	15.5	59.7	61.2	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.5	57.7	57.3
AQ37	0515074	0737082	201	N	32.0	15.3	15.4	45.6	50.1	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.5	61.0	49.9
AQ38	0514741	0737021	198	N	31.3	15.3	15.5	46.6	48.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.6	59.3	50.3
AQ39	0514306	0736923	177	N	30.4	15.4	15.6	47.7	49.2	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.2	57.7	43.4
AQ40	0513946	0736817	182	N	30.7	15.5	15.7	37.7	43.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	58.3	51.0
AQ41	0513867	0737113	221	NE	30.8	15.7	15.8	55.1	57.8	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.3	61.0	50.1
AQ42	0514140	0737114	188	N	30.9	15.4	15.7	52.3	55.7	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.6	59.3	51.3
AQ43	0514380	0737129	183	N	30.8	14.4	15.1	53.8	56.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	57.7	43.4
AQ44	0514546	0737142	192	N	30.6	13.6	14.3	55.5	58.2	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.3	58.6	41.4
AQ45	0514450	0737282	190	NE	30.1	13.7	15.3	51.1	54.9	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	54.9	50.1
AQ46	0513079	0736258	172	N	31.4	14.1	15.3	49.1	52.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	55.5	51.3
AQ47	0512624	0735832	170	N	31.4	14.2	14.4	57.7	58.5	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	56.6	51.1
AQ48	0511962	0735503	166	N	31.6	13.4	14.5	46.9	49.6	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	57.8	55.5
AQ49	0511207	0735317	162	N	31.5	14.1	14.2	43.3	47.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.6	55.7	49.8
AQ50	0510668	0735493	171	NE	31.6	15.3	15.4	44.8	49.6	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.5	56.0	38.8
AQ 51	0510415	0734700	155	N	39.2	12.7	14.7	48.1	50.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	59.8	42.3
AQ 52	0511127	0734905	170	N	38.8	10.2	13.4	46.1	49.6	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	58.1	43.1
AQ 53	0511972	0735104	173	N	39.4	12.6	14.5	48.4	51.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	59.8	41.4
AQ 54	0512740	0735345	175	N	37.8	10.7	12.3	39.2	45.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	59.6	42.4
AQ 55	0513461	0735783	187	N	37.4	11.3	14.4	36.8	42.8	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	56.7	51.1
AQ 56	0514309	0735676	179	N	38.8	10.7	11.2	48.1	52.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	70.1	61.3
AQ 57	0514087	0735476	185	N	38.4	10.2	10.9	46.4	55.8	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	72.3	60.1
AQ 58	0513632	0735085	191	NE	37.6	10.6	11.4	38.5	47.6	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	72.1	58.8
AQ 59	0512910	0734970	173	NE	36.7	10.7	11.5	39.2	45.2	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	60.7	58.9
AQ 60	0512361	0734853	180	NE	39.2	11.3	12.1	45.8	51.9	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	67.4	56.7
AQ 61	0511792	0734669	181	NE	38.1	10.8	11.7	42.4	49.6	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	68.4	56.9
AQ 62	0511234	0734562	162	NW	39.4	12.7	13.1	40.6	47.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	66.6	60.1
AQ 63	0510354	0734234	164	N	38.1	12.5	13.1	43.1	50.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	67.4	62.2
AQ 64	0510721	0733751	179	N	39.3	13.8	14.2	39.5	48.1	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	66.7	56.3
AQ 65	0511378	0734173	169	N	38.4	12.1	12.7	42.8	51.7	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	67.8	61.4
AQ 66	0513568	0733948	190	N	37.6	10.3	11.8	40.7	54.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	66.6	65.3
AQ 67	0513569	0733947	191	E	38.7	13.6	14.2	47.6	58.6	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	67.4	60.1
AQ 68	0513572	0733953	192	N	38.9	12.4	13.9	40.3	49.9	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	68.6	56.1
AQ 69	0513582	0733949	193	NE	39.9	12.1	12.8	43.8	52.7	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	50.1	41.3

Points	Easting	Northing	Elev. (m)	Wind Dire	Temp. °C	RH (%)		Noise (dB)		NO_2 (ppm)	SO_2 (ppm)	NO (ppm)	CO (ppm)	CO_2 (ppm)	NH_3 (pm)	H_2S (ppm)	O_2 %	PM10 µg/m³	PM2.5 µg/m³
						Min	Max	Min	Max										
AQ 70	0513573	0733951	194	N	39.4	11.8	13.1	38.4	48.6	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.7	51.7	50.1
AQ 71	0513574	0733933	195	N	38.7	12.4	13.4	41.7	52.1	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	56.6	51.3
AQ 72	0513577	0753392	194	N	38.8	15.2	15.4	49.4	56.8	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	60.0	43.4
AQ 73	0513563	0753372	195	N	39.4	14.6	14.9	45.4	53.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	70.1	51.7
AQ 74	0513554	0753372	194	N	39.6	14.2	14.6	40.8	51.7	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	71.1	60.3
AQ 75	0513555	0753383	194	N	38.3	14.9	15.2	44.6	55.9	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	73.3	53.4
AQ 76	0509234	0728909	184	N	35.4	15.8	16.1	41.3	45.8	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	56.7	42.5
AQ 77	0509188	0728926	189	N	32.7	15.4	15.9	38.9	47.2	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	51.3	38.5
AQ 78	0519005	0730836	212	N	33.1	15.9	16.3	40.4	46.9	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.8	59.5	44.6
AQ 79	0518900	0730874	220	N	32.3	16.2	16.5	44.5	49.3	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	55.2	41.4
AQ 80	0519441	0738128	220	N	31.6	15.8	16.2	42.7	47.4	<0.01	<0.01	<0.01	<0.01	397	<0.01	<0.01	21.9	58.4	42.8
Average					**33.6**	**16.2**	**16.8**	**41.1**	**48.4**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**399**	**<0.01**	**<0.01**	**21.7**	**65.6**	**53.5**
FMEnv Limits					**<40**	**90 – 100**		**90**		**0.01**	**26.0**	**0.4**	**10**	**-**	**2.0**	**0.9**	**-**	**150**	**112.5**

Source: Field Work, 2020

4.6.1.2 Analysis of Air Quality Results

The results of air quality for the proposed project at baseline level falls within the Federal Ministry of Environment's limit which is the guiding principle for Nigeria Air Quality Standard. The results of measured parameters show that NO_2, SO_2, NO, CO, NH_3, and H_2S recorded values that were below detection limit. Average value for PM10 recorded 10.2µg/m^3 and 65.6µg/m^3 for wet and dry seasons respectively which are far below FMEnv limit of 150µg/m^3.

Average value for PM2.5 recorded 8.1µg/m^3 and 53.5µg/m^3 for wet and dry seasons respectively which are far below FMEnv limit of 112.5µg/m^3. Suspended Particulate Matter (SPM) would be monitored monthly when the project becomes operational, which is a major part of the Environmental Management Plan (EMP) for the project operation.

Asides from the monthly environmental monitoring, already mentioned as a means of checking the air quality during operation, there shall equally be the conduct of a more detailed and comprehensive triennial environmental audit of the project to follow up on the checking of the general environmental quality so as to benchmark current realities against the baseline and ascertain the trend of change against the latter.

Relative Humidity measured an average of 19.8% - 20.5% during wet season and 16.2% - 16.8% during dry season. Temperature measured an average of 32.4^{0}C during wet season and 33.6^{0}C during dry season while Noise measured an average of 30.5dB - 46.4dB during wet season and 41.1dB – 48.4dB during dry season. The noise level is very much within human tolerable limit (for 8-hour exposure duration) set by the Federal Ministry of Environment (FMEnv).

Table 4.14: Comparison of Temperature, RH, Noise, NO_2, SO_2, NO, CO, NH_3, H_2S, PM10 and PM2.5 values with FMEnv's limit

	Temp (°C)	RH (%)	Noise (dB)	NO_2 (ppm)	SO_2 (ppm)	NO (ppm)	CO (ppm)	NH_3 (ppm)	H_2S (ppm)	O_2 (%)	PM10 (µg/m³)	PM2.5 (µg/m³)
Wet Season values (Max)	32.4	20.5	46.4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	21.8	10.2	8.1
Dry Season values (Max)	33.6	16.8	48.4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	21.7	65.6	53.5
FMEnv's limit	**40.0**	**100.0**	**90.0**	**0.01**	**26.0**	**0.4**	**10.0**	**2.0**	**0.9**	**-**	**150.0**	**112.5**

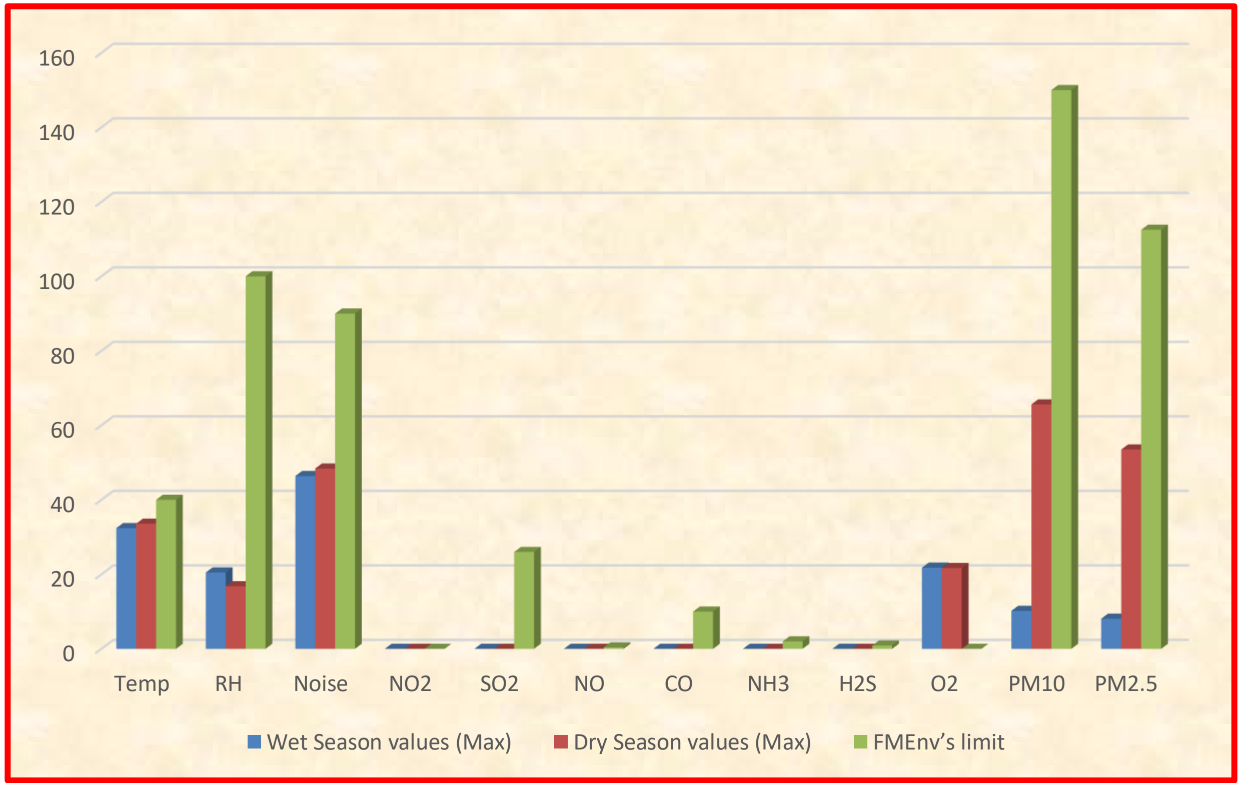

Figure 4.12: Graphical comparison of Temperature, RH, Noise, SO_2, NO_2, NO, CO, NH_3, H_2S, O_2, PM10 and PM2.5 values with FMEnv's limit

The graph above shows a comparison of all the air quality parameters (Temperature, Relative Humidity-RH, Noise, Nitrogen (IV) Oxide-NO_2, Sulphur (IV) Oxide-SO_2, Nitrogen (II) Oxide-NO, Carbon (II) Oxide-CO, Ammonia-NH_3, Hydrogen Sulphide H_2S, Particulate Matter-PM10 & PM2.5, and with the limits of the FMEnv. As shown on the graph, the results of the ambient air quality of the project site at baseline level falls within the Federal Ministry of Environment's limit which is the guiding principle for Nigeria Air quality standard.

Plate 4.4: Air Quality Sampling Measurement at the Project Site

4.6.2 Soil Quality

4.6.2.1 Soil Results and Analysis

The collected samples in and around the sites were mixed together to obtain a composite sample. This composite sample was grounded in a laboratory after oven drying for 24 hours. 2 cm sieve was used to remove gravel fraction. From the sieved fractions, log sub-samples were used for laboratory analyses. The samples were analyzed for texture, pH, Exchangeable cations (Ca, Mg, K and Na), total Nitrogen, available Phosphorus and other physicochemical elements.

Soil textural fractions were determined using hydrolytes method; soil pH was determined using pH meter. Available phosphorous was determined using Brays no. 1

method. Total Nitrogen was determined using macro-kjeldahl method. The amounts of exchangeable bases in the samples were extracted using ammonium acetate extraction method. From the extract, propositions of Ca and Mg were determined using flame emission while those of Na and K were determined using Atomic Absorption Spectrophotometer. CEC was determined using ammonium acetate extraction method.

Table 4.15: Location of soil sampling points in UTM

Location	Easting	Northing	Elev. (m)
SS 1	0515990	0736054	185
SS 2	0515892	0736039	178
SS 3	0515748	0735989	180
SS 4	0515627	0735901	177
SS 5	0515475	0735920	178
SS 6	0515252	0735840	190
SS 7	0515318	0735619	194
SS 8	0515447	0735493	197
SS 9	0514954	0735698	192
SS 10	0514652	0735929	177
SS 11	0514874	0736145	173
SS 12	0515161	0736101	173
SS 13	0515334	0736338	182
SS 14	0515585	0736289	186
SS 15	0515817	0736390	183
SS 16	0516141	0736425	196
SS 17	0516438	0736515	193
SS 18	0516715	0736303	189
SS 19	0516226	0736613	202
SS 20	0516070	0736624	185
SS 21	0515830	0736592	191
SS 22	0515600	0736578	192
SS 23	0515189	0736621	187
SS 24	0514907	0736401	183
SS 25	0514611	0736196	173
SS 26	0514112	0736246	175
SS 27	0514455	0736446	174
SS 28	0514770	0736493	180
SS 29	0514872	0736716	186
SS 30	0515116	0736820	199
SS 31	0515444	0736849	201
SS 32	0515722	0736920	202
SS 33	0516086	0737107	206
SS 34	0515967	0737343	196
SS 35	0515613	0737177	198
SS 36	0515221	0737113	202
SS 37	0515074	0737082	201
SS 38	0514741	0737021	198
SS 39	0514306	0736923	177

Location	Easting	Northing	Elev. (m)
SS 40	0513946	0736817	182
SS 41	0513867	0737113	221
SS 42	0514140	0737114	188
SS 43	0514380	0737129	183
SS 44	0514546	0737142	192
SS 45	0514450	0737282	190
SS 46	0513079	0736258	172
SS 47	0512624	0735832	170
SS 48	0511962	0735503	166
SS 49	0511207	0735317	162
SS 50	0510668	0735493	171
SS 51	0510415	0734700	155
SS 52	0511127	0734905	170
SS 53	0511972	0735104	173
SS 54	0512740	0735345	175
SS 55	0513461	0735783	187
SS 56	0514309	0735676	179
SS 57	0514087	0735476	185
SS 58	0513632	0735085	191
SS 59	0512910	0734970	173
SS 60	0512361	0734853	180
SS 61	0511792	0734669	181
SS 62	0511234	0734562	162
SS 63	0510354	0734234	164
SS 64	0510721	0733751	179
SS 65	0511378	0734173	169
SS 66	0513568	0733948	190
SS 67	0513569	0733947	191
SS 68	0513572	0733953	192
SS 69	0513582	0733949	193
SS 70	0513573	0733951	194
SS 71	0513574	0733933	195
SS 72	0513577	0753392	194
SS 73	0513563	0753372	195
SS 74	0513554	0753372	194
SS 75	0513555	0753383	194
SS 76 (Control 1)	0509234	0728909	184
SS 77 (Control 2)	0509188	0728926	189
SS 78 (Control 3)	0519005	0730836	212
SS 79 (Control 4)	0518900	0730874	220
SS 80 (Control 5)	0519441	0738128	220

Source: Fieldwork, 2019

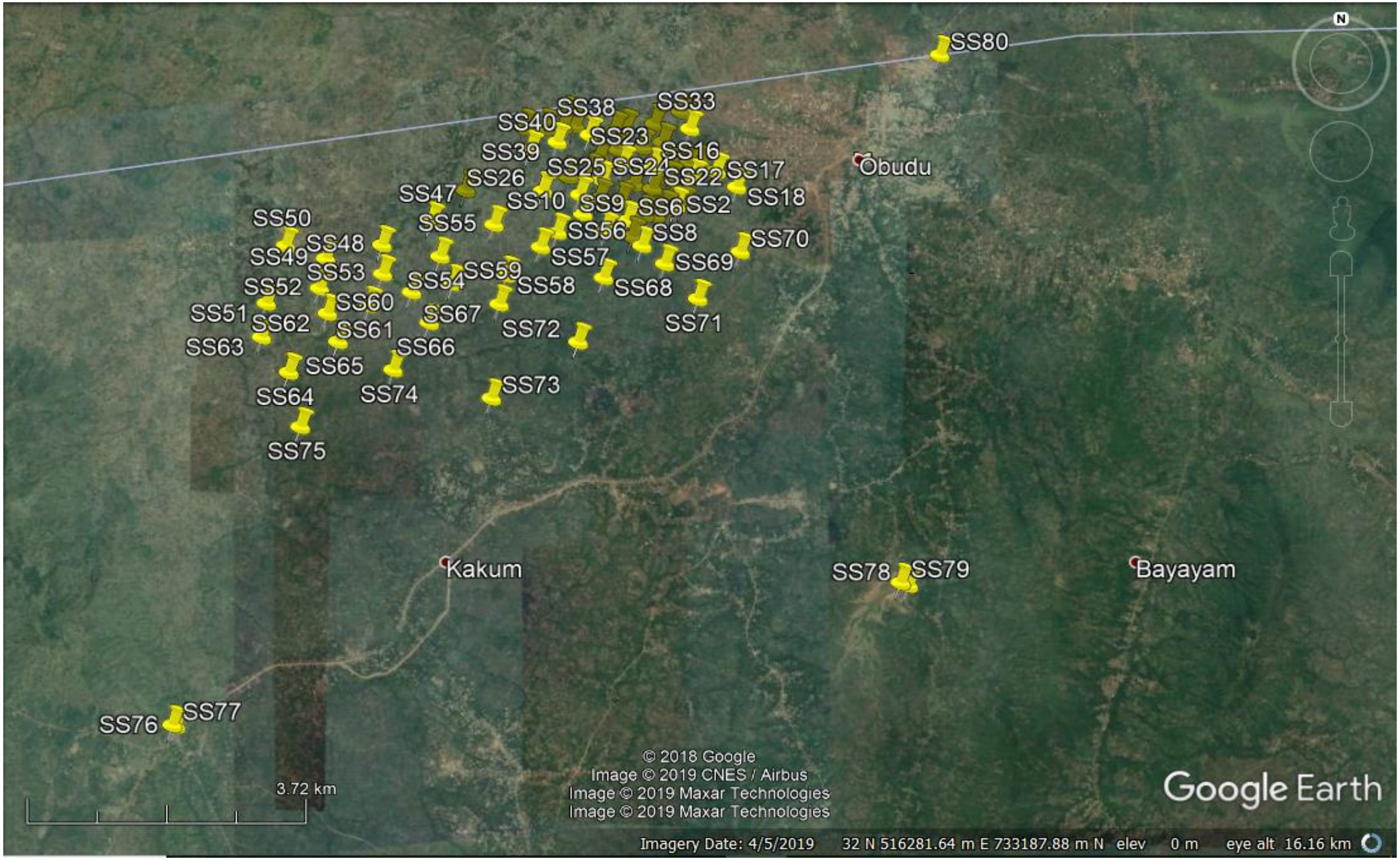

Figure 4.13: Google map of soil sampling points

Table: 4.16(a): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Wet Season

Parameters & Units		Methodology	SS 1	SS 2	SS 3	SS 4	SS 5	SS 6	SS 7	SS 8	SS 9	SS 10
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	36.28	24.00	25.23	31.82	33.84	53.11	44.86	42.15	44.36	31.82
	CS	1000-500	27.57	21.22	21.55	23.08	24.92	19.79	16.08	18.44	21.15	23.08
	MS	500-250	26.06	37.08	32.32	33.33	33.50	18.32	19.83	20.09	21.56	33.33
	FS	250-100	5.38	9.86	9.78	8.51	5.63	4.78	9.11	7.00	6.11	8.51
	VFS	100-50	0.00	0.09	0.08	0.00	0.00	0.00	0.15	0.09	40.08	0.00
% Total	SAND		95.28	92.25	88.95	96.74	97.89	96.00	90.03	87.77	93.26	96.74
	SILT	50-2µm	0.30	0.38	0.04	0.07	0.20	0.11	0.40	0.51	0.51	0.07
	CLAY	< 2 µm	4.82	7.24	1.25	3.01	1.60	2.45	7.87	9.31	6.00	3.01
	GRAND TOTAL		99.92	99.87	99.74	99.82	99.69	98.56	98.30	97.59	99.77	99.82
	Texture	Class	Sand	Sand	Loamy Sand	Sand	Sand	Sand	Sand	Loamy Sand	Sand	Sand
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Coarse	Fine	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Fine
Porosity			55.26	52.63	52.78	57.89	56.76	89.29	54.29	48.65	48.78	50.00
Bulk Density		**Uncomp**	1.32	1.32	1.39	1.32	1.35	1.79	1.43	1.35	1.22	1.39
		Comp	1.52	1.52	1.57	1.43	1.47	1.92	1.72	1.57	1.35	1.61
Permeability		g/**cm³**	0.042	0.45	0.039	0.060	0.062	0.125	0.075	0.060	0.051	0.033
Colour		Munsell Chart	Brownish 10YR5/8	Strong brown 7.5YR6/8	Grayish 10YR5/6	Dark brown 7.5YR4/6	Dark brown 7.5YR4/6	Dark brown 7.5YR4/6	Brownish 10YR5/6	Brownish 10YR5/6	Strong brown 7.5YR5/6	Dark brown 7.5YR5/6
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25⁰C		Electrometric	6.40	6.55	6.49	6.27	6.09	6.70	6.06	6.41	6.55	6.72
Temp.⁰/C		Thermoelectric	25.7	25.1	25.1	25.0	25.1	25.1	25.0	25.0	25.0	25.2
E.C. µS/cm³		Electrometric	132.0	132	135	423	155.0	157	140	148	244	212
M.C %		Gravimetric	9.2	8.1	9.6	8.2	8.9	8.7	9.0	12.5	14.2	10.8
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND
T. Nitrogen %		Colorimetric	7.40	7.22	8.10	7.0	7.97	8.1	8.19	8.5	9.10	8.8
Available Phosphorus		Colorimetric	1.5	1.2	1.24	1.6	1.9	0.87	0.90	0.712	1.44	0.32
SO_4^{-2} mg/kgDW		Colorimetric	57	60	52	69	67	58	49	55	51	56
NO_3^- mg/kgDW		Colorimetric	16	16.5	15.9	20.1	19	21.5	18	21.0	19.2	19.4
Ni mg/kgDW		Colorimetric	0.201	0.3898	0.3211	0.1728	0.001	0.4764	ND	0.367	0.3596	0.3395
Fe^{2+} mg/kgDW		Colorimetric	20.00	65.943	65.214	65.395	19.7	65.924	19.20	65.290	65.248	65.762
Ca^{2+} mg/kgDW		Colorimetric	40.9	30.655	23.40	1.2350	45.3	1.7203	42.1	12.485	9.6873	9.887
Pb^{2+} mg/kgDW		Colorimetric	33.321	33.788	3.647	3.6208	4.691	5.4878	4.210	3.219	4.0230	3.985
Zn^{2+} mg/kgDW		Colorimetric	2.3	0.3376	0.321	0.2709	5.51	0.2590	0.95	0.164	0.1783	0.650
Cu^{2+} mg/kgDW		Colorimetric	1.7	0.0063	0.0039	ND	1.8	0.5745	0.71	0.0081	0.0074	0.0049
Mg^{2+} mg/kgDW		Colorimetric	10.3	9.8764	9.992	4.2939	10.89	7.0865	10.61	6.451	4.6796	9.339

Parameters & Units	Methodology	SS 1	SS 2	SS 3	SS 4	SS 5	SS 6	SS 7	SS 8	SS 9	SS 10
Mn^{2+} mg/kgDW	Colorimetric	0.12	5.2450	8.378	20.961	0.17	28.210	10.090	12.238	18.531	16.900
K^{2+} mg/kgDW	Flametric	10.00	12.1	12.2	21.1	17.5	0.5	11.9	16.8	17.4	20.9
Na^{2+} mg/kgDW	Flametric	1.3	1.3	1.7	1.5	1.3	0.0	1.3	1.8	2.1	2.4
Cl^- mg/kgDW	Colorimetric	27.7	18.202	22.66	27.928	21.70	33.51	27.10	32.049	21.991	29.555
Cr mg/KgDW	Colorimetric	0.007	0.4979	0.009	ND	0.008	1.6893	0.005	0.0039	0.8639	0.0067
Cd mg/KgDW	Colorimetric	0.020	ND	0.031	ND	0.030	ND	0.020	0.029	ND	0.0032
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	2.0	22.18	18.19	ND	2.5	36.73	1.41	1.445	4.0	27.37
Co mg/KgDW	Colorimetric	ND	0.1300	0.167	0.0030	ND	0.9860	ND	0.004	ND	1.781
Organic Matter %	Gravimetric	30	31	28	30	33	30	32.0	23	32	22
Oil & Grease		2.0	2.1	2.7	3.0	3.0	2.1	3.0	2.8	2.6	3.0
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	150	142	155	90	10	66	5	8	820	10
Yeast & Mold	Cfu/g	20	21	32	6	3	61	25	14	184	40
TCC Cfu/100ml	Plate count	50	52	30	48	$3.0x10^3$	56	Nil	20	85	15
FCC Cfu/100ml	Plate Count	Nil	Nil	Nil	520	$1.6x10^3$	5	230	Nil	730	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
T. H. Fungi	Plate Count	54	8	78	78	12	145	68	130	369	350

Source: Laboratory Analysis by Labchemnec Jans Limited, 2019

Table: 4.16(b): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Wet Season (cont'd)

Parameters & Units		Methodology	SS 11	SS 12	SS 13	SS 14	SS 15	SS 16	SS 17	SS 18	SS 19	SS 20
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	32.43	29.76	34.83	30.29	28.29	35.76	34.61	38.73	32.70	34.62
	CS	1000-500	25.76	24.38	20.81	19.64	22.52	21.79	19.71	20.85	19.79	21.63
	MS	500-250	21.49	28.72	36.38	30.29	29.98	23.73	28.60	24.52	25.93	22.58
	FS	250-100	6.65	5.68	7.39	6.83	8.29	7.53	6.83	5.76	7.54	9.52
	VFS	100-50	0.12	0.06	0.17	0.02	0.02	0.09	0.03	0.05	0.07	0.01
% Total	SAND		90.57	94.18	92.84	91.49	95.27	93.54	93.76	90.48	89.49	92.39
	SILT	50-2µm	0.06	0.03	0.09	0.05	0.14	0.06	0.20	0.29	0.19	0.03
	CLAY	< 2 µm	3.29	2.93	2.58	1.82	3.82	1.93	4.61	2.96	4.62	1.93
	GRAND TOTAL		99.80	99.56	99.25	99.94	99.06	99.89	99.59	97.16	99.84	99.32
	Texture	Class	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Sticky	Gritty	Gritty
	Appearance		Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Fine	Coarse	Coarse
Porosity			55.26	52.63	52.78	57.89	56.76	89.29	54.29	48.65	48.78	50.00
Bulk Density		**Uncomp**	1.38	1.27	1.41	1.36	1.49	1.51	1.42	1.47	1.38	1.47
		Comp	1.62	1.58	1.53	1.60	1.58	1.58	1.54	1.51	1.49	1.54
Permeability		g/**cm³**	0.052	0.048	0.042	0.052	0.044	0.048	0.062	0.049	0.048	0.054
Colour		Munsell Chart	Brownish 10YR5/6	Strong brown 7.5YR6/8	Grayish 10YR4/6	Dark brown 7.5YR5/6	Dark brown 7.5YR4/6	Dark brown 7.5YR4/6	Brownish 10YR4/7	Brownish 10YR5/6	Strong brown 7.5YR5/6	Dark brown 7.5YR6/8
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25⁰C		Electrometric	6.64	6.73	6.52	6.47	6.82	6.42	5.71	6.58	6.52	5.93
Temp.⁰/C		Thermoelectric	25.9	25.5	26.4	25.8	24.9	26.3	25.4	25.8	25.2	25.6
E.C. µS/cm³		Electrometric	156	129	167	148	203	163	172	197	188	161
M.C %		Gravimetric	10.9	9.7	9.8	10.4	9.6	9.2	10.2	9.7	10.4	12.6
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T. Nitrogen %		Colorimetric	9.29	8.18	9.67	6.45	8.32	7.32	7.54	9.41	8.87	6.92
Available Phosphorus		Colorimetric	1.97	1.43	1.82	1.38	1.29	1.49	1.62	1.19	1.73	1.48
SO_4^{-2} mg/kgDW		Colorimetric	63	58	67	56	62	51	59	64	57	61
NO_3^- mg/kgDW		Colorimetric	19.2	17.8	17.2	22.3	20.3	18.6	21.5	20.2	18.1	20.2
Ni mg/kgDW		Colorimetric	0.2213	0.2721	0.2643	0.3438	0.2712	0.3843	0.0321	0.2195	0.2629	0.3635
Fe^{2+} mg/kgDW		Colorimetric	54.49	60.31	53.29	49.93	41.92	53.62	48.52	54.94	60.39	57.82
Ca^{2+} mg/kgDW		Colorimetric	15.7	25.76	31.65	21.73	29.82	23.92	31.79	19.38	21.39	18.62
Pb^{2+} mg/kgDW		Colorimetric	3.4328	2.5091	2.4981	3.3854	2.4942	4.7328	3.9854	2.5932	3.9847	2.4892
Zn^{2+} mg/kgDW		Colorimetric	0.297	0.395	0.494	0.392	0.863	0.482	0.583	0.893	0.583	0.592
Cu^{2+} mg/kgDW		Colorimetric	0.0891	0.0984	0.0492	0.043	0.248	0.587	0.492	0.093	0.063	0.083
Mg^{2+} mg/kgDW		Colorimetric	8.572	6.743	8.848	7.8939	9.529	10.863	8.793	8.692	9.738	7.472

Parameters & Units	Methodology	SS 11	SS 12	SS 13	SS 14	SS 15	SS 16	SS 17	SS 18	SS 19	SS 20
Mn^{2+} mg/kgDW	Colorimetric	3.768	2.769	12.638	9.692	10.498	14.831	18.903	10.729	10.592	11.592
K^{2+} mg/kgDW	Flametric	14.6	10.7	16.5	12.9	20.4	10.4	13.4	12.9	11.8	13.7
Na^{2+} mg/kgDW	Flametric	1.5	1.2	1.3	1.9	1.4	1.4	1.8	1.3	1.2	1.6
Cl^- mg/kgDW	Colorimetric	21.34	20.28	24.76	23.74	29.41	27.83	24.39	30.72	20.29	26.49
Cr mg/KgDW	Colorimetric	0.002	0.084	0.056	0.005	0.019	0.039	0.012	0.083	0.007	0.062
Cd mg/KgDW	Colorimetric	0.018	0.032	0.026	0.012	0.025	0.052	0.024	0.031	0.019	0.048
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	1.092	2.327	4.603	0.028	0.504	8.043	0.078	2.062	1.093	4.052
Co mg/KgDW	Colorimetric	0.192	0.114	0.072	0.052	0.028	0.074	0.094	0.049	0.034	0.194
Organic Matter %	Gravimetric	35	30	36	29	31	30	34	30	34	31
Oil & Grease		3.0	2.5	3.2	2.8	2.6	3.3	2.9	3.2	3.7	2.8
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	96	105	25	117	10	30	50	70	90	100
Yeast & Mold	Cfu/g	45	30	25	12	10	24	20	18	28	24
TCC Cfu/100ml	Plate count	80	50	45	50	75	50	42	39	57	21
FCC Cfu/100ml	Plate Count	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
T. H. Fungi	Plate Count	65	28	10	39	40	62	54	98	42	30

Source: Laboratory Analysis by Labchemnec Jans Limited, 2019

Table: 4.16(c): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Wet Season (cont'd)

Parameters & Units		Methodology	SS 21	SS 22	SS 23	SS 24	SS 25	SS 26	SS 27	SS 28	SS 29	SS 30
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	28.64	31.59	27.39	30.37	25.49	35.93	29.48	32.58	32.83	30.39
	CS	1000-500	22.83	24.73	26.48	20.93	23.47	23.53	19.69	21.59	23.73	20.91
	MS	500-250	31.63	28.57	29.57	30.29	24.48	21.52	22.39	22.82	29.68	31.69
	FS	250-100	7.29	6.52	7.48	6.73	8.39	5.538	7.59	6.52	8.83	7.69
	VFS	100-50	0.02	0.04	0.00	0.03	0.00	0.05	0.02	0.03	0.06	0.02
% Total	SAND		96.64	94.38	91.59	93.22	96.48	94.73	96.48	92.50	95.59	94.79
	SILT	50-2μm	0.07	0.14	0.03	0.02	0.50	0.05	0.03	0.09	0.41	0.43
	CLAY	< 2 μm	5.49	4.93	3.84	7.39	4.73	5.73	5.49	4.72	5.67	6.83
	GRAND TOTAL		99.97	99.52	99.79	99.76	99.06	98.35	98.69	97.35	99.21	99.96
	Texture	Class	Sand	Loamy Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand
	Type		Sticky	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty
	Appearance		Coarse	Fine	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse
Porosity			63.18	57.92	55.27	71.46	60.48	53.76	59.63	63.38	58.49	57.58
Bulk Density		**Uncomp**	1.66	1.58	1.75	1.74	1.67	1.48	1.84	1.57	1.62	1.68
		Comp	1.84	1.673	1.93	1.55	1.93	1.73	1.96	1.83	1.89	1.94
Permeability		g/**cm³**	0.067	0.034	0.058	0.041	0.083	0.053	0.063	0.042	0.059	0.048
Colour		Munsell Chart	Brownish 10YR5/6	Strong brown 7.5YR6/8	Grayish 10YR5/8	Dark brown 7.5YR4/6	Dark brown 7.5YR4/6	Dark brown 7.5YR4/6	Brownish 10YR5/8	Brownish 10YR5/6	Strong brown 7.5YR4/6	Dark brown 7.5YR5/8
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25⁰C		Electrometric	6.58	6.63	6.37	5.62	6.59	6.61	6.29	6.57	6.93	6.51
Temp.⁰/C		Thermoelectric	26.2	25.8	25.6	24.9	25.8	25.5	25.4	25.4	25.2	25.1
E.C. μS/cm³		Electrometric	141	148	132	217	193	194	178	269	185	154
M.C %		Gravimetric	10.5	8.8	11.2	9.5	10.5	9.2	11.6	10.4	9.4	8.6
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T. Nitrogen %		Colorimetric	8.26	6.85	9.62	9.64	10.51	9.93	7.45	6.87	8.65	8.21
Available Phosphorus		Colorimetric	1.73	1.19	1.11	1.32	1.48	1.32	1.49	1.92	1.32	1.28
SO_4^{-2} mg/kgDW		Colorimetric	65	57	55	61	59	69	53	58	63	51
NO_3^- mg/kgDW		Colorimetric	19.3	17.2	20.3	18.5	18.5	17.9	19.5	19.2	20.4	21.7
Ni mg/kgDW		Colorimetric	0.23297	0.2854	0.3529	0.2439	0.2185	0.2875	0.0548	0.6831	0.2756	0.1793
Fe^{2+} mg/kgDW		Colorimetric	54.689	43.835	57.322	39.921	56.387	52.361	33.381	63.065	60.395	64.764
Ca^{2+} mg/kgDW		Colorimetric	18.3	15.94	20.39	24.81	21.49	28.91	31.9	23.62	12.39	22.67
Pb^{2+} mg/kgDW		Colorimetric	3.838	2.732	4.394	2.879	3.712	3.275	2.572	1.783	2.394	2.274
Zn^{2+} mg/kgDW		Colorimetric	0.0438	0.2985	0.1853	0.0837	1.0054	0.3693	0.6282	0.0957	0.8391	0.0382
Cu^{2+} mg/kgDW		Colorimetric	0.0472	0.1854	0.3538	0.4693	0.4762	0.8582	0.3782	0.5931	0.0736	0.0386
Mg^{2+} mg/kgDW		Colorimetric	6.398	8.582	8.382	10.582	8.654	9.879	7.835	8.927	8.683	7.471

Parameters & Units	Methodology	SS 21	SS 22	SS 23	SS 24	SS 25	SS 26	SS 27	SS 28	SS 29	SS 30
Mn^{2+} mg/kgDW	Colorimetric	7.849	9.473	4.682	6.846	8.483	12.938	9.793	8.582	11.732	10.682
K^{2+} mg/kgDW	Flametric	14.47	10.74	16.68	13.68	11.85	13.83	10.68	12.73	14.82	12.48
Na^{2+} mg/kgDW	Flametric	1.9	1.5	1.1	1.9	1.2	2.4	1.8	1.2	1.7	1.2
Cl^{-} mg/kgDW	Colorimetric	31.748	28.427	20.592	24.572	26.492	30.381	23.892	28.274	27.381	22.492
Cr mg/KgDW	Colorimetric	0.0272	0.0582	0.0792	0.0231	0.0562	0.0563	0.0372	0.02835	0.0623	0.0548
Cd mg/KgDW	Colorimetric	ND	ND	0.027	ND	ND	ND	0.032	ND	ND	ND
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^{-} mg/KgDW	Colorimetric	3.42	2.59	5.65	3.53	4.84	4.27	3.73	4.63	5.82	3.82
Co mg/KgDW	Colorimetric	ND	ND	0.4631	ND	ND	0.6143	ND	ND	ND	0.3957
Organic Matter %	Gravimetric	27	38	33	32	29	24	31	29	32	27
Oil & Grease		3.2	2.7	2.3	2.8	2.8	3.2	2.9	2.3	2.2	2.7
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	91	80	98	60	20	30	155	40	18	28
Yeast & Mold	Cfu/g	26	19	26	18	15	20	16	24	22	19
TCC Cfu/100ml	Plate count	65	78	35	38	47	32	44	28	39	25
FCC Cfu/100ml	Plate Count	Nil	Nil	Nil	Nil	Nil	12	Nil	5	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	2	Nil	Nil	Nil	Nil	Nil	Nil
T. H. Fungi	Plate Count	48	98	10	18	7	25	16	28	78	94

Source: Laboratory Analysis by Labchemnec Jans Limited, 2019

Table: 4.16(d): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Wet Season (cont'd)

Parameters & Units		Methodology	SS 31	SS 32	SS 33	SS 34	SS 35	SS 36	SS 37	SS 38	SS 39	SS 40
		RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL										
Sand Fraction (%)	VCS	2000-1000	32.13	29.31	33.18	27.53	30.37	32.63	29.59	36.38	30.49	33.39
	CS	1000-500	24.38	29.14	26.49	20.57	17.72	23.42	21.58	24.26	26.47	21.47
	MS	500-250	31.48	26.58	30.59	28.92	30.29	29.52	26.27	22.47	26.38	30.17
	FS	250-100	7.47	5.93	7.49	9.72	10.38	9.49	8.92	9.82	8.38	7.86
	VFS	100-50	0.05	0.02	0.09	0.04	0.05	0.06	0.03	0.06	0.06	0.08
% Total	SAND		97.42	95.48	92.83	95.72	94.59	95.91	94.52	92.69	95.19	94.28
	SILT	50-2μm	0.27	0.32	0.21	0.13	0.09	0.32	0.19	0.12	0.30	0.21
	CLAY	< 2 μm	5.74	4.38	7.13	6.73	4.38	6.92	5.49	4.84	7.72	8.48
	GRAND TOTAL		99.94	99.16	99.01	99.36	99.87	98.27	98.59	97.64	99.99	99.94
	Texture	Class	Sand	Sand	Sand	Sand	Loamy Sand	Sand	Sand	Sand	Sand	Sand
	Type		Gritty	Gritty	Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Coarse	Coarse	Coarse	Fine	Coarse	Coarse	Coarse	Coarse	Coarse
Porosity			59.73	56.92	54.49	49.17	58.53	56.73	55.73	54.38	59.93	54.76
Bulk Density		**Uncomp**	1.47	1.43	1.52	1.58	1.39	1.33	1.47	1.30	1.36	1.41
		Comp	1.62	1.57	1.73	1.71	1.56	1.61	1.65	1.52	1.59	1.64
Permeability		**g/cm³**	0.076	0.57	0.061	0.075	0.054	0.059	0.063	0.052	0.058	0.067
Colour		Munsell Chart	Brownish 7.5YR4/6	Brownish 10YR5/6	Grayish 10YR5/6	Dark brown 7.5YR4/6	Brownish 7.5YR4/6	Dark brown 7.5YR4/6	Brownish 10YR5/6	Brownish 10YR5/6	Dark brown 7.5YR5/6	Strong brown 7.5YR5/6
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25⁰C		Electrometric	5.64	6.48	6.52	6.39	6.57	6.18	6.47	5.74	6.59	6.61
Temp.⁰/C		Thermoelectric	25.3	25.9	24.6	25.7	26.3	25.5	25.7	25.2	26.4	24.8
E.C. μS/cm³		Electrometric	127	230	156	174	142	284	163	157	252	169
M.C %		Gravimetric	11.4	7.8	10.2	7.9	9.3	9.7	8.4	10.2	8.7	7.4
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T. Nitrogen %		Colorimetric	9.35	8.58	8.62	7.53	8.42	7.18	9.43	7.82	8.39	7.73
Available Phosphorus		Colorimetric	1.64	1.28	1.59	1.52	1.48	1.27	1.38	1.48	1.82	1.76
SO_4^{-2} mg/kgDW		Colorimetric	59	52	64	58	63	60	57	51	62	58
NO_3^- mg/kgDW		Colorimetric	19.3	15.8	20.2	18.7	17.4	19.7	22.3	20.6	17.8	15.8
Ni mg/kgDW		Colorimetric	0.354	0.296	0.317	0.282	0.412	0.284	0.187	0.254	0.198	0.307
Fe^{2+} mg/kgDW		Colorimetric	32.31	29.64	34.74	56.84	47.48	59.542	40.93	60.48	60.16	58.82
Ca^{2+} mg/kgDW		Colorimetric	28.84	37.39	27.73	40.83	33.87	15.63	28.71	22.38	18.57	18.75
Pb^{2+} mg/kgDW		Colorimetric	2.647	1.582	2.832	2.389	3.756	1.832	2.394	1.852	2.947	2.489
Zn^{2+} mg/kgDW		Colorimetric	0.274	0.138	0.347	0.262	1.387	0.371	0.438	0.297	0.283	0.582
Cu^{2+} mg/kgDW		Colorimetric	0.482	0.073	0.039	0.263	0.573	0.916	0.385	0.095	0.0834	0.0876
Mg^{2+} mg/kgDW		Colorimetric	7.5733	10.8362	8.4849	8.6391	6.5936	9.6581	7.4925	9.7288	10.2879	8.4815
Mn^{2+} mg/kgDW		Colorimetric	10.658	9.738	11.827	15.729	13.582	10.846	13.492	10.937	13.693	11.528

Parameters & Units	Methodology	SS 31	SS 32	SS 33	SS 34	SS 35	SS 36	SS 37	SS 38	SS 39	SS 40
K^{2+} mg/kgDW	Flametric	16.59	10.69	14.39	12.49	15.82	13.83	17.48	19.81	13.58	14.69
Na^{2+} mg/kgDW	Flametric	2.8	1.7	1.3	1.8	2.2	1.4	1.8	1.6	1.8	1.6
Cl^- mg/kgDW	Colorimetric	21.684	32.163	29.387	23.762	35.492	30.829	34.983	28.472	32.682	31.628
Cr mg/KgDW	Colorimetric	0.047	0.038	0.074	0.063	0.028	0.0487	0.036	0.003	0.072	0.037
Cd mg/KgDW	Colorimetric	0.035	0.046	0.064	0.076	0.038	0.047	0.082	0.053	0.046	0.0082
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	23.76	14.83	25.58	10.36	6.93	18.59	4.92	12.58	17.73	21.63
Co mg/KgDW	Colorimetric	0.021	0.043	0.095	0.048	0.023	0.069	0.034	0.056	0.038	0.014
Organic Matter %	Gravimetric	36	27	34	32	26	29	28	31	30	27
Oil & Grease		3.1	2.8	2.2	2.2	3.5	3.2	2.4	2.2	2.4	2.8
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	100	80	120	10	55	75	19	17	40	60
Yeast & Mold	Cfu/g	45	28	11	50	8	30	18	29	43	35
TCC Cfu/100ml	Plate count	43	32	38	20	35	50	45	28	42	25
FCC Cfu/100ml	Plate Count	Nil	4	Nil	Nil	Nil	2	3	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	4	Nil	Nil	Nil	Nil	Nil	2	Nil	Nil
T. H. Fungi	Plate Count	92	25	38	18	26	16	22	29	39	27

Source: Laboratory Analysis by Labchemnec Jans Limited, 2019

Table: 4.16(e): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Wet Season (cont'd)

Parameters & Units		Methodology	SS 41	SS 42	SS 43	SS 44	SS 45	SS 46	SS 47	SS 48	SS 49	SS 50
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	32.57	38.29	29.83	27.59	30.39	38.91	52.84	37.48	40.83	35.49
	CS	1000-500	19.83	25.49	29.32	20.79	18.45	22.58	19.74	21.94	25.62	22.47
	MS	500-250	36.69	32.73	36.27	38.28	29.86	31.43	26.71	28.58	30.27	24.72
	FS	250-100	7.17	7.53	8.53	9.93	8.35	10.72	8.28	9.54	9.62	10.28
	VFS	100-50	0.03	0.02	0.05	0.06	0.03	0.08	0.05	0.06	0.06	0.01
% Total	SAND		97.57	95.73	92.28	95.29	94.48	97.14	93.48	90.26	96.73	92.56
	SILT	50-2µm	0.28	0.42	0.23	0.32	0.05	0.08	0.24	0.03	0.49	0.42
	CLAY	< 2 µm	3.37	5.84	4.67	5.38	2.73	4.72	6.58	5.83	7.29	5.48
	GRAND TOTAL		99.94	99.32	99.90	99.35	99.86	98.52	98.44	97.46	99.18	99.87
	Texture	Class	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Fine	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Fine
Porosity			48.63	56.54	55.37	55.39	54.62	50.27	48.59	58.18	51.49	52.49
Bulk Density		**Uncomp**	1.47	1.45	1.40	1.38	1.36	1.41	1.40	1.39	1.34	1.37
		Comp	1.69	1.64	1.62	1.56	1.59	1.58	1.60	1.56	1.51	1.54
Permeability		g/**cm³**	0.047	0.41	0.053	0.048	0.051	0.058	0.064	0.058	0.062	0.058
Colour		Munsell Chart	Brownish 7.5YR6/8	Dark brown 10YR5/8	Grayish 10YR5/6	Dark brown 7.5YR4/6	Brownish 7.5YR4/6	Dark brown 7.5YR4/6	Brownish 10YR5/6	Brownish 10YR5/6	Brownish 7.5YR5/6	Dark brown 7.5YR5/6
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25^0C		Electrometric	6.58	6.84	6.36	6.17	5.73	6.55	6.38	6.59	6.51	6.62
Temp.^{0}/C		Thermoelectric	25.3	25.5	26.1	25.8	25.4	25.8	25.2	25.4	25.3	25.4
E.C. µS/cm^3		Electrometric	132	146	138	294	328	144	163	157	146	248
M.C %		Gravimetric	7.6	9.4	8.4	7.9	8.2	8.8	7.4	10.2	9.1	9.3
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T. Nitrogen %		Colorimetric	9.53	8.37	8.54	9.48	8.36	7.58	7.82	9.29	8.44	7.65
Available Phosphorus		Colorimetric	1.9	1.4	1.8	1.5	1.7	1.9	2.0	1.8	1.6	1.2
SO_4^{-2} mg/kgDW		Colorimetric	51	58	61	48	60	56	64	61	59	52
NO_3^- mg/kgDW		Colorimetric	20.1	18.7	19.2	17.7	19.4	16.9	19.0	20.4	18.3	17.5
Ni mg/kgDW		Colorimetric	0.376	0.284	0.248	0.271	0.173	0.354	0293	0.184	0.248	0.293
Fe^{2+} mg/kgDW		Colorimetric	59.672	63.683	65.845	66.287	58.284	65.486	50.729	60.473	65.694	65.491
Ca^{2+} mg/kgDW		Colorimetric	21.353	34.169	14.873	19.673	38.481	17.593	53.832	32.287	20.472	18.472
Pb^{2+} mg/kgDW		Colorimetric	4.658	3.382	2.368	2.832	2.289	2.387	3.482	2.576	2.284	1.692
Zn^{2+} mg/kgDW		Colorimetric	0.2849	0.1849	0.2802	0.1936	1.4892	0.3897	0.3872	0.5824	0.4873	0.4827
Cu^{2+} mg/kgDW		Colorimetric	0.3782	0.1738	0.2793	0.1849	0.4983	0.2984	0.1894	0.3856	0.0852	0.1836
Mg^{2+} mg/kgDW		Colorimetric	8.2857	10.4298	11.4892	8.4861	9.3784	8.3874	10.2898	9.3874	7.38726	10.2835

Parameters & Units	Methodology	SS 41	SS 42	SS 43	SS 44	SS 45	SS 46	SS 47	SS 48	SS 49	SS 50
Mn^{2+} mg/kgDW	Colorimetric	11.583	8.386	14.298	12.387	8.287	17.484	15.482	20.947	14.736	13.472
K^{2+} mg/kgDW	Flametric	16.54	10.83	18.59	15.84	20.96	12.49	16.47	12.46	11.84	18.4
Na^{2+} mg/kgDW	Flametric	1.6	2.2	1.8	1.2	1.9	1.4	2.1	1.7	1.8	1.7
Cl^- mg/kgDW	Colorimetric	26.883	22.482	26.581	21.482	30.582	32.592	24.398	29.482	25.692	23.849
Cr mg/KgDW	Colorimetric	0.173	0.385	0.284	0.059	0.296	0.359	0.583	0.482	0.261	0.418
Cd mg/KgDW	Colorimetric	ND	ND	0.025	ND	ND	ND	0.016	0.035	ND	ND
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	1.85	2.32	ND	ND	1.9	2.82	4.31	2.583	3.271	2.18
Co mg/KgDW	Colorimetric	ND	0.037	0.048	0.050	0.076	0.572	0.438	ND	ND	0.437
Organic Matter %	Gravimetric	27	29	24	32	29	21	28	30	30	26
Oil & Grease		2.4	2.0	2.4	2.7	3.2	2.4	2.0	2.2	2.6	2.4
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	185	90	18	50	70	45	90	50	120	100
Yeast & Mold	Cfu/g	45	10	22	25	30	20	40	21	55	46
TCC Cfu/100ml	Plate count	34	46	38	31	34	50	27	32	49	30
FCC Cfu/100ml	Plate Count	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	3	Nil	Nil	Nil	Nil	10	Nil
T. H. Fungi	Plate Count	34	15	59	30	38	13	47	52	39	32

Source: Laboratory Analysis by Labchemnec Jans Limited, 2019

Table: 4.16(f): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Wet Season (cont'd)

Parameters & Units		Methodology	SS 51	SS 52	SS 53	SS 54	SS 55	SS 56	SS 57	SS 58	SS 59	SS 60
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	40.19	36.52	29.37	33.25	27.47	30.53	43.52	50.42	36.72	39.58
	CS	1000-500	31.38	26.64	23.48	27.29	20.84	22.39	25.47	21.56	19.43	25.47
	MS	500-250	22.37	30.27	28.27	25.47	21.38	27.43	24.29	18.39	26.49	30.82
	FS	250-100	7.47	6.13	8.26	8.74	7.27	9.71	7.38	10.42	8.38	7.29
	VFS	100-50	0.04	0.07	0.03	0.02	0.02	0.06	0.24	0.18	0.16	0.42
% Total	SAND		90.57	96.44	93.76	92.38	91.59	90.16	95.17	92.48	95.73	92.38
	SILT	50-2µm	0.43	0.32	0.29	0.14	0.48	0.29	0.34	0.48	0.41	0.26
	CLAY	< 2 µm	2.47	4.75	2.48	1.48	4.42	3.38	5.59	7.26	5.83	4.87
	GRAND TOTAL		99.35	99.70	99.18	99.39	99.88	98.79	98.83	97.71	99.42	99.71
	Texture	Class	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Loamy Sand	Sand	Sand
	Type		Gritty	Gritty	Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Gritty
	Appearance		Coarse	Coarse	Coarse	Coarse	Fine	Coarse	Coarse	Coarse	Coarse	Coarse
Porosity			50.76	55.47	54.63	51.87	59.75	54.37	63.54	61.48	58.24	47.28
Bulk Density		**Uncomp**	1.47	1.45	1.45	1.40	1.32	1.35	1.33	1.40	1.31	1.33
		Comp	1.65	1.61	1.58	1.63	1.57	1.60	1.58	1.62	1.55	1.59
Permeability		g/cm^3	0.028	0.065	0.041	0.038	0.054	0.061	0.028	0.044	0.064	0.052
Colour		Munsell Chart	Brownish 10YR5/8	Strong brown 7.5YR6/8	Brownish 10YR5/6	Dark brown 7.5YR4/6	Brownish 10YR5/8	Strong brown 7.5YR5/6	Brownish 10YR5/6	Brownish 10YR5/6	Strong brown 7.5YR5/6	Dark brown 7.5YR5/6
			RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL									
pH @25⁰C		Electrometric	6.62	5.88	6.42	6.68	6.53	6.57	6.39	6.65	6.74	6.28
Temp.⁰/C		Thermoelectric	24.9	25.7	25.5	24.6	26.4	25.9	25.2	25.2	24.8	25.6
E.C. $\mu S/cm^3$		Electrometric	125	145	138	242	128	143	139	298	141	138
M.C %		Gravimetric	8.6	9.3	8.3	9.4	9.6	9.1	9.2	8.5	10.8	8.3
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T. Nitrogen %		Colorimetric	8.74	7.32	9.48	8.36	8.41	8.96	8.55	8.86	9.57	8.49
Available Phosphorus		Colorimetric	1.9	1.4	1.6	1.3	1.7	1.7	1.5	1.2	1.8	1.6
SO_4^{-2} mg/kgDW		Colorimetric	64	58	56	62	60	56	63	67	55	52
NO_3^- mg/kgDW		Colorimetric	19.6	17.9	20.7	18.6	17.8	19.4	16.8	19.5	21.6	19.8
Ni mg/kgDW		Colorimetric	0.364	0.272	0.118	0.196	0.207	0.386	0.426	0.174	0.294	0.596
Fe^{2+} mg/kgDW		Colorimetric	60.59	63.87	66.85	65.86	60.58	65.67	62.79	64.59	65.76	64.13
Ca^{2+} mg/kgDW		Colorimetric	10.7264	9.2847	11.9435	8.5274	12.8962	9.4638	18.5208	10.6937	15.3861	11.5794
Pb^{2+} mg/kgDW		Colorimetric	5.8469	3.8351	5.4895	1.6792	2.6721	3.8264	3.5832	5.3856	3.8352	2.5863
Zn^{2+} mg/kgDW		Colorimetric	0.2974	0.2431	0.2792	0.1793	0.2487	0.3168	0.4287	0.3683	0.2789	0.2094
Cu^{2+} mg/kgDW		Colorimetric	1.3846	0.3285	0.2753	0.3957	0.3846	0.2428	0.4285	0.1473	0.4683	0.2742
Mg^{2+} mg/kgDW		Colorimetric	7.6428	10.4846	8.2794	8.9184	9.5842	10.5742	8.4962	10.4738	8.6845	10.7462

Parameters & Units	Methodology	SS 51	SS 52	SS 53	SS 54	SS 55	SS 56	SS 57	SS 58	SS 59	SS 60
Mn^{2+} mg/kgDW	Colorimetric	10.573	14.454	12.572	10.619	13.583	12.274	15.793	17.593	11.193	12.604
K^{2+} mg/kgDW	Flametric	14.42	19.63	10.49	13.64	10.49	10.58	14.38	13.87	12.45	16.52
Na^{2+} mg/kgDW	Flametric	2.4	1.2	1.9	1.1	1.7	1.3	1.8	1.5	1.5	1.4
Cl^{-} mg/kgDW	Colorimetric	20.584	24.573	20.472	23.174	26.583	25.739	22.598	29.972	24.437	30.728
Cr mg/KgDW	Colorimetric	0.2638	0.4286	0.2742	0.2295	0.3749	0.3735	0.2649	0.3174	0.4973	0.2845
Cd mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^{-} mg/KgDW	Colorimetric	11.43	17.75	20.69	12.74	21.76	13.59	19.58	20.38	12.73	16.37
Co mg/KgDW	Colorimetric	0.736	0.273	0.285	0.474	0.683	0.735	0.251	0.286	0.328	0.473
Organic Matter %	Gravimetric	37	30	28	27	30	28	32	29	31	33
Oil & Grease		3.0	2.6	2.4	2.8	2.4	2.5	2.9	3.2	2.3	2.8
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	100	50	80	16	70	19	35	80	60	90
Yeast & Mold	Cfu/g	25	13	47	7	12	19	14	15	38	20
TCC Cfu/100ml	Plate count	32	42	25	31	29	42	29	25	24	38
FCC Cfu/100ml	Plate Count	Nil	8	5	Nil	Nil	8	Nil	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	2	Nil	Nil	Nil	Nil	Nil
T. H. Fungi	Plate Count	12	7	24	42	34	25	31	38	26	18

Source: Laboratory Analysis by Labchemnec Jans Limited, 2019

Table: 4.16(g): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Wet Season (cont'd)

Parameters & Units		Methodology	SS 61	SS 62	SS 63	SS 64	SS 65	SS 66	SS 67	SS 68	SS 69	SS 70
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	40.28	32.57	30.81	35.37	31.69	42.98	37.37	40.15	34.82	39.37
	CS	1000-500	19.43	26.48	23.91	28.52	20.48	26.51	23.69	22.52	29.49	20.38
	MS	500-250	30.47	28.47	29.92	26.48	17.49	20.57	31.47	24.38	29.18	25.52
	FS	250-100	7.47	7.93	9.29	7.63	9.82	7.29	5.83	6.82	9.63	8.12
	VFS	100-50	0.03	0.01	0.00	0.04	0.03	0.03	0.02	0.01	0.03	0.02
% Total	SAND		96.76	94.25	91.84	92.48	93.37	90.42	95.38	92.63	96.38	94.15
	SILT	50-2μm	0.08	0.17	0.09	0.02	0.11	0.13	0.21	0.18	0.32	0.16
	CLAY	< 2 μm	2.37	4.62	3.73	2.37	2.74	5.68	4.24	7.42	5.00	2.68
	GRAND TOTAL		99.13	99.25	99.75	99.43	99.36	99.19	99.83	99.48	99.47	99.25
	Texture	Class	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Coarse	Fine	Coarse	Coarse	Fine	Coarse	Coarse	Coarse	Coarse
Porosity			62.74	58.29	56.39	55.27	59.38	62.63	58.17	54.27	53.49	56.73
Bulk Density		**Uncomp**	1.48	1.42	1.45	1.38	1.47	1.36	1.42	1.52	1.37	1.48
		Comp	1.62	1.59	1.54	1.61	1.62	1.69	1.61	1.58	1.56	1.57
Permeability		g/**cm³**	0.039	0.53	0.053	0.032	0.054	0.072	0.048	0.055	0.041	0.047
Colour		Munsell Chart	Dark brown 10YR5/8	Strong brown 7.5YR6/8	Dark brown 10YR5/6	Brownish 7.5YR4/6	Strong brown 7.5YR4/6	Dark brown 7.5YR4/6	Brownish 10YR5/6	Brownish 10YR5/6	Dark brown 7.5YR5/6	Dark brown 7.5YR5/6
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25^{0}C		Electrometric	5.65	6.51	6.48	6.55	6.47	6.50	6.63	5.82	6.64	6.43
Temp.^{0}/C		Thermoelectric	25.2	25.4	25.7	25.1	25.3	25.1	25.4	25.2	25.4	25.3
E.C. μS/cm³		Electrometric	135	194	176	289	164	182	169	179	193	262
M.C %		Gravimetric	10.8	9.3	8.9	10.6	9.3	8.5	8.6	9.7	8.7	9.6
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND
T. Nitrogen %		Colorimetric	6.74	9.46	8.74	8.57	9.25	7.66	8.73	9.26	8.38	7.93
Available Phosphorus		Colorimetric	0.94	1.14	1.65	0.84	1.62	1.26	0.64	0.41	1.28	0.83
SO_4^{-2} mg/kgDW		Colorimetric	52	63	59	50	61	55	57	62	56	60
NO_3^- mg/kgDW		Colorimetric	19.3	17.8	16.7	18.4	17.9	20.3	18.4	16.4	18.2	20.7
Ni mg/kgDW		Colorimetric	0.2748	0.1472	0.2437	0.3649	0.2549	0.2849	0.2743	0.3263	0.2706	0.2471
Fe^{2+} mg/kgDW		Colorimetric	62.281	64.647	65.179	64.274	58.472	63.372	50.371	60.327	66.437	65.274
Ca^{2+} mg/kgDW		Colorimetric	27.264	12.472	20.76	18.53	24.764	29.528	20.47	19.574	23.258	14.736
Pb^{2+} mg/kgDW		Colorimetric	4.214	3.473	2.836	4.312	2.158	3.428	2.547	4.428	3.428	4.527
Zn^{2+} mg/kgDW		Colorimetric	0.4204	0.1583	0.2793	0.1954	0.2947	0.5372	0.2703	0.4295	0.3859	0.2793
Cu^{2+} mg/kgDW		Colorimetric	0.0072	0.0092	0.0083	0.0027	0.0372	0.0036	0.0372	0.0289	0.0027	0.0084
Mg^{2+} mg/kgDW		Colorimetric	8.965	10.824	7.583	8.483	9.375	11.374	8.395	9.874	10.482	8.173

Parameters & Units	Methodology	SS 61	SS 62	SS 63	SS 64	SS 65	SS 66	SS 67	SS 68	SS 69	SS 70
Mn^{2+} mg/kgDW	Colorimetric	13.435	8.748	6.472	11.748	5.968	12.538	8.739	10.174	13.538	10.472
K^{2+} mg/kgDW	Flametric	8.5	10.4	9.7	11.4	9.4	10.9	12.4	10.3	11.2	9.5
Na^{2+} mg/kgDW	Flametric	1.6	2.5	1.3	1.9	1.6	1.0	1.8	2.2	1.4	1.8
Cl^- mg/kgDW	Colorimetric	19.475	24.328	17.375	20.253	16.38	26.62	20.639	23.529	25.472	20.473
Cr mg/KgDW	Colorimetric	0.0539	0.0539	0.0849	0.0428	0.0693	0.3672	0.1553	0.3462	0.1739	0.3842
Cd mg/KgDW	Colorimetric	0.0529	0.2849	0.1739	0.7392	0.3052	0.2941	0.2193	0.2729	0.5729	0.2838
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	3.28	1.62	2.29	3.29	4.82	2.492	4.284	3.529	2.492	4.18
Co mg/KgDW	Colorimetric	0.572	0.384	0.052	0.342	0.096	0.372	0.228	0.439	0.094	0.274
Organic Matter %	Gravimetric	28	32	30	27	32	27	34	29	34	28
Oil & Grease		2.4	2.0	3.2	2.0	2.4	2.6	2.4	2.0	3.0	2.5
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	70	30	90	14	100	75	160	95	10	70
Yeast & Mold	Cfu/g	15	20	10	9	14	24	20	11	18	24
TCC Cfu/100ml	Plate count	35	50	35	24	41	35	40	28	32	25
FCC Cfu/100ml	Plate Count	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	3
T. H. Fungi	Plate Count	12	25	17	32	23	46	37	49	30	47

Source: Laboratory Analysis by Labchemnec Jans Limited, 2019

Table: 4.16(h): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Wet Season (cont'd)

Parameters & Units		**Methodology**	**SS 71**	**SS 72**	**SS 73**	**SS 74**	**SS 75**	**SS 76 (Control 1)**	**SS 77 (Control 2)**	**SS 78 (Control 3)**	**SS 79 (Control 4)**	**SS 80 (Control 5)**
		RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL										
Sand Fraction (%)	VCS	2000-1000	33.53	25.63	30.29	32.48	21.64	32.98	23.46	20.99	25.05	20.91
	CS	1000-500	20.24	24.75	19.38	25.17	22.46	19.83	20.35	25.29	17.0	14.32
	MS	500-250	34.48	30.25	33.19	33.27	32.72	23.57	29.35	30.40	33.10	38.00
	FS	250-100	7.19	9.72	8.47	8.83	9.62	9.77	12.17	10.24	12.23	14.70
	VFS	100-50	0.07	0.05	0.09	0.05	0.04	0.06	0.13	0.15	0.50	0.00
% Total	SAND		94.47	96.54	95.92	94.73	95.21	85.71	85.46	37.07	88.07	87.93
	SILT	50-2µm	0.28	0.34	0.19	0.35	0.27	1.16	1.30	0.40	10.57	0.96
	CLAY	< 2 µm	3.17	5.14	7.82	4.47	6.58	13.00	13.20	12.24	11.22	10.98
	GRAND TOTAL		99.96	99.88	99.43	99.62	99.33	99.87	99.96	99.71	99.86	00.07
	Texture	Class	Sand	Sand	Land	Loamy Sand	Sand	Loamy Sand	Loamy Sand	Clay	Loamy Sand	Loamy Sand
	Type		Gritty	Gritty	Gritty	Sticky	Gritty	Gritty	Sticky	Gritty	Sticky	Sticky
	Appearance		Coarse	Coarse	Coarse	Fine	Coarse	Coarse	Fine	Coarse	Fine	Fine
Porosity			53.52	58.47	55.83	54.38	59.52	57.50	57.50	52.27	53.85	52.50
Bulk Density		**Uncomp**	1.41	1.36	1.28	1.38	1.42	1.25	1.25	1.14	1.28	1.25
		Comp	1.60	1.55	1.51	1.59	1.56	1.47	1.47	1.32	1.43	1.43
Permeability		g/**cm³**	0.086	0.036	0.028	0.047	0.083	0.046	0.049	0.030	0.062	0.037
Colour		Munsell Chart	Brownish 7.5YR6/8	Strong brown 10YR5/8	Grayish 7.5YR5/6	Dark brown 7.5YR4/6	Dark brown 7.5YR5/6	Dark brown 7.5YR6/8	Brownish 10YR6/8	Yellowish 10YR8/6	Dark brown 7.5YR5/6	Dark brown 10YR5/8
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25⁰C		Electrometric	5.94	6.75	6.69	6.68	6.27	5.90	6.01	5.92	5.22	5.95
Temp.⁰/C		Thermoelectric	25.3	24.8	26.4	25.8	26.5	25.1	25.1	25.5	25.0	25.0
E.C. µS/cm³		Electrometric	141	128	149	163	192	98	99	59	60	69
M.C %		Gravimetric	8.7	7.9	8.2	9.6	8.1	15.5	17.8	32.8	10.8	9.7
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	0.0001	0.001	ND	ND
T. Nitrogen %		Colorimetric	9.28	8.64	7.23	9.27	8.58	5.94	10.92	6.95	9.18	5.32
Available Phosphorus		Colorimetric	1.8	1.3	1.8	1.5	1.2	0.551	0.70	0.79	0.91	0.520
SO_4^{-2} mg/kgDW		Colorimetric	63	56	58	62	61	42	49	56	39	57
NO_3^- mg/kgDW		Colorimetric	18.4	15.7	19.3	18.3	16.7	5.11	7.8	7	7.4	8.7
Ni mg/kgDW		Colorimetric	0.054	0.073	0.004	0.008	0.004	3.9910	2.828	ND	0.3708	0.321
Fe^{2+} mg/kgDW		Colorimetric	67.165	65.483	64.118	66.217	64.375	65.972	64.900	40.0	61.521	54.33
Ca^{2+} mg/kgDW		Colorimetric	36.542	39.739	40.258	31.381	42.58	2.4150	3.945	20.9	0.1058	1.993
Pb^{2+} mg/kgDW		Colorimetric	2.648	4.294	2.572	3.846	3.197	2.9939	2.873	1.117	1.2217	1.130
Zn^{2+} mg/kgDW		Colorimetric	0.427	0.658	0.268	0.174	0.246	1.2149	1.253	1.750	0.1625	0.558
Cu^{2+} mg/kgDW		Colorimetric	0.9482	0.548	0.473	0.836	0.727	1.3040	1.855	1.86	0.2423	0.300
Mg^{2+} mg/kgDW		Colorimetric	7.618	6.458	8.293	9.683	8.274	28.112	12.779	5.200	0.5533	0.474

Parameters & Units	Methodology	SS 71	SS 72	SS 73	SS 74	SS 75	SS 76 (Control 1)	SS 77 (Control 2)	SS 78 (Control 3)	SS 79 (Control 4)	SS 80 (Control 5)
Mn^{2+} mg/kgDW	Colorimetric	7.472	8.629	5.487	9.427	4.482	28.267	0.0385	0.01	9.1537	5.010
K^{2+} mg/kgDW	Flametric	14.64	11.28	15.3	12.16	15.28	4.1	6.4	3.2	6.6	2.0
Na^{2+} mg/kgDW	Flametric	1.8	1.5	2.0	1.7	1.2	2.2	3.9	1.4	1.0	2.6
Cl^- mg/kgDW	Colorimetric	20.2	26.7	21.5	26.8	24.8	34.896	40.112	47.7	35.941	45.001
Cr mg/KgDW	Colorimetric	0.004	0.008	0.006	0.017	0.024	4.4713	3.3041	0.009	ND	0.0028
Cd mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	0.0011	0.002	ND	0.0021
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	14.65	24.73	16.93	13.48	22.42	36.73	1.225	1.300	ND	1.0004
Co mg/KgDW	Colorimetric	0.0418	0.1539	0.0472	0.0629	0.4902	1.9104	1.117	ND	ND	0.0053
Organic Matter %	Gravimetric	37	29	34	36	30	29	21	22.	19	21
Oil & Grease		3.3	2.8	2.4	3.1	2.0	1.9	1.3	1.5	1.4	1.5
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	60	45	90	65	80	15	9	90	52	12
Yeast & Mold	Cfu/g	9	24	16	19	31	122	84	7	2	26
TCC Cfu/100ml	Plate count	35	47	32	40	28	13	25	30	45	32
FCC Cfu/100ml	Plate Count	Nil	Nil	Nil	Nil	Nil	Nil	Nil	20	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	Nil	Nil	Nil	8	Nil	Nil
T. H. Fungi	Plate Count	13	9	7	10	7	9	8	5	6	22

Source: Laboratory Analysis by Labchemnec Jans Limited, 2019

Table: 4.17(a): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Dry Season

Parameters & Units		Methodology	SS 1	SS 2	SS 3	SS 4	SS 5	SS 6	SS 7	SS 8	SS 9	SS 10
		RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL										
Sand Fraction (%)	VCS	2000-1000	26.32	25.41	26.97	24.82	25.62	27.43	24.68	26.51	26.79	25.54
	CS	1000-500	19.44	15.76	21.58	17.82	20.74	18.52	19.69	15.85	19.47	21.34
	MS	500-250	22.58	27.43	25.76	30.32	24.58	31.79	29.43	32.42	27.64	30.63
	FS	250-100	9.42	13.42	12.68	15.59	12.83	10.56	14.82	17.65	15.82	13.69
	VFS	100-50	0.00	0.43	0.0	0.12	0.09	0.31	0.28	0.02	0.07	0.24
% Total	SAND		77.76	74.58	79.62	75.48	81.73	76.98	72.57	80.54	76.49	79.63
	SILT	50-2µm	0.82	0.32	0.57	0.71	0.49	0.38	0.69	0.31	0.45	0.54
	CLAY	< 2 µm	20.48	22.31	19.45	21.76	20.58	18.98	23.59	21.36	22.48	20.34
	GRAND TOTAL		99.06	99.02	99.15	99.65	99.43	99.28	99.75	99.04	99.19	99.62
	Texture	Class	Sandy loam	Sandy	Loamy	Sandy	Sandy loam	Sandy	Loamy	Sandy	Sandy loam	Sandy
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Coarse	Course	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse
Porosity			66.67	69.41	60.39	71.24	68.43	65.79	59.83	64.79	69.62	70.72
Bulk Density		**Uncomp**	1.52	1.43	1.67	1.43	1.61	1.54	1.83	1.74	1.58	1.39
		Comp	1.67	1.94	1.85	1.58	1.69	1.74	1.53	1.49	1.74	1.59
Permeability		**g/cm^3**	0.064	0.049	0.032	0.049	0.027	0.046	0.036	0.059	0.051	0.048
Colour		Munsell Chart	Brownish 10YR6/8	Brownish 8YR6/8	Brownish 10YR5/6	Dark brown 7.5YR4/6	Brownish 7.5YR4/6	Dark brown 7.5YR4/6	Dark brown 10YR5/6	Brownish 10YR5/6	Brownish 7.5YR5/6	Strong brown 7.5YR5/6
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25^0C		Electrometric	6.60	6.73	6.58	6.49	6.46	6.63	6.42	6.69	6.62	6.39
Temp.^{0}/C		Thermoelectric	27.5	28.6	27.4	29.6	28.7	28.9	28.4	27.6	29.4	28.4
E.C. $\mu S/cm^3$		Electrometric	173	158	176	165	171	152	178	184	163	160
M.C %		Gravimetric	8.5	4.0	4.5	3.5	4.5	4.0	5.3	4.8	4.2	5.9
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND
T. Nitrogen %		Colorimetric	7.66	12.43	9.84	15.43	18.76	14.59	10.68	12.43	17.41	15.78
Available Phosphorus		Colorimetric	1.42	1.64	1.38	1.25	2.03	1.82	1.69	1.42	1.72	1.52
SO_4^{-2} mg/kgDW		Colorimetric	56.9	48.42	62.93	67.29	45.42	55.84	39.63	48.17	58.45	61.58
NO_3^- mg/kgDW		Colorimetric	15.32	10.42	12.38	8.27	10.62	5.49	8.32	6.18	9.39	11.32
Ni mg/kgDW		Colorimetric	0.11	0.02	0.14	0.17	0.05	0.2	0.08	0.05	0.02	0.12
Fe^{2+} mg/kgDW		Colorimetric	20.40	15.93	13.47	17.54	15.83	19.26	17.28	16.53	21.48	18.45
Ca^{2+} mg/kgDW		Colorimetric	40.25	29.65	42.58	37.84	40.82	43.74	38.51	34.83	30.48	39.48
Pb^{2+} mg/kgDW		Colorimetric	33.55	10.67	14.71	8.47	1.42	5.48	1.59	4.47	5.49	3.82
Zn^{2+} mg/kgDW		Colorimetric	2.25	1.43	1.79	1.55	2.18	1.92	1.58	2.09	1.79	2.18
Cu^{2+} mg/kgDW		Colorimetric	1.79	1.24	1.32	1.83	1.58	2.05	1.94	2.05	1.47	1.42
Mg^{2+} mg/kgDW		Colorimetric	10.28	6.78	9.43	12.53	9.38	12.72	10.58	7.92	11.47	9.43
Mn^{2+} mg/kgDW		Colorimetric	0.15	0.06	0.02	0.15	0.13	0.01	0.09	0.04	0.13	0.05

Parameters & Units	Methodology	SS 1	SS 2	SS 3	SS 4	SS 5	SS 6	SS 7	SS 8	SS 9	SS 10
K^{2+} mg/kgDW	Flametric	14.5	19.43	15.289	16.96	21.71	16.68	19.27	20.54	18.38	15.82
Na^{2+} mg/kgDW	Flametric	1.6	1.2	2.3	1.9	2.4	1.2	1.8	2.2	1.9	1.5
Cl^- mg/kgDW	Colorimetric	26.72	20.54	17.83	19.41	22.59	20.75	24.68	21.92	17.49	20.28
Cr mg/KgDW	Colorimetric	0.005	0.002	0.007	0.005	0.001	0.003	0.003	0.002	0.004	0.003
Cd mg/KgDW	Colorimetric	0.022	0.004	0.017	0.014	0.004	0.006	0.008	0.004	0.018	0.005
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	2.07	2.32	1.95	1.84	1.49	2.14	1.89	1.74	2.19	1.78
Co mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organic Matter %	Gravimetric	28.9	21.56	27.48	25.59	20.13	26.48	24.69	30.21	28.69	27.47
Oil & Grease		2.3	2.5	2.3	2.3	2.2	2.0	2.0	2.0	2.4	2.2
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	168	112	57	124	75	146	120	154	142	127
Yeast & Mold	Cfu/g	46	38	48	21	28	20	34	76	43	58
TCC Cfu/100ml	Plate count	22	32	46	40	36	42	29	57	41	38
FCC Cfu/100ml	Plate Count	Nil	Nil	3	Nil	Nil	2	5	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	1	Nil	4	Nil	Nil	Nil	Nil	Nil	Nil
T. H. Fungi	Plate Count	62	24	20	39	26	42	59	146	70	64

Source: Laboratory Analysis by Labchemnec Jans Limited, 2020

Table: 4.17(b): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Dry Season (cont'd)

Parameters & Units		Methodology	SS 11	SS 12	SS 13	SS 14	SS 15	SS 16	SS 17	SS 18	SS 19	SS 20
		RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL										
Sand Fraction (%)	VCS	2000-1000	27.48	24.58	29.62	28.39	27.28	30.32	28.39	30.37	29.48	31.49
	CS	1000-500	20.47	18.93	23.32	24.81	20.39	19.58	21.49	24.73	21.48	20.49
	MS	500-250	25.73	23.49	30.92	28.57	31.59	27.91	25.49	27.91	29.42	24.82
	FS	250-100	8.47	7.57	6.28	9.82	6.95	8.49	9.47	8.23	10.82	7.48
	VFS	100-50	0.09	0.05	0.08	0.18	0.14	0.05	0.18	0.15	0.05	0.08
% Total	SAND		91.48	90.48	90.61	92.47	92.58	90.82	94.48	93.72	91.92	90.59
	SILT	50-2μm	0.15	0.17	0.05	0.08	0.02	0.09	0.13	0.17	0.06	0.06
	CLAY	< 2 μm	2.54	1.59	2.21	2.49	1.42	2.82	2.92	1.58	3.82	2.71
	GRAND TOTAL		99.73	99.38	99.92	99.82	99.49	99.28	99.81	97.59	99.58	99.73
	Texture	Class	Sand loamy	Sand	Sand loamy	Sand	Sand	Sand	Sand	Sand loamy	Sand	Sand
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Sticky	Gritty	Gritty
	Appearance		Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse
Porosity			58.41	64.92	60.49	62.73	59.59	64.49	60.95	56.32	61.59	59.92
Bulk Density		**Uncomp**	1.74	1.69	1.81	1.45	1.62	1.59	1.48	1.42	1.58	1.62
		Comp	1.38	1.52	1.58	1.64	1.52	1.48	1.61	1.48	1.57	1.52
Permeability		g/**cm³**	0.064	0.049	0.042	0.056	0.048	0.059	0.053	0.068	0.043	0.051
Colour		Munsell Chart	Brownish 10YR6/8	Dark brown 7.5YR5/6	Grayish 7.5YR6/8	Dark brown 10YR4/6	Dark brown 7.5YR5/6	Dark brown 10YR4/6	Brownish 7.5YR4/7	Brownish 7.5YR6/8	Strong brown 10YR5/6	Strong brown 10YR6/8
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25⁰C		Electrometric	6.51	6.49	6.75	6.54	6.42	6.59	6.14	5.96	5.82	6.62
Temp.⁰/C		Thermoelectric	27.9	28.2	27.9	27.4	28.2	29.7	28.6	28.2	27.6	27.3
E.C. μS/cm³		Electrometric	125	149	132	157	143	194	162	205	137	141
M.C %		Gravimetric	8.2	7.8	7.5	9.2	8.1	8.9	8.5	7.6	10.1	9.4
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T. Nitrogen %		Colorimetric	9.32	13.29	10.92	8.38	13.71	11.68	9.63	12.83	10.49	9.58
Available Phosphorus		Colorimetric	2.06	1.86	1.64	1.94	1.58	1.31	1.43	1.52	1.34	1.68
SO_4^{-2} mg/kgDW		Colorimetric	43	34	53	38	47	40	52	48	50	59
NO_3^- mg/kgDW		Colorimetric	13.7	18.2	15.4	18.5	16.9	17.2	20.3	18.6	21.7	20.8
Ni mg/kgDW		Colorimetric	0.45	0.39	0.83	0.69	0.82	0.74	0.42	0.57	0.93	0.59
Fe^{2+} mg/kgDW		Colorimetric	15.65	18.47	17.32	21.48	17.45	21.69	20.59	22.62	20.85	22.81
Ca^{2+} mg/kgDW		Colorimetric	32.68	28.47	37.93	30.74	38.32	40.47	44.91	39.69	35.73	41.64
Pb^{2+} mg/kgDW		Colorimetric	12.62	10.34	18.47	9.92	11.58	10.93	8.47	13.82	10.29	9.53
Zn^{2+} mg/kgDW		Colorimetric	2.61	2.82	2.38	1.72	1.62	2.48	2.63	2.58	2.48	1.63
Cu^{2+} mg/kgDW		Colorimetric	2.36	1.39	1.78	2.05	2.16	1.73	2.59	2.63	2.48	1.15
Mg^{2+} mg/kgDW		Colorimetric	7.59	9.39	7.69	10.32	12.52	8.45	11.73	9.49	9.62	11.82
Mn^{2+} mg/kgDW		Colorimetric	0.04	0.09	0.14	0.09	0.04	0.07	0.06	0.08	0.04	0.08

Parameters & Units	Methodology	SS 11	SS 12	SS 13	SS 14	SS 15	SS 16	SS 17	SS 18	SS 19	SS 20
K^{2+} mg/kgDW	Flametric	20.82	21.59	19.74	22.48	20.49	22.21	27.31	24.71	21.27	18.46
Na^{2+} mg/kgDW	Flametric	2.4	1.9	1.5	1.2	1.8	2.5	2.1	1.8	1.6	1.8
Cl^- mg/kgDW	Colorimetric	20.58	23.81	25.29	17.83	20.48	24.21	25.31	18.41	20.68	23.67
Cr mg/KgDW	Colorimetric	0.004	0.006	0.004	0.003	0.005	0.002	0.005	0.006	0.003	0.005
Cd mg/KgDW	Colorimetric	0.015	0.002	0.009	0.021	0.038	0.0012	0.003	0.009	0.004	0.007
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	1.12	2.01	1.47	1.21	1.29	1.38	1.04	1.38	1.38	1.44
Co mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organic Matter %	Gravimetric	22.44	25.94	20.49	20.48	23.93	23.29	28.42	25.83	21.67	24.73
Oil & Grease		2.8	2.3	2.7	2.9	2.1	2.9	2.2	2.5	2.5	2.4
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	96	90	81	91	88	107	99	125	104	195
Yeast & Mold	Cfu/g	36	42	40	29	32	28	20	24	21	42
TCC Cfu/100ml	Plate count	26	21	33	28	30	39	25	28	29	59
FCC Cfu/100ml	Plate Count	Nil	Nil	2	2	3	Nil	Nil	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	Nil	2	1	Nil	Nil	Nil
T. H. Fungi	Plate Count	32	38	31	29	32	33	31	47	32	38

Source: Laboratory Analysis by Labchemnec Jans Limited, 2020

Table: 4.17(c): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Dry Season (cont'd)

Parameters & Units		Methodology	SS 21	SS 22	SS 23	SS 24	SS 25	SS 26	SS 27	SS 28	SS 29	SS 30
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	23.58	21.63	28.57	26.91	24.12	25.82	27.37	25.48	24.58	27.93
	CS	1000-500	16.87	18.41	24.81	20.43	18.38	21.69	17.38	20.57	17.79	19.62
	MS	500-250	25.43	21.79	31.48	28.71	27.52	28.58	25.78	30.31	25.53	27.91
	FS	250-100	11.65	14.82	10.57	13.47	11.43	14.82	16.52	15.71	17.51	26.81
	VFS	100-50	0.12	0.27	0.08	0.06	0.18	0.24	0.04	0.08	0.21	0.31
% Total	SAND		70.34	81.43	74.49	72.94	79.56	82.94	70.49	76.83	71.74	75.63
	SILT	50-2µm	0.43	0.41	0.36	0.49	0.38	0.52	0.57	0.46	0.57	0.61
	CLAY	< 2 µm	17.73	20.68	23.71	20.49	22.92	20.57	19.42	17.59	20.27	21.62
	GRAND TOTAL		99.59	99.32	99.48	99.32	99.79	99.43	99.59	99.53	99.27	99.51
	Texture	Class	Sand	Sand	Sand loamy	Sand	Loamy	Loamy	Sand	Sand	Loamy	Sandy
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Fine	Course	Coarse	Coarse	Coarse	Fine	Coarse	Coarse	Coarse
Porosity			61.53	70.82	64.65	64.48	65.86	71.58	70.31	68.47	63.84	68.45
Bulk Density		**Uncomp**	1.46	1.52	1.49	1.62	1.57	1.64	1.52	1.63	1.69	1.48
		Comp	1.54	1.68	1.59	1.75	1.65	1.56	1.72	1.64	1.62	1.55
Permeability		**g/cm³**	0.051	0.065	0.048	0.044	0.048	0.053	0.049	0.052	0.062	0.051
Colour		Munsell Chart	Brownish 10YR6/8	Strong brown 7.5YR4/6	Brownidh 10YR4/6	Strong brown 7.5YR5/8	Brownish 7.5YR4/6	Dark brown 7.5YR4/6	Dark brown 10YR5/8	Brownish 10YR5/6	Dark brown 7.5YR4/6	Dark brown 7.5YR5/8
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25⁰C		Electrometric	6.73	6.48	6.58	5.74	6.58	6.13	6.42	6.54	6.21	6.49
Temp.⁰/C		Thermoelectric	28.4	27.3	27.9	27.3	27.3	27.1	28.5	26.9	27.8	26.4
E.C. µS/cm³		Electrometric	175	143	168	162	176	181	163	148	194	172
M.C %		Gravimetric	9.8	10.4	8.7	10.8	9.5	11.8	7.8	12.3	10.9	7.8
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T. Nitrogen %		Colorimetric	10.7	14.56	11.43	13.82	15.98	10.46	12.65	9.45	10.38	11.42
Available Phosphorus		Colorimetric	1.68	1.92	1.59	1.58	1.73	1.69	1.83	1.57	1.57	1.47
SO_4^{-2} mg/kgDW		Colorimetric	52	44	50	54	38	43	51	45	52	57
NO_3^- mg/kgDW		Colorimetric	21.6	18.9	21.4	20.6	16.9	18.3	21.2	20.5	17.8	20.5
Ni mg/kgDW		Colorimetric	0.221	0.169	0.254	0.169	0.208	0.254	0.194	0.462	0.331	0.1218
Fe^{2+} mg/kgDW		Colorimetric	50.217	61.435	55.832	48.472	46.143	50.943	41.482	57.549	43.839	60.482
Ca^{2+} mg/kgDW		Colorimetric	16.84	19.43	18.76	17.65	23.72	20.47	25.71	20.57	19.65	20.92
Pb^{2+} mg/kgDW		Colorimetric	4.549	3.582	3.273	4.481	5.581	4.964	4.863	3.374	4.842	3.731
Zn^{2+} mg/kgDW		Colorimetric	0.1642	0.0463	0.0958	0.3942	1.3295	0.5982	0.3253	0.2417	0.4921	0.3285
Cu^{2+} mg/kgDW		Colorimetric	0.9584	0.5492	0.8402	0.2942	0.8382	0.5492	0.6982	0.2352	0.3852	0.3702
Mg^{2+} mg/kgDW		Colorimetric	9.548	6.872	9.432	7.722	5.739	8.434	8.588	6.592	7.984	9.658

Parameters & Units	Methodology	SS 21	SS 22	SS 23	SS 24	SS 25	SS 26	SS 27	SS 28	SS 29	SS 30
Mn^{2+} mg/kgDW	Colorimetric	0.05	0.13	0.09	0.09	0.06	0.15	0.12	0.08	0.06	0.09
K^{2+} mg/kgDW	Flametric	19.75	16.86	20.57	18.32	16.58	12.92	22.81	25.82	21.49	19.54
Na^{2+} mg/kgDW	Flametric	2.4	2.8	1.6	2.4	1.8	2.6	2.4	1.6	2.3	1.9
Cl^{-} mg/kgDW	Colorimetric	19.53	23.82	20.92	21.73	20.46	18.93	21.73	23.48	19.92	22.49
Cr mg/KgDW	Colorimetric	0.002	0.004	0.003	0.004	0.004	0.002	0.001	0.004	0.002	0.003
Cd mg/KgDW	Colorimetric	0.006	0.012	0.005	0.008	0.002	0.009	0.005	0.002	0.006	0.004
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^{-} mg/KgDW	Colorimetric	1.52	1.59	2.63	1.47	1.52	1.68	2.42	2.82	1.73	1.62
Co mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organic Matter %	Gravimetric	24.65	20.93	24.86	29.32	28.71	24.59	27.37	26.43	31.48	29.82
Oil & Grease		1.9	2.2	2.0	1.8	2.0	2.3	2.3	2.2	2.1	2.0
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	128	87	105	74	95	91	99	88	132	99
Yeast & Mold	Cfu/g	58	40	49	38	54	47	34	46	29	36
TCC Cfu/100ml	Plate count	32	38	26	30	33	24	28	31	30	34
FCC Cfu/100ml	Plate Count	2	Nil	6	Nil	Nil	Nil	4	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	3	Nil	Nil	Nil	Nil	Nil	5	Nil	3
T. H. Fungi	Plate Count	28	32	30	25	29	31	27	34	29	31

Source: Laboratory Analysis by Labchemnec Jans Limited, 2020

Table: 4.17(d): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Dry Season (cont'd)

Parameters & Units		Methodology	SS 31	SS 32	SS 33	SS 34	SS 35	SS 36	SS 37	SS 38	SS 39	SS 40
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	22.58	27.21	25.69	28.43	29.31	26.67	30.29	28.93	25.69	29.43
	CS	1000-500	20.73	18.43	18.94	21.47	17.58	20.31	20.38	19.54	17.32	16.59
	MS	500-250	26.43	29.82	22.49	26.73	30.86	26.43	25.69	30.61	29.32	27.42
	FS	250-100	12.65	10.73	9.75	10.43	14.62	9.83	11.37	14.81	12.41	15.49
	VFS	100-50	0.32	0.18	0.09	0.24	0.03	0.19	0.06	0.07	0.04	0.06
% Total	SAND		68.54	70.93	72.43	69.73	74.54	70.41	68.39	73.84	71.58	75.82
	SILT	50-2µm	0.72	0.59	0.51	0.48	0.59	0.64	0.44	0.57	0.49	0.61
	CLAY	< 2 µm	17.56	24.74	21.68	23.51	18.69	21.54	21.18	19.69	20.32	23.81
	GRAND TOTAL		99.19	99.53	99.36	99.47	99.31	99578	99.43	99.91	99.59	99.74
	Texture	Class	Sand	Loamy	Loamy	Loamy	Sand	Sandy loamy	Sandy loamy	Sand	Loamy	Sand
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Coarse	Course	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse	Coarse
Porosity			72.54	63.68	69.41	65.79	73.69	68.32	71.91	60.58	66.47	73.83
Bulk Density		**Uncomp**	1.49	1.32	1.58	1.93	1.48	1.73	1.57	1.88	1.71	1.64
		Comp	1.51	1.56	1.67	1.72	1.59	1.41	1.28	1.79	1.63	1.42
Permeability		**g/cm³**	0.037	0.058	0.046	0.028	0.056	0.082	0.049	0.061	0.048	0.073
Colour		Munsell Chart	Dark drown 7.5YR4/6	Brownish 10YR5/6	Strong brown 10YR5/6	Brownish 7.5YR4/6	Brownish 7.5YR4/6	Dark brown 7.5YR4/6	Dark brown 10YR5/6	Brownish 10YR5/6	Dark brown 7.5YR5/6	Brownish 7.5YR5/6
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25^{0}C		Electrometric	6.54	6.32	6.69	6.37	6.79	6.54	6.68	6.72	6.48	6.57
Temp.^{0}/C		Thermoelectric	28.7	28.2	29.1	27.3	27.8	28.2	27.5	27.2	28.7	27.6
E.C. µS/cm^3		Electrometric	194	172	149	179	151	168	163	174	185	177
M.C %		Gravimetric	4.8	5.4	4.2	7.9	6.2	4.8	6.8	5.2	5.7	6.1
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND
T. Nitrogen %		Colorimetric	10.48	9.69	11.51	13.93	11.86	10.39	15.73	14.59	11.59	16.53
Available Phosphorus		Colorimetric	2.06	1.82	1.49	2.19	1.72	1.63	1.91	1.68	1.86	1.47
SO_4^{-2} mg/kgDW		Colorimetric	62.76	54.92	60.38	58.38	49.98	50.57	61.84	52.61	61.32	58.19
NO_3^- mg/kgDW		Colorimetric	8.41	11.73	8.69	11.57	9.41	13.52	6.49	9.72	6.56	8.91
Ni mg/kgDW		Colorimetric	0.05	0.09	0.04	0.09	0.12	0.04	0.13	0.08	0.01	0.04
Fe^{2+} mg/kgDW		Colorimetric	14.62	19.42	16.83	21.583	16.49	15.93	20.59	22.81	18.59	21.49
Ca^{2+} mg/kgDW		Colorimetric	30.41	42.13	34.83	33.71	28.47	38.43	30.73	39.49	43.62	41.93
Pb^{2+} mg/kgDW		Colorimetric	1.82	1.68	2.31	1.59	1.69	2.4	3.58	2.68	2.59	2.32
Zn^{2+} mg/kgDW		Colorimetric	1.41	1.27	2.09	1.49	1.04	1.63	1.24	1.72	1.31	1.47
Cu^{2+} mg/kgDW		Colorimetric	1.13	1.04	1.58	1.51	1.69	1.43	2.18	1.68	2.83	1.49
Mg^{2+} mg/kgDW		Colorimetric	5.93	7.27	5.94	8.43	6.84	9.53	4.69	8.65	7.58	6.92
Mn^{2+} mg/kgDW		Colorimetric	0.09	0.14	0.06	0.08	0.04	0.06	0.12	0.09	0.05	0.09

Parameters & Units	Methodology	SS 31	SS 32	SS 33	SS 34	SS 35	SS 36	SS 37	SS 38	SS 39	SS 40
K^{2+} mg/kgDW	Flametric	21.59	16.38	19.273	21.58	17.47	18.54	21.83	17.76	21.69	19.63
Na^{2+} mg/kgDW	Flametric	1.9	2.1	1.8	1.3	1.8	2.5	1.3	1.8	1.2	1.7
Cl^- mg/kgDW	Colorimetric	21.54	18.96	19.69	24.63	20.82	18.48	20.91	18.48	22.75	19.57
Cr mg/KgDW	Colorimetric	0.003	0.003	0.005	0.002	0.004	0.005	0.004	0.003	0.007	0.004
Cd mg/KgDW	Colorimetric	0.006	0.004	0.008	0.004	0.007	0.007	0.005	0.005	0.004	0.004
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	1.58	1.92	1.38	2.04	2.53	1.48	1.83	1.59	1.83	1.29
Co mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organic Matter %	Gravimetric	21.74	19.38	24.69	20.42	18.59	22.94	20.48	23.59	21.47	21.58
Oil & Grease		1.9	2.1	1.8	2.6	2.3	2.2	2.2	1.8	2.7	2.1
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	96	84	126	113	95	79	91	112	194	86
Yeast & Mold	Cfu/g	58	49	36	53	44	38	31	56	49	50
TCC Cfu/100ml	Plate count	51	37	29	48	40	30	36	42	38	45
FCC Cfu/100ml	Plate Count	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
T. H. Fungi	Plate Count	48	52	31	26	41	32	28	43	52	43

Source: Laboratory Analysis by Labchemnec Jans Limited, 2020

Table: 4.17(e): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Dry Season (cont'd)

Parameters & Units		Methodology	SS 41	SS 42	SS 43	SS 44	SS 45	SS 46	SS 47	SS 48	SS 49	SS 50
		RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL										
Sand Fraction (%)	VCS	2000-1000	29.61	24.57	27.48	29.21	24.83	14.24	29.43	27.72	22.58	30.84
	CS	1000-500	14.68	18.32	15.79	21.46	16.59	19.45	21.72	19.84	16.68	20.51
	MS	500-250	28.37	25.79	31.45	34.56	31.78	33.20	25.94	29.84	31.48	26.61
	FS	250-100	14.65	11.79	10.97	8.73	10.86	13.02	12.37	12.81	14.47	10.73
	VFS	100-50	0.15	0.26	0.18	0.23	0.14	0.23	0.05	0.13	0.21	0.16
% Total	SAND		68.51	78.46	82.68	73.52	78.29	80.14	77.93	83.75	71.53	80.85
	SILT	50-2μm	0.47	0.72	0.51	0.65	0.82	0.95	0.32	0.48	0.57	0.63
	CLAY	< 2 μm	18.73	24.26	21.57	18.59	20.67	18.00	19.69	19.94	18.22	23.79
	GRAND TOTAL		99.48	99.48	99.34	99.79	99.82	99.09	99.76	99.38	99.49	99.38
	Texture	Class	Sand	Sand	Loamy	Loamy	Loamy	Sandy loam	Sandy	Sandy	Loamy	Sandy
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Coarse	Course	Coarse	Fine	Fine	Coarse	Coarse	Fine	Coarse
Porosity			62.32	59.69	68.41	64.79	60.58	51.11	61.39	69.57	61.48	65.19
Bulk Density		**Uncomp**	1.73	1.51	1.38	1.91	1.87	1.15	1.62	1.71	1.39	1.73
		Comp	1.46	1.78	1.49	1.64	1.84	1.25	1.69	1.84	1.52	1.69
Permeability		g/**cm³**	0.072	0.059	0.083	0.053	0.082	0.049	0.081	0.068	0.042	0.072
Colour		Munsell Chart	Dark brown 10YR6/8	Brownish 8YR5/6	Brownish 10YR6/8	Dark brown 7.5YR4/6	Dark brown 10YR5/6	Brown 10YR6/4	Dark brown 10YR5/6	Brownish 10YR5/6	Brownish 10YR5/6	Dark brown 7.5YR5/6
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25^{0}C		Electrometric	6.32	6.89	6.53	6.76	6.68	6.40	6.94	6.82	6.49	6.61
Temp.^{0}/C		Thermoelectric	28.1	28.8	28.7	27.3	28.5	27.5	27.9	28.7	28.2	27.1
E.C. μS/cm^3		Electrometric	148	163	121	185	132	207	147	124	142	151
M.C %		Gravimetric	5.7	5.1	6.4	4.5	5.0	8.2	5.2	5.3	7.1	6.3
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND
T. Nitrogen %		Colorimetric	10.43	7.58	10.39	13.65	12.59	10.02	14.39	14.21	11.59	13.34
Available Phosphorus		Colorimetric	1.75	1.29	1.83	1.43	1.42	1.88	2.03	2.38	1.91	1.48
SO_4^{-2} mg/kgDW		Colorimetric	71.53	64.65	51.48	47.51	50.93	65.64	31.82	59.81	73.69	59.43
NO_3^- mg/kgDW		Colorimetric	4.59	6.21	8.49	3.49	7.42	19.25	5.93	4.91	8.41	6.69
Ni mg/kgDW		Colorimetric	0.03	0.09	0.06	0.06	0.12	0.001	0.02	0.14	0.13	0.07
Fe^{2+} mg/kgDW		Colorimetric	16.47	18.921	16.32	15.83	12.49	20.6	20.39	22.43	18.49	21.81
Ca^{2+} mg/kgDW		Colorimetric	31.48	39.18	28.86	41.69	49.43	46.12	42.69	39.61	36.59	53.14
Pb^{2+} mg/kgDW		Colorimetric	26.74	29.31	28.31	23.58	20.26	4.82	23.91	24.75	19.51	17.31
Zn^{2+} mg/kgDW		Colorimetric	1.54	1.84	1.38	1.71	1.47	5.76	2.58	1.73	2.49	1.54
Cu^{2+} mg/kgDW		Colorimetric	1.32	1.58	1.81	1.43	1.48	1.89	1.41	1.59	1.64	1.79
Mg^{2+} mg/kgDW		Colorimetric	8.94	8.49	8.72	10.81	7.59	10.88	12.51	9.45	13.32	15.83
Mn^{2+} mg/kgDW		Colorimetric	0.07	0.02	0.06	0.02	0.05	28.52	0.04	0.02	0.07	0.02

Parameters & Units	Methodology	SS 41	SS 42	SS 43	SS 44	SS 45	SS 46	SS 47	SS 48	SS 49	SS 50
K^{2+} mg/kgDW	Flametric	11.9	15.421	10.74	14.87	13.42	58.7	15.69	17.63	14.69	18.73
Na^{2+} mg/kgDW	Flametric	1.8	1.5	1.7	1.5	1.8	12.7	2.3	2.4	2.5	1.8
Cl^- mg/kgDW	Colorimetric	24.65	19.575	15.57	17.81	20.62	22.73	20.46	19.35	21.88	18.67
Cr mg/KgDW	Colorimetric	0.002	0.007	0.003	0.002	0.002	0.008	0.004	0.003	0.002	0.002
Cd mg/KgDW	Colorimetric	0.004	0.001	0.001	0.004	0.002	0.039	0.002	0.001	0.002	0.001
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	1.54	1.69	2.05	1.59	1.81	2.66	1.53	1.89	1.43	1.64
Co mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organic Matter %	Gravimetric	24.54	27.97	24.66	29.43	26.82	33	21.59	26.74	23.93	25.64
Oil & Grease		1.8	2.2	1.7	1.5	2.7	3.1	1.9	2.1	2.1	2.4
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	95	78	165	191	48	12	58	67	94	84
Yeast & Mold	Cfu/g	51	47	41	48	32	3	49	62	38	42
TCC Cfu/100ml	Plate count	27	20	31	39	39	250	33	43	38	43
FCC Cfu/100ml	Plate Count	Nil	Nil	Nil	Nil	Nil	14	Nil	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
T. H. Fungi	Plate Count	48	38	28	23	29	8	43	43	52	48

Source: Laboratory Analysis by Labchemnec Jans Limited, 2020

Table: 4.17(f): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Dry Season (cont'd)

Parameters & Units		Methodology	SS 51	SS 52	SS 53	SS 54	SS 55	SS 56	SS 57	SS 58	SS 59	SS 60
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	20.37	27.21	25.43	29.34	21.59	30.43	24.64	28.97	28.37	8.4
	CS	1000-500	19.43	21.91	20.57	17.69	22.74	19.48	21.54	23.86	19.38	12.75
	MS	500-250	22.54	27.69	26.95	30.32	26.37	30.91	28.67	26.85	29.81	37.15
	FS	250-100	14.72	12.45	17.74	14.83	15.58	13.41	13.94	12.68	10.68	19.37
	VFS	100-50	0.05	0.18	0.05	0.17	0.09	0.04	0.21	0.14	0.08	0.07
% Total	SAND		76.12	72.65	78.83	80.42	74.81	79.61	81.57	79.32	76.63	77.68
	SILT	50-2µm	0.84	1.53	0.82	0.34	1.46	0.41	0.68	0.52	0.61	1.49
	CLAY	< 2 µm	21.47	17.86	20.48	18.76	20.56	18.62	17.84	20.68	21.53	19.92
	GRAND TOTAL		99.37	99.85	99.59	99.28	99.66	99.49	99.31	99.58	99.46	99.09
	Texture	Class	Sand	Sand	Loamy	Sand	Loamy	Loamy	Sand	Sand	Loamy	Sandy loam
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Coarse	Course	Coarse	Coarse	Coarse	Course	Coarse	Fine	Fine
Porosity			68.31	73.27	68.49	61.29	69.53	70.26	74.18	61.24	68.96	58.82
Bulk Density		**Uncomp**	1.72	1.46	1.68	1.54	1.74	1.69	1.39	1.48	1.83	1.47
		Comp	1.82	1.51	1.68	1.63	1.76	1.45	1.58	1.43	1.88	1.67
Permeability		g/**cm³**	0.074	0.069	0.076	0.059	0.037	0.086	0.071	0.068	0.051	0.034
Colour		Munsell Chart	Brownish 10YR6/8	Brown 7.5YR4/6	Brownidh 10YR4/6	Dark brown 7.5YR5/8	Brownish 7.5YR4/6	Brownish 7.5YR4/6	Brownish 10YR5/8	Brownish 10YR5/6	Dark brown 7.5YR4/6	Light grey 10YR5/3
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25⁰C		Electrometric	6.37	6.75	6.51	5.24	5.98	6.68	6.91	6.76	6.85	6.40
Temp.⁰/C		Thermoelectric	27.8	27.5	28.2	27.6	27.8	28.3	28.7	28.4	27.5	27.5
E.C. µS/cm^3		Electrometric	159	185	124	153	182	164	129	193	142	211
M.C %		Gravimetric	11.2	8.31	10.4	12.2	7.5	13.2	11.5	10.0	8.4	8.1
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T. Nitrogen %		Colorimetric	12.65	9.47	9.32	14.95	8.59	11.32	10.47	10.32	13.46	11.12
Available Phosphorus		Colorimetric	1.74	1.63	1.79	1.77	1.61	1.45	1.38	1.68	1.52	0.85
SO_4^{-2} mg/kgDW		Colorimetric	64	52	58	50	48	56	62	48	57	55.2
NO_3^- mg/kgDW		Colorimetric	13.4	10.3	15.2	9.8	11.3	15.6	13.8	10.7	14.2	21.40
Ni mg/kgDW		Colorimetric	0.073	0.048	0.136	0.061	0.194	0.152	0.231	0.192	0.273	0.362
Fe^{2+} mg/kgDW		Colorimetric	21.154	18.141	26.418	16.183	21.842	14.481	10.946	19.528	15.425	65.7
Ca^{2+} mg/kgDW		Colorimetric	13.21	17.81	15.59	14.97	20.28	19.42	17.49	19.13	21.83	12.52
Pb^{2+} mg/kgDW		Colorimetric	2.391	2.428	2.439	3.714	2.692	5.548	3.8283	2.541	4.710	3.26
Zn^{2+} mg/kgDW		Colorimetric	0.0854	0.1737	0.1739	0.4861	0.3291	0.2174	0.3274	0.2184	0.2849	0.168
Cu^{2+} mg/kgDW		Colorimetric	0.6582	0.3915	0.5829	0.4194	0.5832	0.4894	0.7328	0.4863	02974	0.009
Mg^{2+} mg/kgDW		Colorimetric	6.729	8.494	11.681	9.381	8.629	10.739	6.417	8.834	9.638	6.59
Mn^{2+} mg/kgDW		Colorimetric	0.06	0.09	0.03	0.06	0.02	0.06	0.03	0.09	0.07	12.25

Parameters & Units	Methodology	SS 51	SS 52	SS 53	SS 54	SS 55	SS 56	SS 57	SS 58	SS 59	SS 60
K^{2+} mg/kgDW	Flametric	15.58	12.91	16.83	24.48	20.91	27.54	18.69	19.29	24.85	27.1
Na^{2+} mg/kgDW	Flametric	1.8	2.1	2.2	2.1	2.3	1.9	1.2	2.8	1.8	6.2
Cl^- mg/kgDW	Colorimetric	17.72	20.49	24.57	23.48	18.93	24.58	24.62	20.39	22.84	32.74
Cr mg/KgDW	Colorimetric	0.003	0.001	0.002	0.002	0.002	0.001	0.002	0.002	0.004	0.873
Cd mg/KgDW	Colorimetric	0.002	0.006	0.004	0.003	0.004	0.004	0.003	0.005	0.003	0.032
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	2.41	2.82	2.48	2.28	2.63	2.81	1.83	1.54	2.58	1.523
Co mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.003
Organic Matter %	Gravimetric	29.93	24.68	20.47	25.81	20.59	28.82	22.59	20.91	26.81	22
Oil & Grease		2.4	2.7	1.6	2.5	1.8	2.1	1.8	1.4	2.8	2.6
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	85	153	204	112	99	89	104	78	148	22
Yeast & Mold	Cfu/g	84	57	44	51	50	39	47	52	38	13
TCC Cfu/100ml	Plate count	39	30	32	27	30	21	23	19	24	32
FCC Cfu/100ml	Plate Count	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	53
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
T. H. Fungi	Plate Count	19	17	22	20	18	26	21	24	23	12

Source: Laboratory Analysis by Labchemnec Jans Limited, 2020

Table: 4.17(g): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Dry Season (cont'd)

Parameters & Units		Methodology	SS 61	SS 62	SS 63	SS 64	SS 65	SS 66	SS 67	SS 68	SS 69	SS 70
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	26.73	29.19	25.96	30.98	34.72	25.58	32.85	26.59	27.87	33.45
	CS	1000-500	23.84	20.62	18.47	22.68	24.96	17.78	20.41	23.65	19.85	16.68
	MS	500-250	32.49	28.36	30.59	31.97	26.55	30.46	29.63	26.51	30.39	33.32
	FS	250-100	12.49	15.38	14.68	12.65	16.34	11.58	15.85	14.46	16.91	13.38
	VFS	100-50	0.23	0.19	0.15	0.14	0.24	0.18	0.13	0.07	0.05	0.13
% Total	SAND		73.74	70.83	75.17	80.41	66.49	74.83	79.38	81.64	80.18	75.93
	SILT	50-2µm	0.65	0.57	0.64	0.44	0.67	0.54	0.51	0.63	0.39	0.42
	CLAY	< 2 µm	21.28	19.71	25.84	20.42	23.96	21.59	28.19	23.75	20.65	21.59
	GRAND TOTAL		99.29	99.83	99.07	99.32	99.19	99.84	99.57	99.21	99.68	99.79
	Texture	Class	Loamy	Sand	Sand	Sand	Sandy Loam	Loamy	Sandy	Sandy	Loamy	Loamyy
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Fine	Coarse	Coarse	Course	Fine	Coarse	Fine	Coarse	Coarse
Porosity			58.74	64.73	61.57	60.71	66.83	72.43	68.74	60.32	70.17	69.83
Bulk Density		**Uncomp**	1.38	1.86	1.54	1.45	1.74	1.59	1.26	1.65	1.46	1.68
		Comp	1.58	1.43	1.64	1.73	1.47	1.65	1.38	1.29	1.57	1.79
Permeability		**g/cm³**	0.064	0.048	0.091	0.069	0.056	0.068	0.073	0.082	0.053	0.068
Colour		Munsell Chart	Light grey 10YR5/6	Brown 10YR5/6	Brown 7.5YR6/8	Sroen brown 10YR4/6	Dark brown 10YR5/6	Dark brown 10YR6/4	Brown 10YR5/6	Brownish 10YR5/6	Brownish 10YR5/6	Brownish 10YR5/6
			RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL									
pH @25⁰C		Electrometric	6.67	6.52	6.78	6.41	5.94	6.21	6.64	6.18	6.46	6.79
Temp.⁰/C		Thermoelectric	27.8	27.4	27.4	28.5	26.9	27.8	27.5	28.6	27.9	28.4
E.C. µS/cm³		Electrometric	136	143	175	164	182	157	132	169	201	183
M.C %		Gravimetric	4.9	5.8	5.2	5.7	6.3	5.6	5.8	4.7	6.1	5.7
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T. Nitrogen %		Colorimetric	13.72	10.49	14.53	18.44	15.68	13.27	13.95	12.58	15.81	14.93
Available Phosphorus		Colorimetric	2.12	1.44	1.37	1.68	1.97	1.75	1.59	1.74	1.58	2.26
SO_4^{-2} mg/kgDW		Colorimetric	56.84	46.85	59.73	68.96	55.48	49.89	58.76	50.35	67.43	61.57
NO_3^- mg/kgDW		Colorimetric	5.84	4.83	6.79	6.31	4.58	48.18	9.73	7.26	10.82	8.73
Ni mg/kgDW		Colorimetric	0.08	0.04	0.07	0.05	0.05	0.04	0.07	0.04	0.07	0.02
Fe^{2+} mg/kgDW		Colorimetric	23.21	16.58	21.93	17.24	27.47	10.81	26.56	16.92	24.73	26.63
Ca^{2+} mg/kgDW		Colorimetric	48.32	42.73	44.57	35.28	40.97	51.86	48.24	50.19	43.38	35.53
Pb^{2+} mg/kgDW		Colorimetric	4.43	6.58	3.24	2.94	5.65	5.45	4.43	3.62	5.32	4.91
Zn^{2+} mg/kgDW		Colorimetric	2.71	1.94	2.44	2.87	1.39	3.18	2.69	1.28	2.83	2.12
Cu^{2+} mg/kgDW		Colorimetric	1.41	1.83	2.27	1.73	2.67	1.47	1.88	1.43	1.79	1.48
Mg^{2+} mg/kgDW		Colorimetric	12.55	10.38	14.75	10.26	15.93	20.33	14.29	10.76	9.56	11.34
Mn^{2+} mg/kgDW		Colorimetric	0.54	0.84	0.28	0.15	0.04	1.52	0.38	0.57	0.48	0.23

Parameters & Units	Methodology	SS 61	SS 62	SS 63	SS 64	SS 65	SS 66	SS 67	SS 68	SS 69	SS 70
K^{2+} mg/kgDW	Flametric	17.5	22.68	23.81	29.43	32.58	40.24	35.76	33.91	55.83	42.55
Na^{2+} mg/kgDW	Flametric	6.4	7.2	5.3	10.8	4.9	8.5	11.7	16.2	12.4	7.6
Cl^{-} mg/kgDW	Colorimetric	29.32	22.65	20.81	28.76	31.46	20.58	30.94	25.49	29.91	26.29
Cr mg/KgDW	Colorimetric	0.008	0.004	0.005	0.001	0.003	0.003	0.001	0.003	0.001	0.002
Cd mg/KgDW	Colorimetric	0.042	0.016	0.028	0.013	0.021	0.013	0.031	0.028	0.038	0.042
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^{-} mg/KgDW	Colorimetric	3.16	3.59	2.32	2.46	1.42	1.83	2.84	1.63	2.82	1.94
Co mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organic Matter %	Gravimetric	41.54	33.75	38.29	42.68	34.81	30.25	39.61	28.43	46.81	31.59
Oil & Grease		4.1	3.6	3.2	4.5	2.8	3.5	2.6	3.4	2.8	3.1
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	98	105	85	163	99	83	93	98	125	91
Yeast & Mold	Cfu/g	35	22	27	10	12	24	10	8	19	15
TCC Cfu/100ml	Plate count	90	48	57	30	112	65	27	58	35	40
FCC Cfu/100ml	Plate Count	Nil	Nil	2	Nil	Nil	14	Nil	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	Nil	Nil	Nil	Nil	Nil	Nil	3	Nil	Nil	Nil
T. H. Fungi	Plate Count	18	7	20	12	9	11	23	21	11	9

Source: Laboratory Analysis by Labchemnec Jans Limited, 2020

Table: 4.17(h): Results of Physical, Chemical and Microbial Analysis of Soil Samples for Dry Season (cont'd)

Parameters & Units		Methodology	SS 71	SS 72	SS 73	SS 74	SS 75	SS 76 (Control 1)	SS 77 (Control 2)	SS 78 (Control 3)	SS 79 (Control 4)	SS 80 (Control 5)
			RESULT OF PHYSICAL ANALYSIS OF COMPOSITE SOIL									
Sand Fraction (%)	VCS	2000-1000	31.55	23.58	30.43	34.81	33.56	25.87	32.43	30.12	28.38	31.72
	CS	1000-500	22.76	18.51	22.42	21.57	16.68	23.83	23.16	17.25	16.38	20.95
	MS	500-250	20.14	29.84	23.31	27.18	31.98	26.25	24.86	28.81	32.27	28.53
	FS	250-100	11.58	17.61	15.49	11.83	16.81	14.46	17.34	21.16	12.45	15.81
	VFS	100-50	0.24	0.19	0.01	0.28	0.03	0.06	0.14	0.28	0.11	0.32
% Total	SAND		81.43	68.41	76.36	79.91	72.51	80.42	77.64	69.78	74.54	81.26
	SILT	50-2µm	0.53	0.96	0.38	0.69	0.58	0.29	0.71	0.48	0.53	0.91
	CLAY	< 2 µm	19.82	17.78	23.82	29.39	25.84	23.49	21.72	24.27	20.69	26.21
	GRAND TOTAL		99.57	99.42	99.69	99.24	99.85	99.34	99.18	99.37	99.38	99.48
	Texture	Class	Sandy	Loamy	Loamy	Sandy loam	Loamy	Loamy	Sandy	Sandy loam	Sandy	Sandy
	Type		Gritty	Gritty	Sticky	Gritty	Gritty	Gritty	Gritty	Gritty	Gritty	Sticky
	Appearance		Coarse	Coarse	Course	Coarse	Fine	Coarse	Fine	Coarse	Coarse	Coarse
Porosity			72.18	65.89	69.45	73.55	71.81	60.81	65.14	59.41	72.38	68.82
Bulk Density		**Uncomp**	1.72	1.65	1.39	1.89	1.35	1.46	1.76	1.68	1.43	1.69
		Comp	1.44	1.39	1.18	1.57	1.25	1.51	1.89	1.58	1.66	1.51
Permeability		g/**cm³**	0.028	0.083	0.044	0.078	0.036	0.041	0.056	0.048	0.091	0.065
Colour		Munsell Chart	Dark brown 7.5YR5/6	Brownish 10YR6/8	Strong brown 10YR5/6	Brown 7.5YR4/6	Brownish 10YR4/6	Brownish 7.5YR4/6	Strong brown 8YR5/6	Brownish 10YR5/6	Brownish 10YR5/6	Brown 7.5YR5/6
		RESULT OF CHEMICAL ANALYSIS OF COMPOSITE SOIL										
pH @25⁰C		Electrometric	6.16	5.69	6.94	6.68	6.52	6.86	5.58	6.65	6.87	6.51
Temp.⁰/C		Thermoelectric	27.8	27.6	28.5	28.2	28.5	27.9	29.3	28.6	27.5	27.9
E.C. µS/cm³		Electrometric	139	158	125	145	167	141	198	153	185	192
M.C %		Gravimetric	5.1	4.6	6.1	4.4	3.6	5.1	4.7	4.3	5.2	4.2
V mg/kgDW		Colorimetric	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND
T. Nitrogen %		Colorimetric	13.67	10.98	16.68	11.58	9.44	13.61	10.48	8.33	14.85	14.13
Available Phosphorus		Colorimetric	1.48	1.86	1.54	1.35	2.81	1.45	1.74	1.43	1.59	1.58
SO_4^{-2} mg/kgDW		Colorimetric	58.48	62.87	52.79	69.31	57.83	70.18	67.34	59.93	68.24	60.45
NO_3^- mg/kgDW		Colorimetric	12.08	9.48	11.75	8.49	7.58	8.13	8.78	7.50	5.38	7.61
Ni mg/kgDW		Colorimetric	0.28	0.14	0.08	0.15	0.06	0.02	0.07	0.04	0.07	0.05
Fe^{2+} mg/kgDW		Colorimetric	20.98	15.59	22.21	14.49	18.58	12.73	14.87	11.79	14.52	10.69
Ca^{2+} mg/kgDW		Colorimetric	51.23	40.65	38.45	44.58	32.73	40.36	36.48	42.68	49.31	38.68
Pb^{2+} mg/kgDW		Colorimetric	2.64	1.35	1.57	1.44	1.24	1.59	2.29	1.37	1.83	1.49

Parameters & Units	Methodology	SS 71	SS 72	SS 73	SS 74	SS 75	SS 76 (Control 1)	SS 77 (Control 2)	SS 78 (Control 3)	SS 79 (Control 4)	SS 80 (Control 5)
Zn^{2+} mg/kgDW	Colorimetric	1.82	1.58	1.32	1.63	1.58	1.04	1.09	1.17	1.72	1.38
Cu^{2+} mg/kgDW	Colorimetric	1.24	1.18	1.98	1.74	1.56	1.52	1.54	1.38	1.81	1.55
Mg^{2+} mg/kgDW	Colorimetric	8.72	11.68	9.68	8.69	10.57	14.98	12.45	9.84	13.36	10.75
Mn^{2+} mg/kgDW	Colorimetric	0.05	0.07	0.03	0.06	0.05	0.09	0.03	0.07	0.08	0.05
K^{2+} mg/kgDW	Flametric	29.81	23.57	28.41	19.69	22.59	28.85	26.42	30.68	18.78	23.74
Na^{2+} mg/kgDW	Flametric	2.3	1.8	1.5	1.9	2.1	1.4	1.8	1.6	2.2	1.6
Cl^- mg/kgDW	Colorimetric	27.93	24.57	22.84	27.48	23.19	20.76	26.28	21.64	19.68	23.68
Cr mg/KgDW	Colorimetric	0.007	0.005	0.009	0.005	0.008	0.005	0.007	0.004	0.006	0.002
Cd mg/KgDW	Colorimetric	0.003	0.002	0.005	0.007	0.004	0.006	0.003	0.008	0.003	0.008
As mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PO_4^- mg/KgDW	Colorimetric	2.09	1.69	2.05	1.57	1.92	1.64	1.61	1.86	1.56	1.71
Co mg/KgDW	Colorimetric	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organic Matter %	Gravimetric	26.63	23.47	20.38	23.84	21.72	18.82	24.56	20.78	22.74	23.83
Oil & Grease		2.9	1.8	2.3	1.8	2.6	2.8	2.4	2.6	1.6	1.8
	RESULT OF MICROBIAL ANALYSIS OF COMPOSITE SOIL										
THB Count	Cfu/g	89	146	96	110	59	85	93	81	62	57
Yeast & Mold	Cfu/g	10	38	18	12	51	18	26	56	49	31
TCC Cfu/100ml	Plate count	45	29	37	24	35	36	48	40	59	17
FCC Cfu/100ml	Plate Count	Nil	8	Nil	4	Nil	14	Nil	Nil	Nil	Nil
E.coli MPN/100ml	Fermentation	2	Nil	Nil	Nil	Nil	Nil	2	Nil	Nil	Nil
T. H. Fungi	Plate Count	10	42	36	28	47	19	12	23	46	32

Source: Laboratory Analysis by Labchemnec Jans Limited, 2020

4.6.2.2 Analysis of soil results (Physical and Chemical)

i) Colour:-

The soil colour ranges from brownish, brown, dark brown, strong brown, grey to greyish for both seasons. This is generally attributable to the presence of organic matter in the soil.

ii) Texture:-

The soil texture of the project site area show that it is majorly of the coarse and scanty fine class belonging to sand, loamy and sandy loam type for both seasons.

iii) pH:-

The range of the soil pH from 5.22 to 6.93 during the wet season sampling and 5.69 to 6.94 during the dry season sampling indicating that the soil at the project are very acidic, distinctly acidic to acidic.

iv) Total Nitrogen:-

The concentration of Total Nitrogen present in the soil for wet season ranges 6.45% to 10.92% and 7.58% to 18.76% for dry season.

v) Heavy Metals:-

These include the following elements as contained in the tables above, viz; Nickel (Ni) Lead (Pb), Chromium (Cr), Cadmium (Cd) etc. These metals are relatively present for both seasons as can be seen from the Table. Cobalt (C) was not detected in all the samples collected for both seasons.

vi) Electric Conductivity: -

The electric conductivity of the soil for wet season ranges for from 59.0μS/cm^3 to 423.0μS/cm^3 and 121.0μS/cm^3 to 211.0μS/cm^3 for dry season.

4.6.2.3 Microbial Analysis of Soil Results

i) THB

From the microbial result of the soil analysis, the Total Heterotrophic Bacterial (THB) counts ranges from $5x10^0$cfu/g to $8.2x10^2$cfu/g during wet season and $1.2x10^1$cfu/g to $2.04x10^2$cfu/g during dry seasons. The THB counts give a general indication of the bacterial carrying quality of the soil in the area which is relevant in pollution control by remediation.

ii) Yeast and Mold

Yeast and Mold during wet season ranges from 2.0cfu/g to 184.0cfu/g and 3.0cfu/g to 84.0cfu/g for during dry season.

iii) Total Coliform Count

The total coliform count during wet season ranges from $1.3x10^1$ to $3.0x10^3$ (cfu/100ml) and $1.7x10^1$ to $2.5x10^2$ (cfu/100ml) during dry season. The total coliform counts give a general indication of the sanitary condition of soil water in the area.

iii) Faecal Coliform Count

The Total Faecal Coliform Count (FCC) showed little presence for both seasons. The Faecal coliform count give a general indication of the pathogenic composition of the soil.

iv) E. Coli

The total *E. Coli* count showed little presence for both seasons. *E. Coli* count is important health-wise. Most *E. coli* are harmless and actually are an important part of a healthy human intestinal tract however, some *E. coli* are pathogenic.

T. H. Fungi

The T. H. Fungi during wet season ranges from $5.0x10^0$ to $3.69x10^2$ (cfu/100ml) and $7.0x10^0$ to $1.46x10^2$ (cfu/100ml) during dry season.

Plate 4.5: Collection of Soil Samples using Auger

4.6.3 Water Quality

4.6.3.1 Water Sampling Results and Analysis

Both surface and ground water samples were collected for laboratory analysis. Surface (Rivers and Streams), and ground (boreholes and well) water samples were collected. The water sample sources taken were the closest to the project site and controls. The implementation and operation of the Obudu Cargo and Passenger Airport project will relatively impact the surface and ground water. Cross River State

Government intends to use modern technology to minimize this impact. For the water quality assessment, the samples were analysed by Lab Chemnec Jans Limited, an accredited laboratory with the Federal Ministry of Environment.

Table 4.18: Location of Soil Sampling Points in UTM

S/N	Location	Easting	Northing	Elevation
W1	Litam River	0515424	0735887	180
W2	Liwhan Jedie (B/H)	0515348	0735217	193
W3	Ikworuikwu (B/H)	0516274	0734200	203
W4	Ukambi Well	0515350	0733394	208
W5	Adima Stream	0513849	0734138	185
W6	Okwortug (B/H)	0509489	0729102	186
W7	Dam	0518904	0730874	220
W8	Atiekpe (B/H)	0517698	0736472	182
W9	Abeb River	0517966	0735327	170

Source: Field Study, 2019

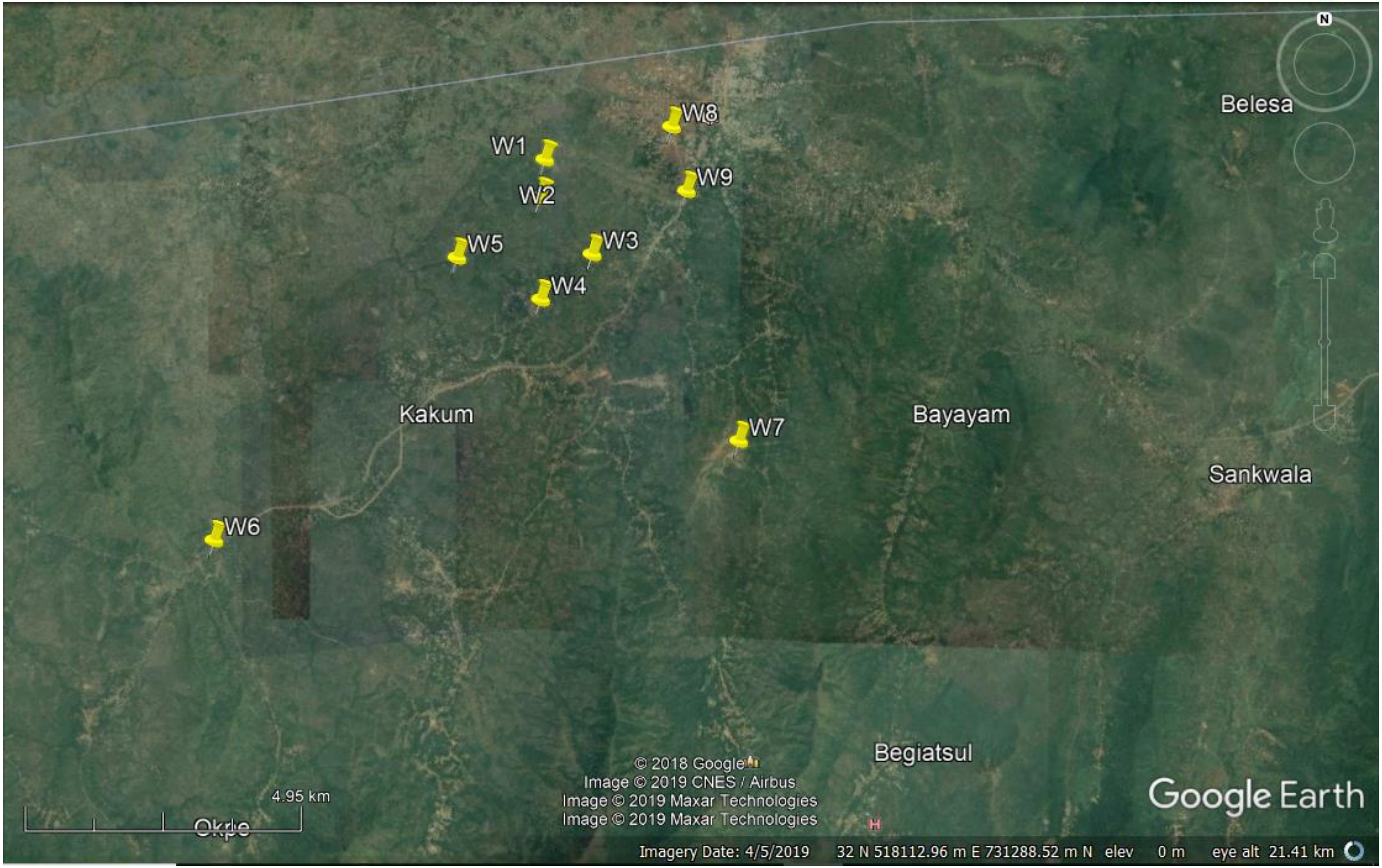

Figure 4.14: Google map of surface and ground water sampling points

Table 4.19: Results of physical, chemical and microbial analysis of surface and ground water samples for wet season

PARAMETERS	METHODOLOGY	GW 1 (BH)	GW 2 (BH)	GW 3 (Well)	GW 4 (BH)	GW 5 (BH)	FEPA STD FOR DRINKING WATER	SW1 (Litam River)	SW2 (Adima Stream)	SW3 (Dam)	SW 4 (Abeb River)	FEPA STD FOR AQUATIC LIFE
	RESULT OF PHYSICAL ANALYSIS OF GROUNDWATER WITH STD											
Colour		Colorless	Colorless	Brownish	Milky	Pale amber						
Odour		Odorless	Odorless	Odorless	Odorful	Odorful	**Unobjectionable**	Odorful	Odorful	Odorless	Odorless	NS
Taste		Tasteless	Tasteless	Tasteful	Tasteless	Tasteless	**Tasteless**	Tasteless	Tasteless	Tasteless	Tasteless	NS
Temp. ^{o}C	Thermoelectric	25.0	25.0	25.0	25.1	25.0	**<40**	25.1	25.1	25.0	25.0	NS
	RESULT OF CHEMICAL ANALYSIS OF GROUNDWATER WITH STD											
pH @25^{0}C	Electrometric	5.75	6.2	6.12	6.00	6.45	**6.5-8.5**	6.83	6.8	6.6	6.94	**6.0-9.0**
Turbidity NTU	Turbidimetric	0.73	1.36	11.28	19.23	11.2	**1.0**	24.6	15.36	38.60	23.7	**NS**
E.C. µS/cm	Electrometric	494	40	83	132	135	**500**	48	67	78	49	**NS**
TSS mg/l	Gravimetric	0.50	0.18	0.09	0.54	0.81	**>10**	0.16	0.033	0.10	0.27	**NS**
TDS mg/l	Electrometric	277	20	46	79	77	**500**	27	39	46	29	**NS**
T. Alkalinity mg/l	Colorimetric	46	42	68	79	88	**100**	72	35	38	34	**NS**
BOD mg/l	Nanometric	2.0	2.1	3.0	4.0	6.0	**0**	6.0	5.4	6.5	7.00	**4.0**
COD mg/l	Reflux	5.0	5.6	6.0	9.2	15.0	**NS**	14.5	12.9	14.1	15.0	**NS**
DO mg/l	Electrometric	7.0	7.2	7.2	7.1	5.9	**7.5**	6.0	6.5	6.2	6.3	**6.8**
Phosphorus Mg/l	Colorimetric	2.1	2.0	2.9	3.8	3.4	**NS**	1.0	2.7	2.9	2.4	**NS**
T. Hardness mg/l	Colorimetric	234.0	229.0	18.0	40.0	42.0	**200**	12.0	32.9	17.1	14.5	**NS**
Ni mg/l	Colorimetric	0.090	0.173	0.12	0.2681	0.004	**0.05**	0.271	0.009	0.1430	0.032	**NS**
SO_4^{-2} mg/l	Colorimetric	21.0	22.11	23.0	21.99	19.7	**5**	20.0	19.32	23.00	27.0	**NS**
NO_3^- mg/l	Colorimetric	8.19	8.13	3.95	1.78	1.99	**10**	1.40	1.73	2.22	2.05	**NS**
NO_2^- mg/l	Colorimetric	2.61	2.98	2.30	1.93	1.226	**1.0**	1.39	1.92	2.0	1.87	**0.06**
NH_4 mg/l	Colorimetric	0.08	0.081	0.10	0.12	0.10	**1.0**	0.07	0.084	0.05	0.10	**1.37-2.2**
Fe^{2+} mg/l	Colorimetric	0.07	0.063	0.08	ND	0.30	**1.0**	0.30	0.071	1.3153	0.29	**1.0**
Pb^{2+} mg/l	Colorimetric	2.48	2.28	ND	2.8713	ND	**0.05**	ND	2.662	2.7597	0.039	**0.0017**
Zn^{2+} mg/l	Colorimetric	1.20	0.06	0.12	ND	0.02	**5.0**	0.15	0.021	ND	0.90	**0.03**
Cu^{2+} mg/l	Colorimetric	2.10	0.12	0.002	0.8384	0.03	**0.1**	0.15	0.21	0.8384	0.009	**0.002-0.004**
Mg^{2+} mg/l	Colorimetric	2.00	2.42	2.20	1.2295	4.00	**NS**	1.11	1.42	1.3298	1.50	**NS**
Mn^{2+} mg/l	Colorimetric	0.5	0.25	0.22	0.1713	0.40	**0.05**	0.011	0.171	0.0750	0.15	**NS**
Ca^{2+} mg/l	Colorimetric	109.5	125.10	8.0	1.9103	15.5	**75**	5.0	6.37	10.1330	6.0	**NS**
As mg/l	Colorimetric	ND	ND	ND	ND	ND	**0.2**	ND	ND	ND	ND	**0.5**
K^{2+} mg/l	Flametric	37.1	21.2	6.4	10.6	7.2	**10**	5.3	9.5	7.6	8.3	**NS**
Na^{2+} mg/l	Flametric	26.7	1.8	5.7	4.2	5.1	**200**	3.1	2.5	1.4	2.7	**NS**
Cl^- mg/l	Titrimetric	47.0	24.19	19.00	23.18	27.00	**250**	21.00	19.28	26.90	22.70	**NS**
Cr mg/l	Colorimetric	0.002	0.003	0.001	ND	0.0003	**0.05**	0.001	0.032	0.0392	0.002	**0.02-2**

PARAMETERS	METHODOLOGY	GW 1 (BH)	GW 2 (BH)	GW 3 (Well)	GW 4 (BH)	GW 5 (BH)	FEPA STD FOR DRINKING WATER	SW1 (Litam River)	SW2 (Adima Stream)	SW3 (Dam)	SW 4 (Abeb River)	FEPA STD FOR AQUATIC LIFE
Cobalt mg/l	Colorimetric	ND	ND	ND	ND	0.001	**-**	0.002	0.001	ND	0.002	**NS**
Barium	Titrimetric	ND	ND	ND	ND	ND	**1.0**	ND	ND	ND	ND	**NS**
Cd mg/l	Colorimetric	0.02	0.02	0.02	0.020	0.09	**0.01**	0.10	11.20	18.20	0.12	**0.0002-0.0018**
PO_4^- mg/l	Colorimetric	40	39	33	40	30	**500**	ND	ND	ND	ND	**NS**
Oil and Grease		0.10	0.12	0.27	0.12	0.32	**0.50**	0.01	0.26	0.11	0.31	**NS**
	RESULT OF MICROBIAL ANALYSIS OF GROUNDWATER WITH STD											
THB Cfu/100ml	Plate count	Nil	Nil	Nil	Nil	15	**$1.0x10^3$**	50	42	10	35	**NS**
TCC Cfu/100ml	Plate count	Nil	Nil	Nil	Nil	5	**$4.0 x10^2$**	10	4	6	Nil	**NS**
FCC Cfu/100ml	Plate count	NIL	NIL	NIL	Nil	Nil	**0**	5	Nil	Nil	Nil	**NS**
E.coli Cfu/100ml	Plate count	Nil	Nil	Nil	Nil	Nil	**0**	4	Nil	Nil	Nil	**NS**
Salmonella Cfu/100ml	Plate count	Nil	Nil	Nil	Nil	Nil	**0**	Nil	Nil	Nil	Nil	**NS**

Source: Laboratory Analysis by Labchemnec Jans Limited, 2019

***ND:- Not Detected,*NS:- Not Specified**

4.6.3.2 Chemical Analysis of Ground and Surface Water during Wet Season

- **Ground Water (Hand pump borehole & Well water)**
  - pH values for all the ground water samples collected shows that the results are faintly acidic to acidic and it is below FMEnv permissible limit for drinking water standard of 6.5-8.5,
  - Turbidity of ground water GW2, GW3, GW4 GW5 recorded 1.36NTU, 11.28NTU, 19.23NTU & 11.20NTU respectively, which are above FMEnv permissible limit for drinking water standard of 1.0NTU,
  - Total hardness of GW1 & GW2 recorded 234mg/l and 229mg/l, which are above FMEnv permissible limit for drinking water standard of 200mg/l,
  - Nickel for GW1, GW2, GW3 and GW4 recorded 0.09mg/l, 0.173mg/l, 0.12mg/l & 0.2681mg/l which are above FMEnv permissible limit for drinking water standard of 0.05mg/l,
  - Sulphate for GW1-GW5 recorded values which are above FMEnv permissible limit for drinking water standard of 5.0mg/l,
  - Nitrite for GW1-GW5 recorded values which are above FMEnv permissible limit for drinking water standard of 1.0mg/l,
  - Lead for GW1, GW2 & GW4 recorded 2.48mg/l, 2.28mg/l and 2.8713mg/l above FMEnv permissible limit for drinking water standard of 0.05mg/l,
  - Copper for GW1, GW2 & GW3 recorded 2.10mg/l, 0.12mg/l & 0.8384mg/l which are above FMEnv permissible limit for drinking water standard of 0.1mg/l,
  - Manganese for GW1-GW5 recorded values which are above FMEnv permissible limit for drinking water standard of 0.05mg/l. etc.
  - Calcium for GW1 and GW2 recorded 109.5mg/l and 125.1mg/l, which are above FMEnv permissible limit for drinking water standard of 75mg/l,
  - Patassium for GW1, GW2 & GW4 recorded 37.1mg/l, 21.2mg/l & 10.6mg/l which are above FMEnv permissible limit for drinking water standard of 10mg/l,
  - Cadmium for GW1, GW2 & GW4 recorded values which are above FMEnv permissible limit for drinking water standard of 0.01mg/l.

Results from the laboratory show that Turbidity, Total hardness, Nickel, Suphur, Nitrite, Lead, Copper, Manganese, Calcium, Potassium and Cadmium were above FMEnv permissible limit for drinking water.

- **Microbiological Analysis of Groundwater during Wet Season**
  - THB for GW5 recorded 1.5×10^1 which is below FMEnv Permissible Limit for Drinking Water of 1.0×10^3,
  - TCC for GW5 recorded 5.0×10^0 which is below FMEnv Permissible Limit for Drinking Water of 4.0×10^2,

Laboratory results of water samples show that THB and TCC were found to be below FMEnv permissible limit for drinking water in sample water GW5. Nevertheless, all the water samples should be properly treated before concumption.

Surface Water (Litam River, Adima Stream, Dam & Abeb River)

From the laboratory results, most of the parameters have not been assessed (NS).

- BOD of SW1, SW2, SW3 & SW4 recorded 6.0mg/l, 5.4mg/l, 6.5mg/l and 7.0mg/l which are above FMEnv permissible limit for aquatic life standard of 4mg/l,
- Nitrite (NO_2) of SW1, SW2, SW3 & SW4 recorded 1.39mg/l, 1.92mg/l, 2.0mg/l and 1.87mg/l which are above FMEnv permissible limit for aquatic life standard of 0.06mg/l,
- Iron (Fe) of SW3 recorded 1.3153mg/l which is above FMEnv permissible limit for aquatic life standard of 1.0mg/l,
- Lead (Pb) of SW2, SW3 & SW4 recorded 2.662mg/l, 2.7597mg/l and 0.039mg/l which are above FMEnv permissible limit for aquatic life standard of 0.0017mg/l,
- Zinc (Zn) of SW1 & SW4 recorded 0.15mg/l and 0.90mg/l which are above FMEnv permissible limit for aquatic life standard of 0.03mg/l,
- Copper (Cu) of SW1, SW2, SW3 & SW4 recorded 0.15mg/l, 0.21mg/l, 0.08384mg/l and 0.009mg/l which are above FMEnv permissible limit for aquatic life standard of 0.04mg/l,
- Cadmium of SW1, SW2, SW3 & SW4 recorded 0.10mg/l, 11.20mg/l, 18.20mg/l and 0.12mg/l which are above FMEnv permissible limit for aquatic life standard of 0.0018mg/l.

- **Microbiological Analysis**

There were presence of Total heterotrophic bacteria (THB) and Total coliform count (TCC) in the surface water sampled.

This further affirms the fact that the surface water samples collected were unfit for human consumption.

Table 4.20: Results of physical, chemical and microbial analysis of surface and ground water samples for dry season

PARAMETERS	METHODOLOGY	GW 1 (BH)	GW 2 (BH)	GW 3 (Well)	GW 4 (BH)	GW 5 (BH)	FEPA STD FOR DRINKING WATER	SW1 (Litam River)	SW2 (Adima Stream)	SW3 (Dam)	SW 4 (Abeb River)	FEPA STD FOR AQUATIC LIFE
	RESULT OF PHYSICAL ANALYSIS OF GROUNDWATER WITH STD											
Colour		Colorless	Colorless	Colorless	Colorless	Colorless		Clear	Clear	Clear	Clear	
Odour		Odorless	Odorless	Odorless	Odorless	Odorless	**Unobjectionable**	Odourless	Odorful	Odorless	Odourless	NS
Taste		Tasteless	Tasteless	Tasteful	Tasteless	Tasteless	**Tasteless**	Tasteless	Tasteless	Tasteless	Tasteless	NS
Temp. ^oC	Thermoelectric	25.0	25.0	25.0	25.1	25.0	**<40**	26.5	25.8	26.7	26.5	NS
	RESULT OF CHEMICAL ANALYSIS OF GROUNDWATER WITH STD											
pH @25^{0}C	Electrometric	6.82	6.48	6.57	6.69	6.81	**6.5-8.5**	7.00	6.82	7.01	6.70	**6.0-9.0**
Turbidity NTU	Turbidimetric	0.35	0.93	5.84	4.82	5.56	**1.0**	0.73	1.58	3.26	4.30	**NS**
E.C. µS/cm	Electrometric	121	92	110	79	109	**500**	40	52	39	67	**NS**
TSS mg/l	Gravimetric	0.43	0.12	0.04	0.39	0.53	**>10**	0.24	0.87	0.56	1.92	**NS**
TDS mg/l	Electrometric	257	132	211	143	128	**500**	22	28	25	31	**NS**
T. Alkalinity mg/l	Colorimetric	31	40	51	50	57	**100**	45	51	42	53	**NS**
BOD mg/l	Nanometric	1.5	2.0	2.0	4.0	3.0	**0**	6.6	3.6	3.1	6.5	**4.0**
COD mg/l	Reflux	7.5	5.8	5.2	6.7	7.4	**NS**	13.9	12.6	13.5	11.8	**NS**
DO mg/l	Electrometric	6.4	5.9	6.9	6.6	7.1	**7.5**	6.2	5.8	6.1	6.5	**6.8**
Phosphorus Mg/l	Colorimetric	3.6	2.8	2.2	2.6	3.1	**NS**	3.1	2.8	3.4	2.5	**NS**
T. Hardness mg/l	Colorimetric	58.0	85.0	126.0	83.0	56.0	**200**	19.2	28.6	31.4	35.0	**NS**
Ni mg/l	Colorimetric	0.006	0.048	0.027	0.074	0.018	**0.05**	0.11	0.09	0.16	0.13	**NS**
SO_4^{-2} mg/l	Colorimetric	12.61	20.82	4.52	8.75	5.00	**5**	24.0	18.7	21.5	23.6	**NS**
NO_3^- mg/l	Colorimetric	4.68	6.67	4.47	2.36	6.58	**10**	2.13	1.72	1.39	1.86	**NS**
NO_2^- mg/l	Colorimetric	0.58	0.63	0.39	0.86	1.06	**1.0**	1.85	0.004	0.008	1.99	**0.06**
NH_4 mg/l	Colorimetric	0.35	0.29	0.68	0.82	0.64	**1.0**	0.086	0.042	0.095	0.080	**1.37-2.2**
Fe^{2+} mg/l	Colorimetric	0.68	0.15	0.59	0.42	0.68	**1.0**	1.24	0.76	0.58	0.44	**1.0**
Pb^{2+} mg/l	Colorimetric	0.068	0.002	0.001	0.073	0.001	**0.05**	2.72	1.05	0.08	2.78	**0.0017**
Zn^{2+} mg/l	Colorimetric	2.65	1.59	2.73	2.46	1.07	**5.0**	0.03	0.007	0.009	0.005	**0.03**
Cu^{2+} mg/l	Colorimetric	0.06	0.04	0.02	0.19	0.03	**0.1**	0.856	0.001	0.001	0.123	**0.002-0.004**
Mg^{2+} mg/l	Colorimetric	3.65	3.81	2.58	4.74	1.32	**NS**	1.33	1.29	1.64	1.50	**NS**
Mn^{2+} mg/l	Colorimetric	0.03	0.21	0.04	0.01	0.04	**0.05**	0.071	0.064	0.0	0.081	**NS**
Ca^{2+} mg/l	Colorimetric	53.81	71.63	59.32	78.46	43.67	**75**	10.55	7.84	11.26	8.123	**NS**
As mg/l	Colorimetric	ND	ND	ND	ND	ND	**0.2**	ND	ND	ND	ND	**0.5**
K^{2+} mg/l	Flametric	6.9	9.5	8.2	3.7	8.6	**10**	4.7	5.3	3.9	2.8	**NS**
Na^{2+} mg/l	Flametric	31.6	27.2	46.1	37.4	19.8	**200**	2.7	1.8	2.5	1.9	**NS**
Cl^- mg/l	Titrimetric	58.44	21.51	48.63	32.73	73.57	**250**	32.4	25.8	30.6	28.62	**NS**
Cr mg/l	Colorimetric	0.002	0.002	0.001	0.003	0.002	**0.05**	0.035	0.064	0.027	0.033	**0.02-2**
Cobalt mg/l	Colorimetric	ND	ND	ND	ND	ND	**-**	ND	ND	ND	ND	**NS**
Barium	Titrimetric	ND	ND	ND	ND	ND	**1.0**	ND	ND	ND	ND	**NS**
Cd mg/l	Colorimetric	0.002	0.001	0.001	0.001	0.004	**0.01**	ND	ND	ND	ND	**0.0002-0.0018**
PO_4^- mg/l	Colorimetric	34	30	28	36	27	**500**	20.14	15.42	18.83	13.70	**NS**

PARAMETERS	METHODOLOGY	GW 1 (BH)	GW 2 (BH)	GW 3 (Well)	GW 4 (BH)	GW 5 (BH)	FEPA STD FOR DRINKING WATER	SW1 (Litam River)	SW2 (Adima Stream)	SW3 (Dam)	SW 4 (Abeb River)	FEPA STD FOR AQUATIC LIFE
Oil and Grease		0.26	0.18	0.31	0.24	0.15	**0.50**	0.125	0.086	0.051	0.111	**NS**
	RESULT OF MICROBIAL ANALYSIS OF GROUNDWATER WITH STD											
THB Cfu/100ml	Plate count	Nil	Nil	Nil	Nil	Nil	**$1.0x10^3$**	13	14	10	11	**NS**
TCC Cfu/100ml	Plate count	Nil	Nil	Nil	Nil	Nil	**$4.0 x10^2$**	11	5	9	2	**NS**
FCC Cfu/100ml	Plate count	Nil	Nil	Nil	Nil	Nil	**0**	Nil	Nil	Nil	0	**NS**
E.coli Cfu/100ml	Plate count	Nil	Nil	Nil	Nil	Nil	**0**	0	Nil	Nil	0	**NS**
Salmonella Cfu/100ml	Plate count	Nil	Nil	Nil	Nil	Nil	**0**	0	Nil	Nil	0	**NS**

Source: Laboratory Analysis by Labchemnec Jans Limited, 2020

***ND:- Not Detected,*NS:- Not Specified**

4.6.3.3 Chemical Analysis of Groundwater during Dry Season

- **Ground Water (Hand pump borehole & Well water)**
  - pH values for all the ground water samples collected ranges from 6.48 – 6.82, this goes to show that the ground water collected are acidic to faintly acidic and the results falls within the FMEnv permissible limit for drinking water standard of 6.5-8.5,
  - Nickel (Ni) of GW4 recorded 0.074mg/l, which is above FMEnv permissible limit for drinking water standard of 0.05mg/l,
  - Sulfate (SO_4) of GW1, GW2 and GW4 recorded 12.61mg/l, 20.82mg/l and 8.75mg/l which are above FMEnv permissible limit for drinking water standard of 5mg/l,
  - Nitrite (NO_2) of GW5 recorded 1.06mg/l, which is above FMEnv permissible limit for drinking water standard of 1.00mg/l,
  - Lead (Pb) of GW1 and GW2 recorded 0.68mg/l and 0.073 which are above FMEnv permissible limit for drinking water standard of 0.05mg/l,
  - Copper (Cu) of GW4 recorded 0.019mg/l, which is above FMEnv permissible limit for drinking water standard of 0.1mg/l,
  - Manganese (Mn) of GW2 recorded 0.21mg/l, which is above FMEnv permissible limit for drinking water standard of 0.05mg/l,
  - Calcium (Ca) of GW4 recorded 78.46mg/l, which is above FMEnv permissible limit for drinking water standard of 75mg/l,

Results from the laboratory show that Nickel (Ni), Sulfate (SO4), Nitrite (NO2), Lead (Pb) Copper (Cu), Manganese and Calcilmu were above FMEnv permissible limit for drinking water.

- **Microbiological Analysis of Groundwater during Dry Season**

The microbial parameters (THB, TCC, FCC, E. coli and Salmonella) were not recorded during the dry season sampling.

- **Surface Water (Litam River, Adima Stream, Dam & Abeb River)**

From the laboratory results, most of the parameters have not been assessed (NS).

- BOD of SW1 & SW4 recorded 6.6mg/l and 6.5mg/l which are above FMEnv permissible limit for aquatic life standard of 4mg/l,
- Nitrite (NO_2) of SW1 & SW4 recorded 1.85mg/l and 1.99mg/l which are above FMEnv permissible limit for aquatic life standard of 0.06mg/l,
- Iron (Fe) of SW1 recorded 1.24mg/l which is above FMEnv permissible limit for aquatic life standard of 1.0mg/l,
- Lead (Pb) of SW1, SW2 & SW4 recorded 2.72mg/l, 1.05mg/l and 2.78mg/l which are above FMEnv permissible limit for aquatic life standard of 0.0017mg/l,
- Copper (Cu) of SW1 & SW4 recorded 1.0856mg/l and 0.123mg/l which are above FMEnv permissible limit for aquatic life standard of 0.04mg/l.

- **Microbiological Analysis**

There were presence of Total heterotrophic bacteria (THB) and Total coliform count (TCC) in the surface water sampled.

This further affirms the fact that the surface water samples collected were unfit for human consumption.

Plate 4.6: Collection of surface water samples

Plate 4.7: Collection of ground water samples

4.6.4 Biodiversity

4.6.4.1 Flora Composition

Vegetal species types encountered and those studied from literature include: *Garcinia cola, Gambaya albida, Cocos nucifera, Milicia excels, Oxytenanthera albyssinica, Terminalia superba, Pentaclethra mcrophylla, Laccosperma spp, Tetrapleutra tetraptera, Tetracarpidum sp.*

In summary, the vegetal cover distributions for the study area are presented in the table below with their economic importance.

Plate 4.8: Vegetation Cover of the Project Location

Table 4.21: Economically Valued Tree Species at the Project Location

S/No	Common name	Botanical name	Products	Uses	Ecological status
1	Black walnut	*Juglans nigra*	Seeds	Food	Rare
2	Bitter kola	*Garcinia kola*	Seeds	Food, medicinal	Abundant
3	African mango/bush mango (ogbono)	*Irvingia gabonensis*	Seeds/ fruits	Food	Rare
4	Pattern wood/stoolwood	*Alstonia boonei*	Leaves/ bark	Medicinal	Abundant
5	Neem tree	*Azadirachta indica*	Bark, roots, leaves	Medicinal	Abundant
6	-	*Anthonotha macrophylla*	Leaves	Food	Rare
7	Oil bean tree	*Pentaclethra macrophylla*	Fruits	Food, medicinal	Abundant
8	African nutmeg	*Monodora myristica*	Seeds	Food, medicinal	Rare
9	White star apple (udala)	*Gambeya albida*	Fruits	Food, medicinal	Abundant
10	African bread fruit	*Treculia africana*	Fruits	Food, medicinal	Abundant
11	Aidan plant	*Tetrapleura tetraptera*	Spice	Food, condiment	Abundant
12	African pepper	*Xylopia aethiopica*	Spice	Food condiment	Abundant
13	Oil palm tree	*Elaeis guineensis*	Fruits/ stem	Food/ wine	Abundant
14	Castor bean	*Ricinus communis*	Fruits, leaves	Food, medicinal	Rare
15	Shea butter tree	*Vitellaria paradoxa*	Roots, nuts, leaves	Leaf vegetable, medicinal	Rare
16	African mesquite	*Prosopis spp*	Fruits, roots	Food, fodder, medicinal	Abundant
17	Red cotton tree/kapok	*Bombax costatum*	Leaves	Leafy vegetables, medicinal	Rare
18	Raphia palm	*Raphia hookeri*	Wine	Wine	Abundant
19	Kola nuts tree	*Cola nitida*	Fruits	Medicinal, stimulant	Abundant
20	Bindura bamboo	*Oxytenanthera abyssinica*	Stem	Craft/ construction	Abundant
21	Coconut tree	*Cocos nucifera*	Fruits/ leaves	Food/ craft	Abundant
22	African teak/Iroko	*Milicia excelsa*	Stem	Timber	Rare
23	Bush fig	*Ficus capensis*	Stem	Timber	Abundant
24	African pearwood	*Baillonella toxisperma*	Stem	Construction, wood work medicinal	Abundant
25	Quickstick	*Gliricidia sepium*	Leaves, stem	Green fodder construction, wood work	Abundant
26	River tamarind	*Leucaena leucocephala*	Leaves, stem	Medicinal, as soilconservation	Abundant

S/No	Common name	Botanical name	Products	Uses	Ecological status
27	White Afara/ African limba wood	*Terminalia superba*	Root/ stem	Timber	Rare
28	African black walnut	*Mansonia altissima*	Stem	Timber	Abundant
29	African rattan palm	*Laccosperma secundiflorum*	Rattan	Furniture/ basketry	Rare
30	Rattan	*Eremospatha spp*	Rattan	Furniture/ basketry	Abundant
31	-	*Oncocalamus spp*	Rattan	Furniture/ basketry	Abundant
32	African cucumber	*Momordica charantia*	Leaves and root	Medicinal	Abundant
33	African walnut	*Tetracarpidium sp*	Nuts, leaves	Food/ medicinal	Abundant

Source: Fieldwork and Literature, 2019

Table 4.22: Economically Valued Shrub Species at the Project Location

S/No	Common name	Botanical name	Products	Uses	Ecological status
1	Soursop	*Annona muricata*	Fruit	Food, medicinal	Abundant
2	Drumstick tree	*Moringa oliefera*	Leaves	Fodder, medicinal	Abundant
3	Pepper fruit	*Dennettia tripetala*	Fruit, root	Food, medicinal	Abundant
4	Bitter leaf	*Vernonia amygdalina*	Leaves	Food, medicinal	Abundant
5	Velvet tamarind	*Dialium guineense*	Stem/ fruits	Chew sticks, food	Abundant
6	Miracle fruit	*Thaumatococcus daniellii*	Leaves	Medicinal wrapping food	Abundant
7	African mahogany	*Afzelia africana*	Root	Medicinal	Abundant
8	Pichon	*Landophira dulcia var barteri*	Fruits	Food, dyes	Abundant
9	Giant Yellow Mulberry	*Myrianthus arboreus*	Leaves	Food/ medicinal	Rare
10	Hard milkwood	*Alcohornea macrophylla*	Leaves	Fodder	Rare
11	Dwarf red ironwood	*Lophira lanceolata*	Stem	Stake, mouth wash	Abundant
12	African basil	*Ocimum gratissimum*	Leaves/ tender stems	Food, medicinal	Abundant
13	Bellyache bush	*Jatropha gossypifolia*	Exudates, leaves, roots	Medicinal	Rare
14	Cattle stick	*Carpolobia lutea*	Leaves	Medicinal	Abundant

Source: Fieldwork and Literature, 2019

4.6.4.2 Fauna Composition

Information on fauna within the project site and its environs were gathered from interviews and field observations. The fauna composition of the project location like most rain forest areas comprise of Mammals such as Monkeys, Cattles, Goats, Dogs, Antelopes, Squirrels, Rabbits, Grass cutter, etc. There are also Reptiles such as Lizards, Crocodile, Snakes, etc.

Amphibians such as Frogs and Toads abound in the state. There are also Wall gecko and Worms. Examples of common worms found include Earthworm.The project location also has a very diverse collection of birds such as Green Fruit-Pigeon, Broad-Winged Hawk, Vulture, Laughing Doves, Eagles etc.

Insects include, Blue Morpho Butterfly, Leafcutter Ant, Monarch Butterfly, Praying Mantis, Harleguin Bettle etc.

Table 4.23: Samples of Fauna Composition of the Study Area

S/No	Animal Name	Class	IUCN Status	Scientific Name
Mammals				
1	Mona monkey	Mammalia	Least concern	*Cercopithecus mona*
2	Bat	Mammalia	Least concern	*Chiroptera*
3	Cane rat	Mammalia	Least concern	*Thryonomys swinderianus*
4	Squirrel	Mammalia	Least concern	*Sciuridae*
5	Grass cutter	Mammalia	Least concern	*Thryonomys Swinderianus*
6	Goat	Mammalia	Least concern	*Capra aegagrus hircus*
7	Dog	Mammalia	Least concern	*Canis lupus familiaris*
8	Antelope	Mammalia	Least concern	*Alcelaphinae*
9	Sheep	Mammalia	Least concern	
Aves				
10	King vulture	Bird/Aves	Least concern	*Sarcoramphus papa*
11	African harrier-hawk	Bird/Aves	Least concern	*Polyboroides typus*
12	Green fruit-pigeon	Bird/Aves	Least concern	*Treronaustralis*
13	Laughing dove	Bird/Aves	Least concern	*Stigmatopelia senegalensis*
14	Rooster	Bird/Aves	Least concern	*Gallus gallus domesticus*
15	Bush fowl	Bird/Aves	Least concern	*Francolinus bicalcaratus*
16	Black kite	Bird/Aves	Least concern	*Milvus migrans*
17	Senegal coucal	Bird/Aves	Least concern	*Centropus senegalensis*
18	White-faced owl	Bird/Aves	Least concern	*Ptilopsis leucotis*
Insects				
19	Leaf cutter ant	Insects	Not assessed	*Atta spp*
20	Praying mantis	Insects	Not assessed	*Stagmomantis sp*
21	Harleguin bettle	Insects	Not assessed	*Acrocinus longimanus*
22	Blue morpho butterfly	Insects	Not assessed	*Morpho peleides*
Amphibians				
23	Earth worm	Amphibian	Least concern	*Lumbricus terrestris*
24	Frog	Amphibian	Not assessed	*Anura ranidae*
Reptiles				
25	Snake	Reptilia	Least concern	*Heterodon nasicus*

S/No	Animal Name	Class	IUCN Status	Scientific Name
26	Red-headed rock agama	Reptilia	Least concern	*Lacertilia*
		Gastropoda		
27	Garden snail	Gastropoda	Least concern	*Helix aspersa*
		Diplopoda		
28	Millipede	Diplopoda	Least concern	*Diplopoda*
		Chilopoda		
29	Centipede	Chilopoda	Least concern	*Chilopoda*

Source: Fieldwork and Literature, 2019

Plate 4.9: A dog in Ikwomikwu Community

Plate 4.10: African Harrier-Hawk

Plate 4.11: Blue Morpho Butterfly

Plate 4.12: Earthworm a common terrestrial organism in the project area

Plate 4.13: Garden Snail, one of the fauna species common in the project area

4.6.4.3 Protection and Conservation of Biodiversity

From thorough assessment of the biodiversity of the project area, it clearly fits into a Natural Habitat as defined by Performance Standard 6 of the IFC's Performance Standards on Environmental and Social Sustainability. Therefore, a number of measures have been itemized to protect and conserve the biodiversity. The first step, which has already been taken, is the documentation of an inventory of the native flora and fauna species within 5 km radius of the project site (See Tables 4.21, 4.22

and 4.23). Thereafter, a careful examination of the proposed project activities and its potentials to adversely affect the biodiversity was considered. For Obudu Cargo and Passenger Airport project, the project activities with high impact level on biodiversity is clearing of vegetation of not more than 75% of the of land earmarked for the project. To mitigate the adverse impacts here, the following measures will be put in place:

i. Restrict land clearing to not more than 75% of the earmarked land take;
ii. Put up a green/vegetation belt as part of the associated project facilities. This is asides the 25% native vegetation that will not be encroached upon.
iii. Project facility will be well secured with a perimeter fence to impede access by grazing ruminants and wanderer into the airport facility.
iv. As part of the consultations with the project affected communities, awareness/sensitization on the level of ecological obliteration consequent of the project has been created to prevent social crises in the future.
v. Land beyond what was acquired for this project shall not in any way be encroached upon.

4.6.4.4 Endangered Flora & Fauna

The terrestrial ecological findings within 5km radius around the project site have confirmed that mona monkey, bat, cane rat, squirrel, grass cutte, goat, dog, antelope, sheep, king vulture, African harrier hawk, green fruit pidgeon, laughing dove, rooster, bush fowl, black kite, Senegal coucal, white-faced owl, earthworm, red-headed rock agama, garden snail, millipede and centipde fall under the least concern category on the International Union for the Conservation of Nature's (IUCN) Red List of Endangered, Threatened and Vulnerable Species. Others including leaf cutter ant, praying mantis, harlegiun beattle, blue morpho butterly and frog fall under not assessed. On the other hand, flora findings within 5km radius around the project location reviews that some fall under the conservation status of abundant and rare.

4.6.5 Socio-Economic Results and Analysis

Socio economic assessments were carried out on the project environment to evaluate the major socio economic activities around the project environment as to how it can be affected (including the health impact assessment - HIA) by the project operation. The socio-economic survey was embarked upon to provide baseline data on the socio-economic status of the inhabitants around the proposed Airport and investigate the perception of the inhabitants of the project affected areas on the likely impacts of the project on their general socio-economic well-being.

4.6.5.1 Host Community

Obudu the project host Local Government is located in the northern part of Cross River State, Nigeria. The Local Government Area of Obudu is located in Obudu town. Obudu is a home to many recreational and tourist resort centers like the Obudu Cattle Ranch, which host an annual mountain race competition called the Obudu Ranch International Mountain Race. The proposed Obudu Cargo and

Passenger Airport is to be hosted by four (4) communities within Obudu LGA, mainly, Atiepke, Igwo, Okambi, and Ikwomikwu.

Plate 4.14: Pictorial view of the Entrance to Obudu Cattle Ranch and Resort

Plate 4.15: Bottom Hill of the Obudu Cattle Ranch

Plate 4.16: Front view of the Bebi Airstrip within Obudu

Plate 4.17: Prof Ben Ayade's Farm

Plate 4.18: Selected Views of Obudu Dam

4.6.5.2 Educational Enrolment and Attainment Overview

Obudu town is a host to various institutions like the Federal College of Education, Joenagi College of Technology, Andoyas College of Health Technology, Urban All-Over Polytechnic, Immaculate College of Health Technology and School of Midwifery etc. However, from socio economic survey, the literacy level across Obudu town is estimated to be well above average in terms of educational qualifications attained by respondents.

Table 4.24: Presence of Educational Institutions in Obudu LGA

Characteristics	Educational Situation
Nursery school	Present
Primary school	Present
Secondary school	Present
College	Present
Technical/Vocational	Present
Adult education centre	Present

Source: Field data gathering

- **Atiekpe community**

Atiekpe community is one of the project affected communities to the proposed Obudu Cargo and Passenger Airport. From the focus group discussion section during socio economic investigation, the following primary schools were present with no trace of secondary schools within the community.

- **Pramiry Schools**

a) St. Patrick Primary School
b) Heritage Nursery and Primary School

100 questionnaires were administered in Atiekpe community, 50 questionnaires were administered to male respondents and 50 to females respondents. The feeback from the completed questionnaires showed that 47 (94%) of the male respondents attended primary school up to the First School Leaving Certificate level, while 38 (76%) of the female respondents obtained First School Leaving Certificate. 34 (68%) male and 26 (52%) female respondents attended secondary school up to Senior Secondary Certificate level. 21 (42%) male and 14 (28%) female respondents have completed or are currently undergoing tertiary education. 3 (6%) male and (24%) female respondents reported that they have no formal education. From these observations, it is clear that the literacy level is higher in males than females. This may partly be attributable to the traditional believe in most part of the African communities that it is more beneficial to educationally empower the male folks over the females. Another observation from the educational distribution observed in Atiekpe is that 85% of the respondents are literate having acquired primary education. Literacy is the ability to read, write, speak and listen in a way that lets us communicate effectively and make sense of the world (National Literacy Trust, United Kingdom).

Table 4.25: Presence of Educational Institutions in Atiekpe Community

Characteristics	Educational Situation
Nursery school	Present
Primary school	Present
Secondary school	Absent
College	Absent
Technical/Vocational	Absent
Adult education centre	Absent

Source: Field data gathering

Plate 4.19: A view of St. Patrick primary school in Atiekpe community

Table 4.26: Educational Attainment in Atiekpe Community

ATIEKPE COMMUNITY		
No.of Respondents that attained Primary Education		
Male	**Female**	**No. of respondents**
47 (94%)	38 (76%)	50 (Males) 50 (Females)
No.of Respondents that attained Secondary Education		
Male	**Female**	
34 (68%)	26 (52%)	50 (Males) 50 (Females)
No. of Respondents currently undergoing/have completed Tertiary Education		
Male	**Female**	
21 (42%)	14 (28%)	50 (Males) 50 (Females)
No.of Respondents without Formal Education		
Male	**Female**	
3 (6%)	12 (24%)	50 (Males) 50 (Females)

Source: Field data gathering

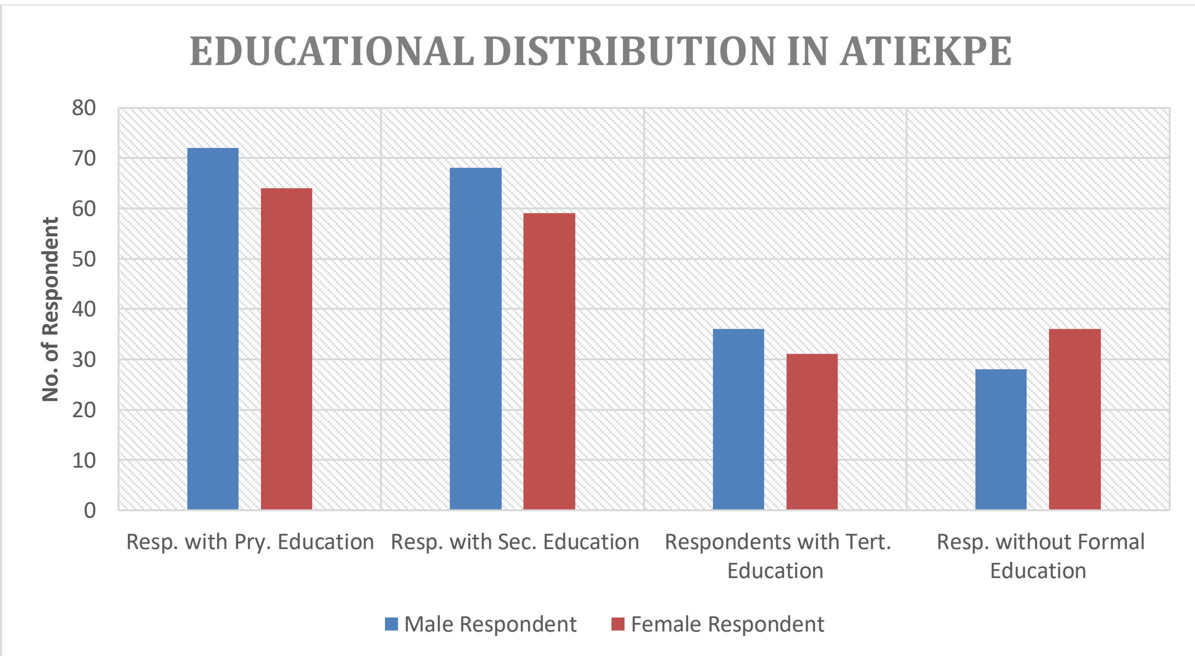

Figure 4.15: Educational Enrollment in Atiekpe Community

❖ **Igwo Community**

From the socio economic studies carried out in Igwo community, it was gathered that the community is blessed with both primary and secondary schools such as:

- **Primary Schools**

i) Government Primary School
ii) Ngwako Government Primary School
iii) Royal Youth Nursery and Primary School

- **Secondary Schools**

a) Comprehensive Secondary School
b) Royal Youth Secondary School

Table 4.27: Presence of Educational Institutions in Igwo Community

Characteristics	Educational Situation
Nursery school	Present
Primary school	Present
Secondary school	Present
College	Absent
Technical/Vocational	Absent
Adult education centre	Absent

Source: Field data gathering

100 questionnaires were administered in Igwo community, 50 to male respondents and 50 to female respondents. From the returned completed questionnaires, 44 (88%) male respondents and 39 (78%) female repondents reported that they have attained primary education up to First School Leaving Certificate level. 31 (62%) male respondents and 30 (60%) female respondents attested to have obtained secondary school education up to certificate level, while 19 (38%) male respondents and 20 (40%) female respondents affirmed that they have or are currently undergoing tertiary education. 6 (12%) male respondents and 11 (22%) female respondents reported that they have no formal education. From the educational distribution results of Igwo, more males are educated compared to the females and also, the people are very well literate with 83% of the respondents having attained primary education.

Table 4.28: Educational Enrolment of Male and Female in Igwo Community

IGWO COMMUNITY		
No. of Respondents that attained Primary Education		
Male	**Female**	**No. of respondents**
44 (88%)	39 (78%)	50 (Males) 50 (Females)
No. of Respondents that attained Secondary Education		
Male	**Female**	
31 (62%)	30 (60%)	50 (Males) 50 (Females)
No. of Respondents currently undergoing/have completed Tertiary Education		
Male	**Female**	

19 (38%)	20 (40%)	50 (Males) 50 (Females)
No. of Respondents without Formal Education		
Male	**Female**	
6 (12%)	11 (22%)	50 (Males) 50 (Females)

Source: Field data gathering

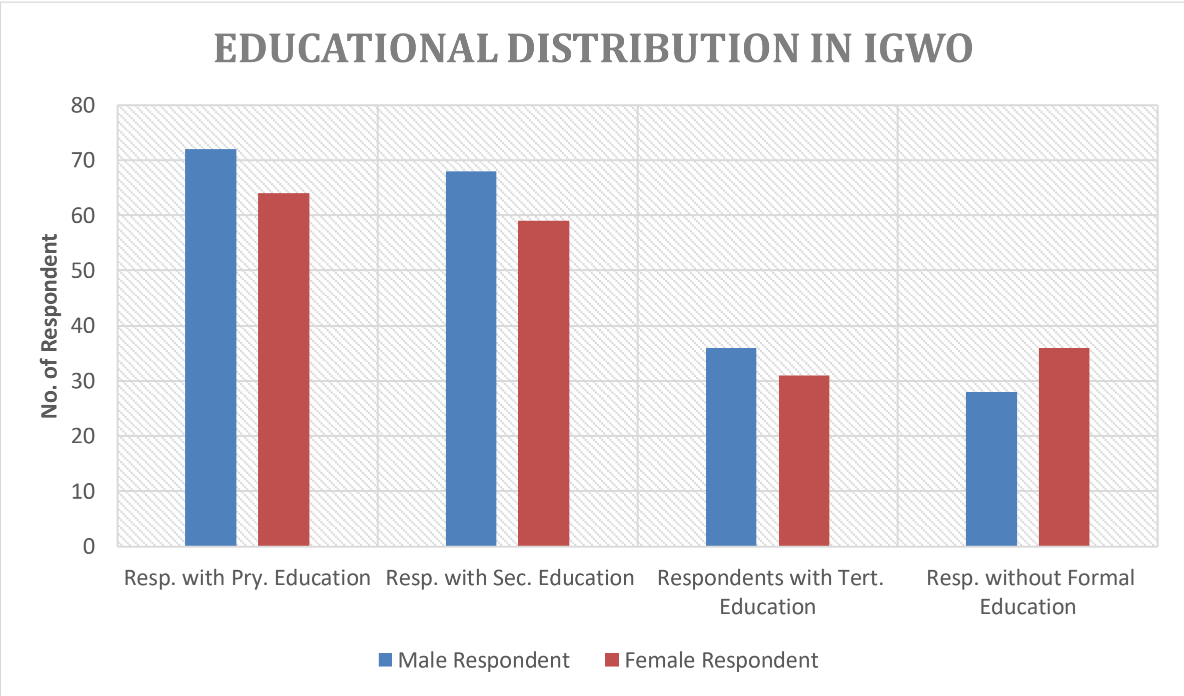

Figure 4.16: Educational Enrollment in Igwo Community

❖ Okambi Community

From the socio economic studies carried out in Okambi community, it was gathered that the community has both primary and secondary schools as listed below:

- **Primary School**

a) Government Primary School

- **Secondary School**

i) Migrant College of Science and Technology
ii) Mary Felix Scondary School

Table 4.29: Presence of Educational Institutions in Okambi

Characteristics	Educational Situation
Nursery school	Present
Primary school	Present
Secondary school	Present
College	Present
Technical/Vocational	Absent
Adult education centre	Absent

Source: Field data gathering

100 questionnaires were administered in Okambi community. 50 were administered to male respondents, and another 50 administered to females respondents. From the completed and returned questionnaires, 40 (80%) male respondents and 32 (64%) female respondents admitted to have attained primary education up to First School Leaving Certificate level. 31 (62%) male respondents and 28 (56%) female respondents stated that they have obtained secondary school education up to certificate level, while 19 (38%) male respondents and 16 (32%) female respondents affirmed that they have or are currently undergoing tertiary education. 10 (20%) male respondents have no formal education, while 18 (36%) female respondents have no formal education. Thus, the educational distribution of Okambi community show a dominance in male educational attainment compared to the females. Also, literacy level is quite commendable at 72%.

Plate 4.20: Old and newly renovated blocks of Primary School within Okambi community

Table 4.30: Educational Enrolment in Okambi Community

OKAMBI COMMUNITY		
No. of Respondents that attained Primary Education		
Male	**Female**	**No. of respondents**
40 (80%)	32 (64%)	50 (Males) 50 (Females)
No. of Respondents that attained Secondary Education		
Male	**Female**	
31 (62%)	28 (56%)	50 (Males) 50 (Females)
No. of Respondents currently undergoing/have completed Tertiary Education		
Male	**Female**	
19 (38%)	16 (32%)	50 (Males) 50 (Females)
No. of Respondents without Formal Education		
Male	**Female**	
10 (20%)	18 (36%)	50 (Males) 50 (Females)

Source: Field data gathering

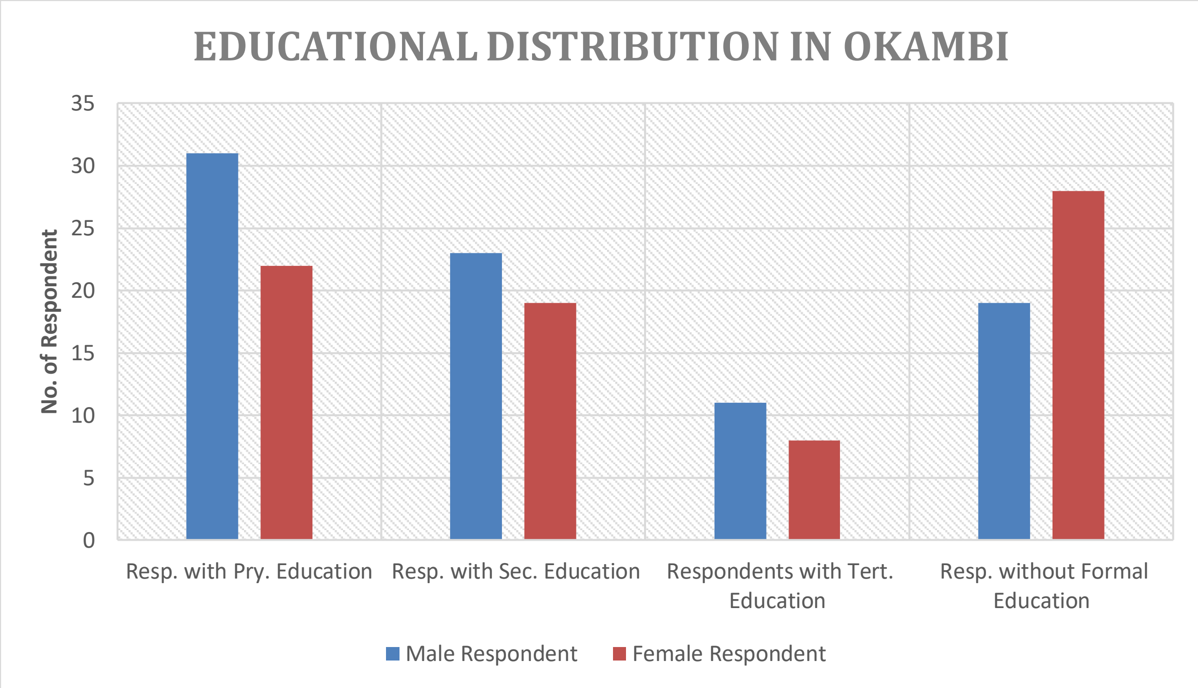

Figure 4.17: Educational Enrollment in Okambi Community

- **Ikwomikwu Community**

From the socio economic studies carried out in Ikwomikwu community, it was gathered that the community has only one government owned nursery and primary school as listed below:

- **Primary School**

b) Government Primary School

Table 4.31: Presence of Educational Institutions in Ikwomikwu

Characteristics	Educational Situation
Nursery school	Present
Primary school	Present
Secondary school	Absent
College	Absent
Technical/Vocational	Absent
Adult education centre	Absent

Source: Field data gathering

100 questionnaires were administered in Ikwomikwu community. 50 were administered to male respondents, and another 50 administered to females respondents. From the completed and returned questionnaires, 31 (62%) male respondents and 22 (44%) female respondents admitted to have attained primary education up to First School Leaving Certificate level. 23 (46%) male respondents and 19 (38%) female respondents stated that they have obtained secondary school education up to certificate level, while 11 (22%) male respondents and 8 (16%) female respondents affirmed that they have or are currently undergoing tertiary education. 19 (38%) male respondents have no formal education, while 28 (56%)

female respondents have no formal education. Therefore, the educational distribution of Ikwomikwu community show a dominance in male educational attainment compared to the females. Also, literacy level is slightly above par at 53%.


Plate 4.21: Government Primary School, Ikwomikwu

Table 4.32: Educational Enrollment in Ikwomikwu Community

IKWOMIKWU COMMUNITY		
No. of Respondents that attained Primary Education		
Male	**Female**	**No. of respondents**
31 (62%)	22 (44%)	50 (Males) 50 (Females)
No. of Respondents that attained Secondary Education		
Male	**Female**	
23 (46%)	19 (38%)	50 (Males) 50 (Females)
No. of Respondents currently undergoing/have completed Tertiary Education		
Male	**Female**	
11 (22%)	8 (16%)	50 (Males) 50 (Females)
No. of Respondents without Formal Education		
Male	**Female**	
19 (38%)	28 (56%)	50 (Males) 50 (Females)

Source: Field data gathering

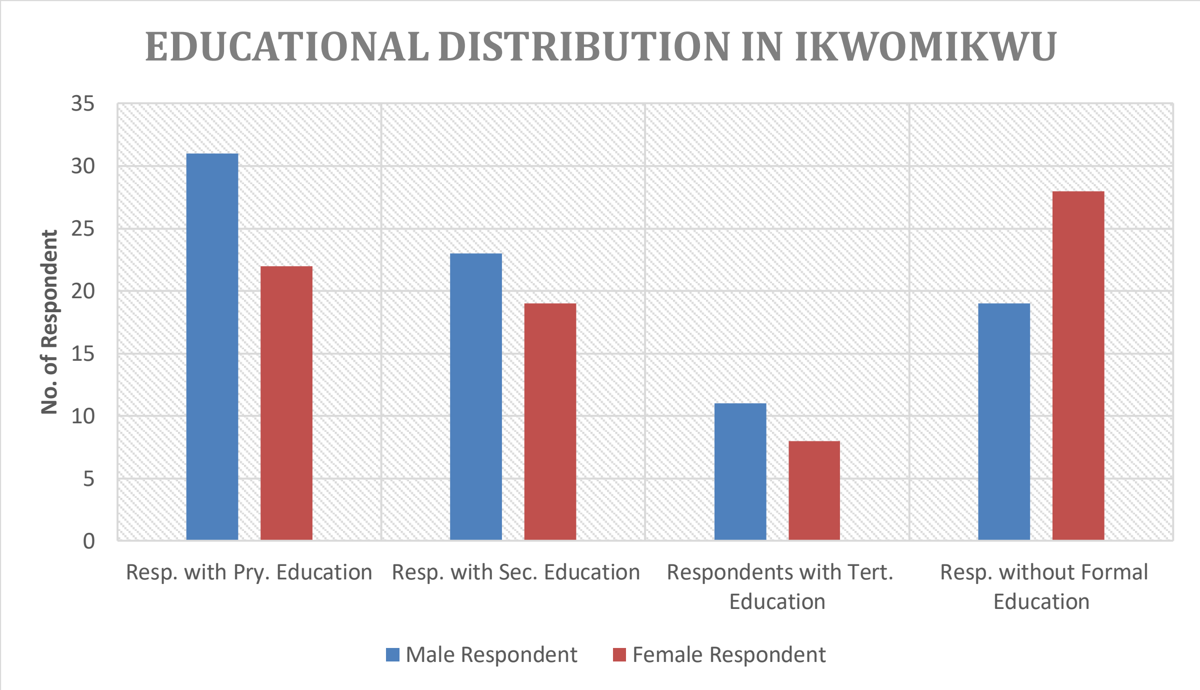

Figure 4.18: Educational Enrollment in Ikwomikwu Community

4.6.5.3 Economic Status

Generally, Obudu is an agricultural town famous for farming and hunting which are the major economic activity of the people. Yam is one of the staple food crop that the Obudu people cultivate and infact to celebrate their bountiful harvest, annually the new yam festival, traditionally called *Bipam bifife* is observed. Nonetheless, the socio economic assessment carried out shows that Obudu is also a commercial town with the presence of some business activities including provision stores, barbing/hairdressing salons, electrical and electronics shops, automechanics, restaurants/food vendors, hotels and resorts, cement dealers and distributors, motorcycle riders and commercial taxi/truck drivers, factory and construction workers, as well as banking activities.

- ❖ **Atiekpe Community**

Atiekpe is one of the project affect communities to the proposed Obudu Cargo and Passenger Airport. The people of Atiekpe are known to be hardworking involved in activities such as hunting, fishing, palm wine tapping and food cultivation which is the main stay of the Atiekpe economy. With agriculture as the major economic activity, the Atiekpe people cultivate yam, cassava, maize, banana, tomatoes, beans rice, oil palm, groundnut, cocoa, cocoyam and vegetables etc.

Trading of farm produce and other goods is also common among the people. From the feedback of this socio-economic assessment as shown in Table 4.25, of the 100 questionnaires administered in the community, 40% of the respondents are farmers, 28% are artisans, 15% are traders, 7% are teachers, 4% civil servants, and 6% fall into the category of others which includes car and motorcycle transporters, itinerant hawkers etc.

Table 4.33: Occupational distribution in Atiekpe Community

No. of Respondents TOTAL: 100	Farmers	Artisans	Traders	Teachers	Civil Servants	Others
ATIEKPE COMMUNITY						
100	40	28	15	7	4	6

Source: Field data gathering

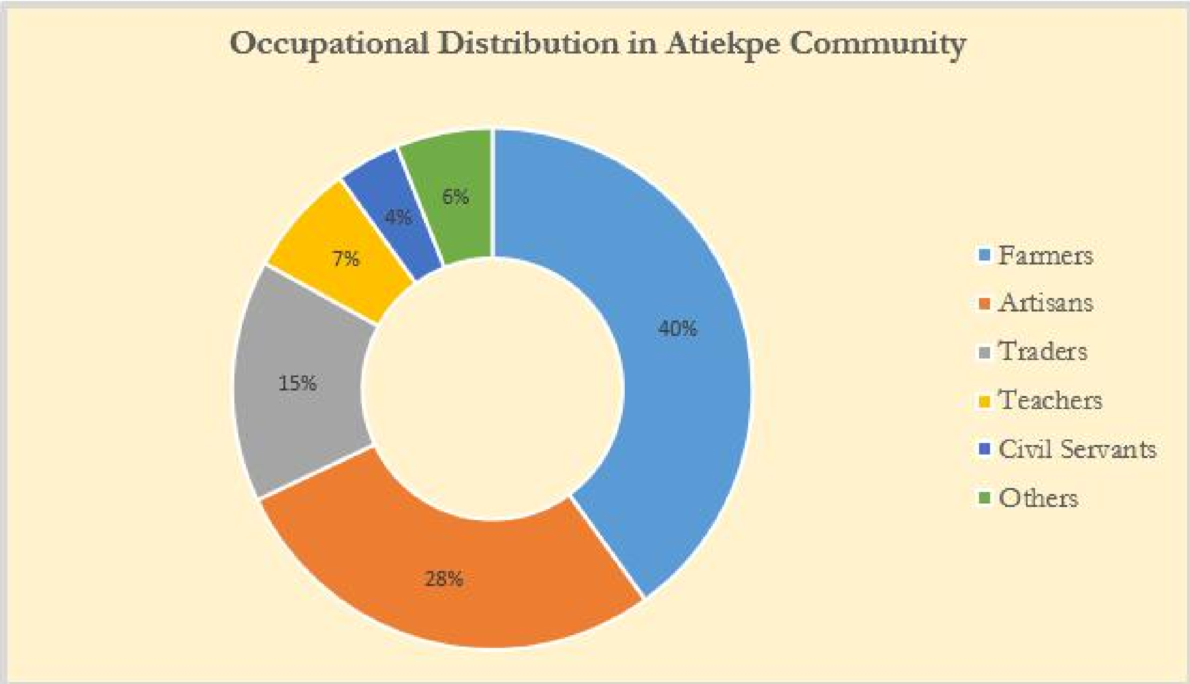

Figure 4.19: Chart showing Occupational Distribution in Atiekpe Community

- ❖ **Igwo Community**

The Igwo people are known to be great farmers, hunters, palm wine tappers etc with farming as their major source of livelihood. Igwo is noted for the cultivation of yam, cassava, maize, banana, tomatoes, beans, rice, oil palm, groundnut, cocoa, cocoyam and vegetables etc. From the 100 questionnaires administered, 42% of the respondents are farmers, 22% are artisans, 18% are traders, 8% are teachers, 3% civil servants, and 7% fall into the categories of others.

Table 4.34: Occupational distribution in Igwo Community

No. of Respondents TOTAL: 100	Farmers	Artisans	Traders	Teachers	Civil Servants	Others
IGWO COMMUNITY						
100	42	22	18	8	3	**7**

Source: Field data gathering

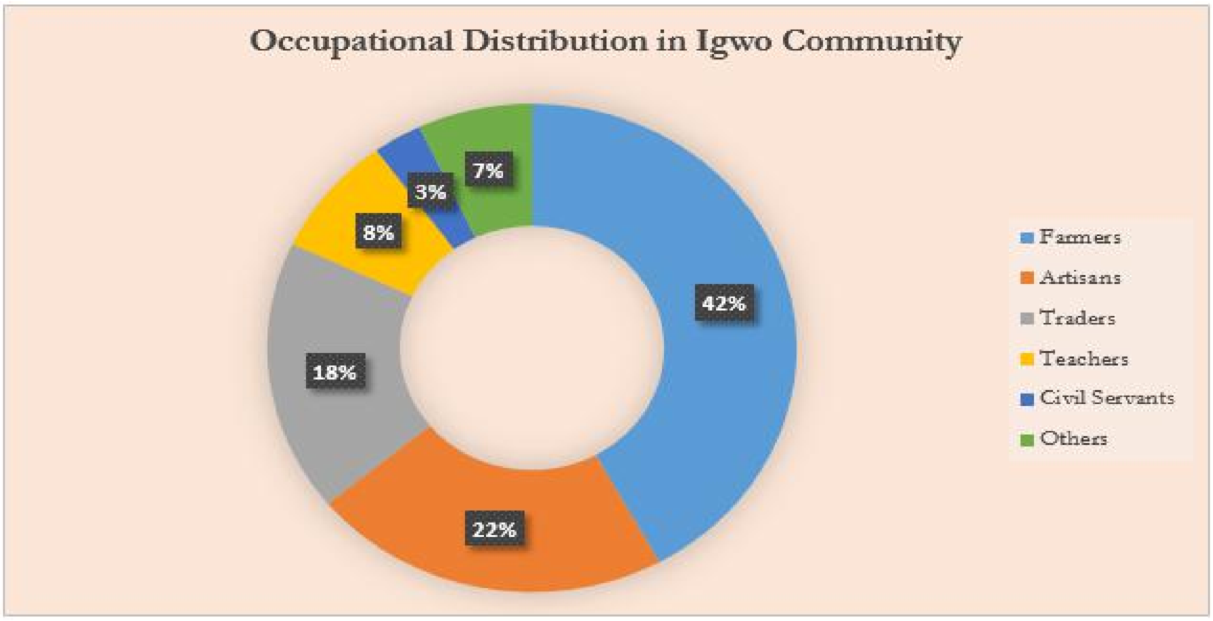

Figure 4.20: Chart showing occupational distribution in Igwo Community

- **Okambi Community**

The socio economic studies shows Okambi people to be farmers, notable for the cultivation of yam, cassava, maize, banana, tomatoes, beans, rice, oil palm, groundnut, and cocoa. 100 questionnaires were administered in Okambi community to assess economic distribution of the people. From the returned completed questionnaires, 41% of the respondents are farmers, 29% are artisans, 16% are traders, 6% are teachers, 3% are civil servants, and 5% fall into the categories of others.

Table 4.35: Occupational distribution in Okambi Community

No. of Respondents TOTAL: 100	Farmers	Artisans	Traders	Teachers	Civil Servants	Others
OKAMBI COMMUNITY						
100	41	29	16	6	3	**5**

Source: Field data gathering

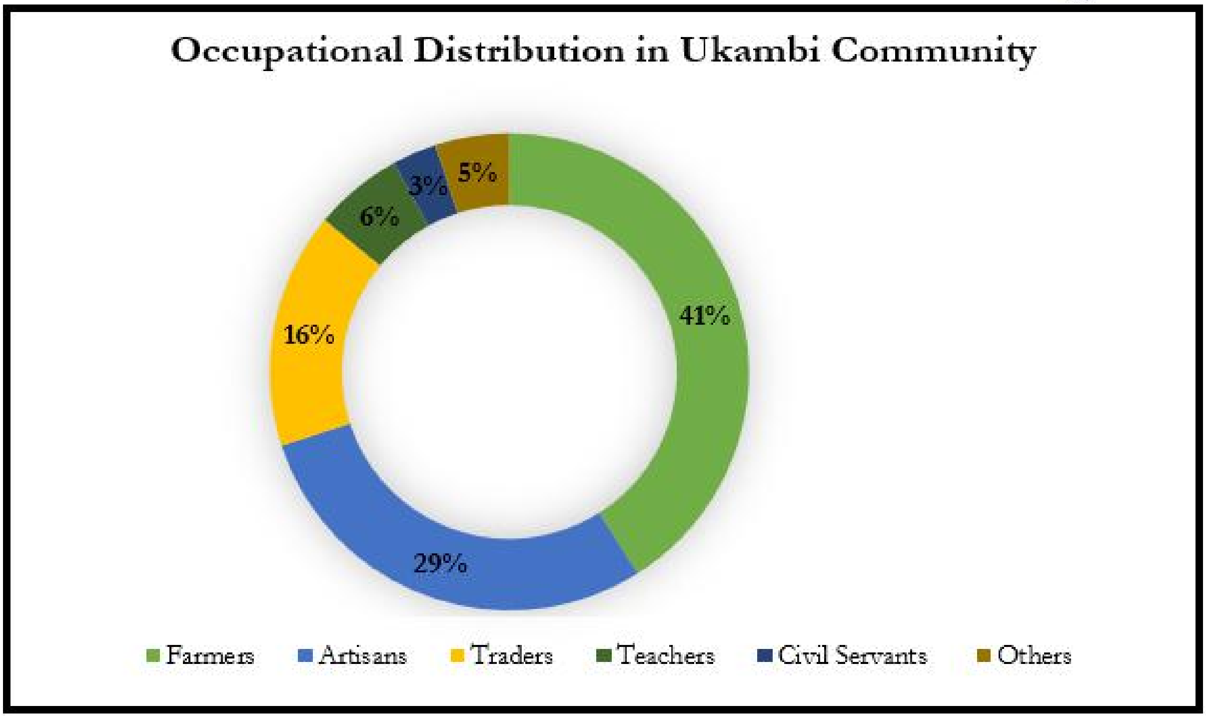

Figure 4.21: Chart showing occupational distribution in Okambi Community

- ❖ **Ikwomikwu Community**

Ikwomikwu community like the other communities, is a home for great farmers involved in the cultivation of a variety of farm products ranging from yam, cassava, maize, sugarcane, oranges and tomatoes etc. From the 100 questionnaires administered in Ikwomikwu, 40% of the respondents are farmers, 30% are artisans, 15% are traders, 7% are teachers, 2% are civil servants, and 6% fall into the category of others.

Table 4.36: Occupational distribution in Ikwomikwu Community

No. of Respondents TOTAL: 100	Farmers	Artisans	Traders	Teachers	Civil Servants	Others
IKWOMIKWU COMMUNITY						
100	40	30	15	7	2	**6**

Source: Field data gathering

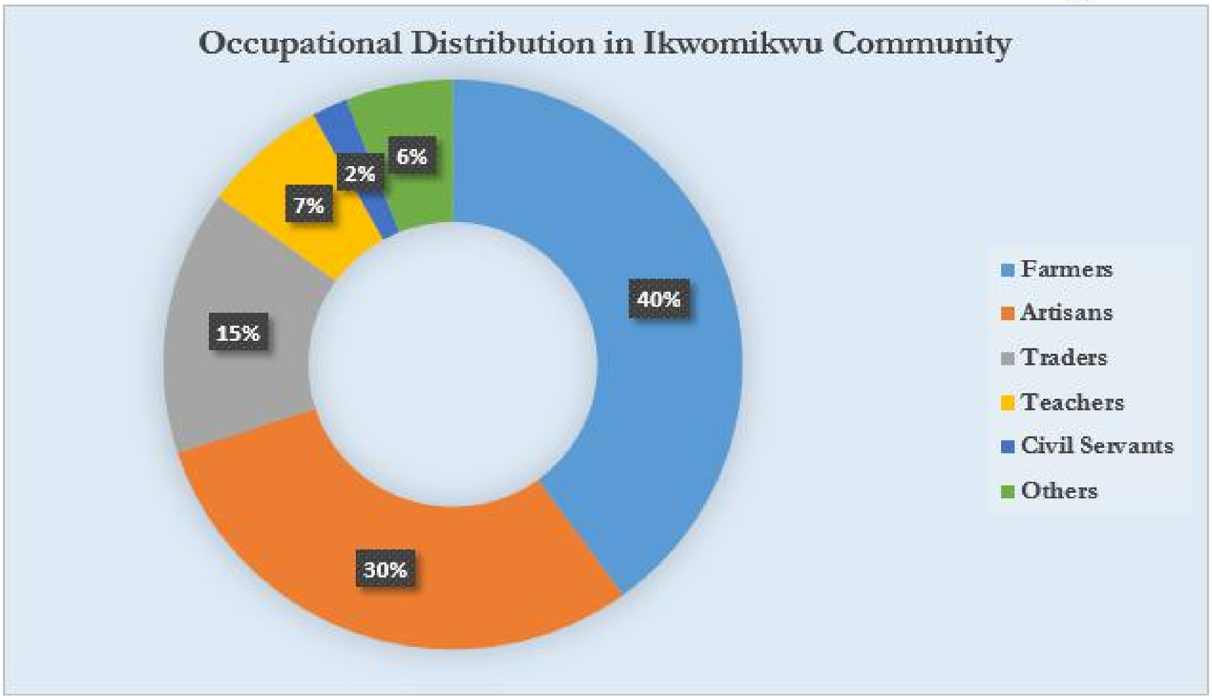

Figure 4.22: Chart showing occupational distribution in Ikwomikwu Community

4.6.5.4 Income Distribution

The results of income distribution from socio economic assessment shows the following results across the four project affected communities.

❖ **Atiekpe Community**

From the analysis of the feedback from respondents, 66% of the Atiekpe populace earn an estimated annual income less than ₦100,000.00. 32% earn a gross annual income less than ₦500,000.00, while 2% earn an annual income of over ₦500,000.00.

Table 4.37: Average annual income distribution of Atiekpe respondents

No. of Respondents TOTAL: 100	<₦100,000.00		<₦500,000.00		>₦500,000.00	
ATIEKPE COMMUNITY						
100	Men	Women	Men	Women	Men	Women
	42(%)	18(%)	22(%)	10(%)	1(%)	1(%)

Source: Field data gathering

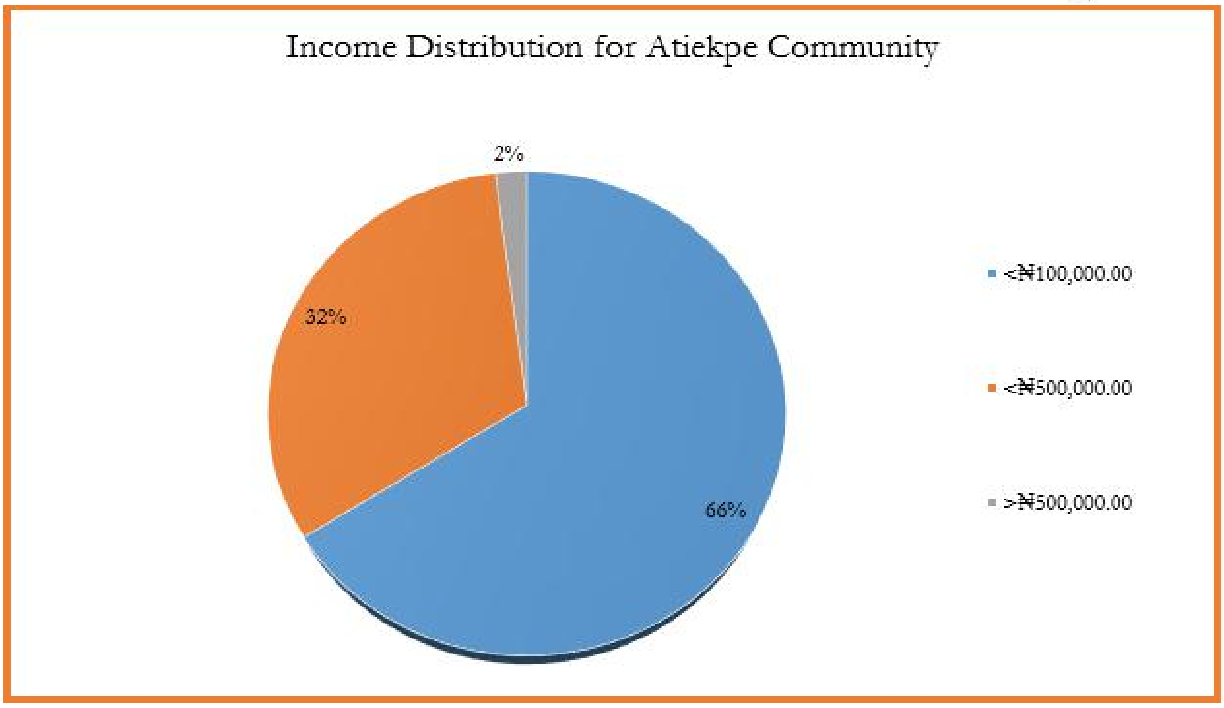

Figure 4.23: Chart showing income distribution of respondents in Atiekpe Community

❖ Igwo Community

The socio economic survey particularly the questionnaire respondents in Igwo community gave a feedback to the effect that 70% earn an estimated annual income less than ₦100,000.00. 27% earn a gross annual income less than ₦500,000.00, while 3% earn an annual income of over ₦500,000.00.

Table 4.38: Average annual income distribution of Igwo respondents

No. of Respondents TOTAL: 100	<₦100,000.00		<₦500,000.00		>₦500,000.00	
ATIEKPE COMMUNITY						
100	Men	Women	Men	Women	Men	Women
	50(%)	20(%)	20(%)	7(%)	2(%)	1(%)

Source: Field data gathering

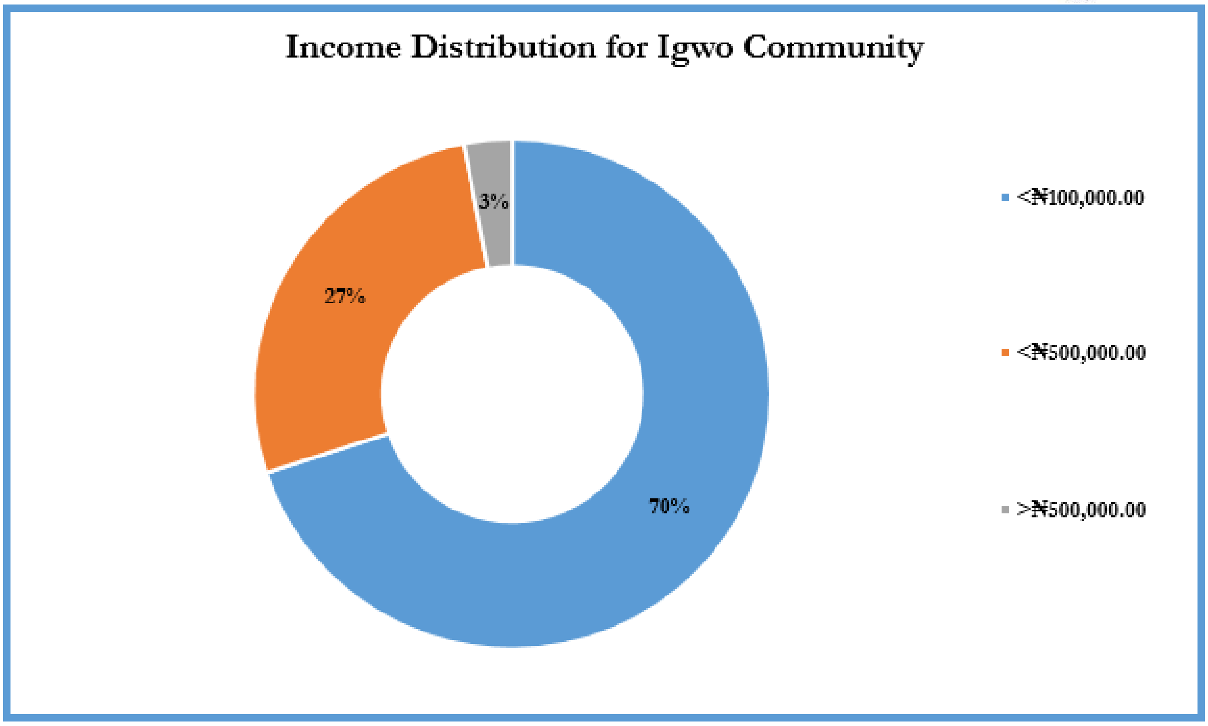

Figure 4.24: Chart showing income distribution of respondents in Igwo Community

❖ **Okambi Community**

In Okambi, going by the feedback from the questionnaire by the respondents, 68% earn an estimated annual income less than ₦100,000.00. 28% earn a gross annual income less than ₦500,000.00, while 4% earn an annual income of over ₦500,000.00

Table 4.39: Average annual income distribution of respondents

No. of Respondents TOTAL: 100	<₦100,000.00		<₦500,000.00		>₦500,000.00	
ATIEKPE COMMUNITY						
100	Men	Women	Men	Women	Men	Women
	58(%)	10(%)	21(%)	7(%)	3(%)	1(%)

Source: Field data gathering

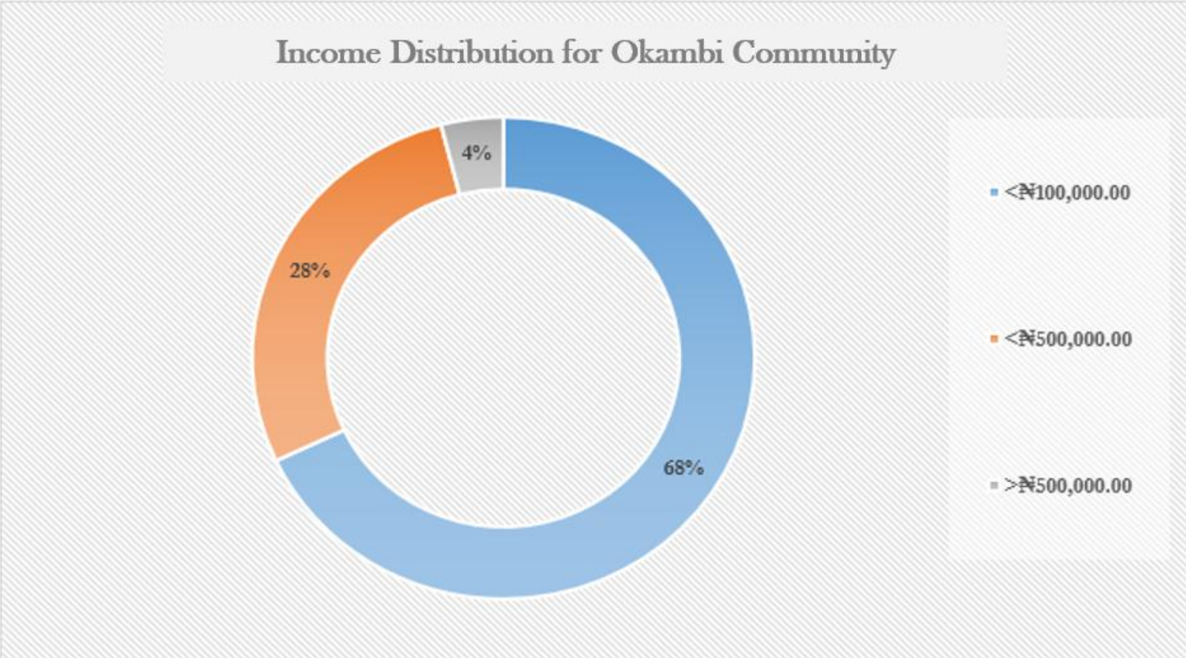

Figure 4.25: Chart showing income distribution of respondents in Okambi Community

- **Ikwomikwu Community**

The respondents' feedback in Ikwomikwu shows that 77% earn an estimated annual income less than ₦100,000.00. 22% earn a gross annual income less than ₦500,000.00, while 1% earn an annual income of over ₦500,000.00.

Table 4.40: Average annual income distribution of respondents

No. of Respondents TOTAL: 100	<₦100,000.00		<₦500,000.00		>₦500,000.00	
IKWOMIKWU COMMUNITY						
100	Men	Women	Men	Women	Men	Women
	61(%)	16(%)	18(%)	4(%)	1(%)	0(%)

Source: Field data gathering

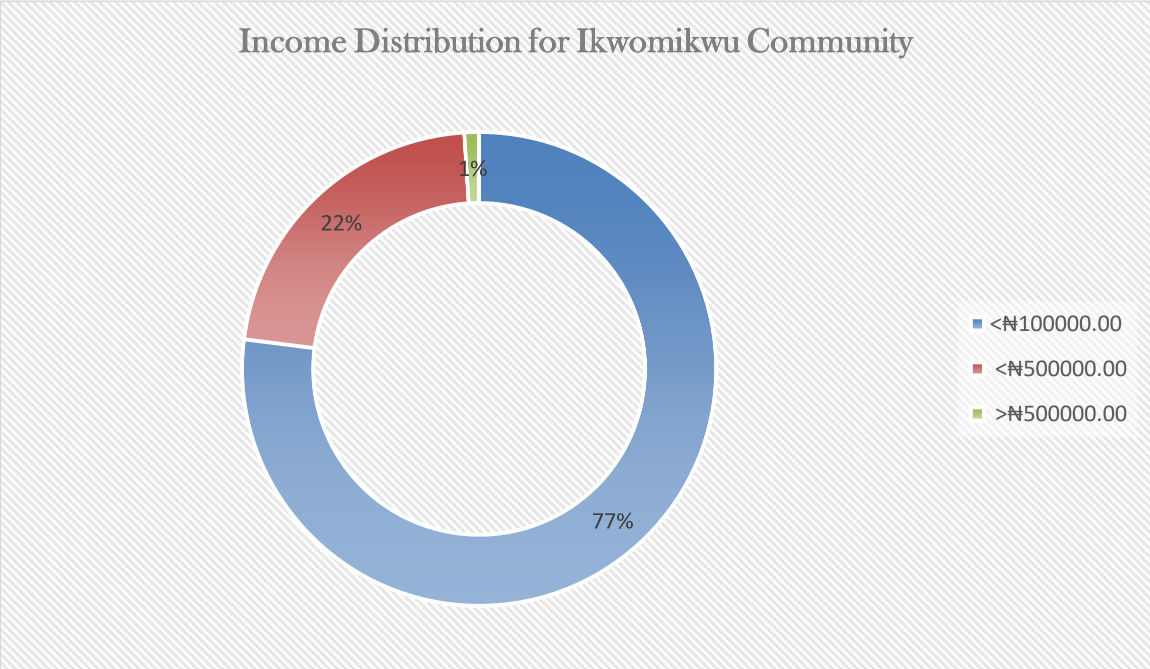

Figure 4.26: Chart showing income distribution of respondents in Ikwomikwu Community

The proposed Obudu Cargo and Passenger Airport by the Cross River State Government will marginally enhance the income level of the inhabitants of the project affected communities as well as other communities around the project site, as it will provide employment and increase patronage for agricultural produce and traders.

Plate 4.22: Cross Section of commercial activities across the four communities

Plate 4.23: Pictorial representative of some fuel stations within the project area

Plate 4.24: A view of Kuciano Hotel within the project area

4.6.5.5 Socio-Cultural Events

The socio-cultural events across the four project communities are similar to each other. In Atiekpe community, New Yam festival is normally celebrated every first Saturday of September. However, the festival is anchored on the worship of *Atiekpe Bewhuyang* deity for a bountiful harvest all through the year. In the same way, Igwo, Okambi and Ikwomikwu communities also observed the new yam festival annually.

4.6.5.6 Religion Distribution

As earlier explained, the inhabitants of Obudu town are predominantly Christians with few Muslims as well as adherent of African traditional religion. Religion distribution assessment was conducted across the four project affected communities and the findings are as presented below.

- **Atiekpe Community**

Going by the data obtained from respondents, 95% of Atiekpe populace are Christians, 3% are Muslims, while 2% practice the African traditional religion. Most of the Muslims in the community were observed to comprise of settlers from the Northern part of Nigeria.

Table 4.41: Religion Distribution in Atiekpe Community

RELIGION	Christianity	95
	Islam	3
	Traditional Worshippers	2
	TOTAL	**100**

Source: Field data gathering

❖ Igwo Community

As presented in table 4.32, Igwo community respondents are 96% Christians, 2% Muslim and 2% practice of African traditional religion.

Table 4.42: Religion Distribution in Igwo Community

RELIGION	Christianity	96
	Islam	2
	Traditional Worshippers	2
	TOTAL	**100**

Source: Field data gathering

❖ Okambi Community

About 97% of Okambi respondents are Christians, while 2% are Muslims and 1% traditional worshippers.

Table 4.43: Religion Distribution across Okambi Community

RELIGION	Christianity	97
	Islam	2
	Traditional Worshippers	1
	TOTAL	**100**

Source: Field data gathering

❖ Ikwomikwu Community

About 98% of Ikwomikwu respondents are Christians, with 1% being Muslim and 1% traditional worshipper.

Table 4.44: Religion Distribution across Ikwomikwu Community

RELIGION	Christianity	98
	Islam	1
	Traditional Worshippers	1
	TOTAL	**100**

Source: Field data gathering

Plate 4.25: Churches within the host communities

4.6.5.7 Population Characteristics

The National population census of 2006 (which is the latest official population census in Nigeria) puts the population of Obudu Local Government Area at 161,457. However, the Nigerian Population Commission forecasted that the population is expected to increase to 215,800 by the end of 2016. There are no official population figures on gender distribution in Obudu and also there is no official population figures on individual communities' basis for the LGA. Table 4.45 represent the population characteristic of Cross River State according to the 2006 National Population Census by the National Population Commission (NPC) with Obudu Local Government Area the project host area highlighted in yellow.

Table 4.45: Population Distribution of Cross River State highlighting Obudu LGA

Name	Status	Population Census 1991-11-26	Population Census 2006-03-21	Population Projection 2016-03-21
Cross River	State	1,911,297	2,892,988	3,866,500
Abi	Local Government Area	...	144,317	192,900
Akamkpa	Local Government Area	118,472	149,705	200,100
Akpabuyo	Local Government Area	103,952	272,262	363,900

Name	Status	Population Census 1991-11-26	Population Census 2006-03-21	Population Projection 2016-03-21
Bakassi [→ Cameroon (2008)]	Local Government Area	...	31,641	42,300
Bekwara	Local Government Area	...	105,497	141,000
Biase	Local Government Area	101,121	168,113	224,700
Boki	Local Government Area	145,010	186,611	249,400
Calabar Municipal	Local Government Area	...	183,681	245,500
Calabar South	Local Government Area	...	191,515	255,900
Etung	Local Government Area	...	80,036	107,000
Ikom	Local Government Area	...	163,691	218,800
Obanliku	Local Government Area	48,611	109,633	146,500
Obubra	Local Government Area	134,225	172,543	230,600
Obudu	Local Government Area	84,799	161,457	215,800
Odukpani	Local Government Area	122,352	192,884	257,800
Ogoja	Local Government Area	...	171,574	229,300
Yakurr	Local Government Area	...	196,271	262,300
Yala	Local Government Area	156,627	211,557	282,700
Nigeria	Federal Republic	88,992,220	140,431,790	193,392,500

Source: National Population Commission, National Bureau of Statistics (web).

However, from respondents' accounts, including key informant interview (KII) and focus group discussion (FGD), the population of the project affected communities are presented below.

4.6.5.7.1 Atiekpe Population Characteristics

From socio economic assessment, it was gathered that Atiekpe community population is estimated to be about 11,000 with 62.5% males and 37.5% females. There are approximately an average of twelve (12) persons per household with an average ratio of two (2) males to one (1) female. Below is a comprehensive age distribution of Atiekpe community.

Table 4.46: Population Distribution across Atiekpe Community

SEX			
	Male	6,875	(62.5%)
	Female	4,125	(37.5%)
	Total	**11,000**	**100**
AGE	≤ 17	2,200	(20%)
	18-23	1,870	(17%)
	24-29	1,650	(15%)
	30-35	1,430	(13%)
	36-41	1,210	(11%)
	42-47	1,100	(10%)
	48-53	770	(7%)
	54-59	440	(4%)
	≥ 60	330	(3%)
	TOTAL	**11,000**	**100**

Source: Field data gathering

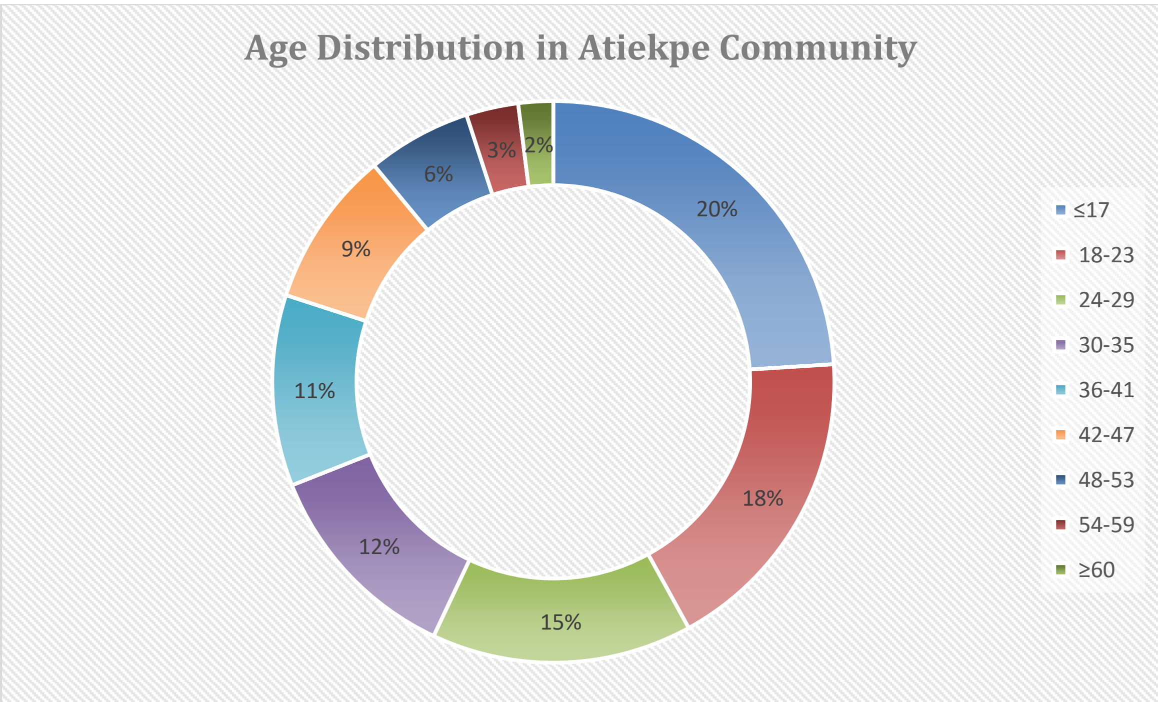

Figure 4.27: Chart showing age distribution in Atiekpe community

4.6.5.7.2 Igwo Population Characteristic

Igwo community has an estimated total population of 7,000 comprising of 61.5% males and 38.5% females with an average of eight (8) persons per household and a gender ratio of two (2) males to one (1) female. Presented in the table below is Igwo's population by age distribution.

Table 4.47: Population Distribution across Igwo Community

SEX			
	Male	4,305	(61.5%)
	Female	2,695	(38.5%)
	Total	**7,000**	**100**
AGE	≤ 17	1,470	(21%)
	18-23	1,260	(18%)
	24-29	980	(14%)
	30-35	980	(14%)
	36-41	770	(11%)
	42-47	700	(10%)
	48-53	490	(7%)
	54-59	210	(3%)
	≥ 60	140	(2%)
	TOTAL	**7,000**	**100**

Source: Field data gathering

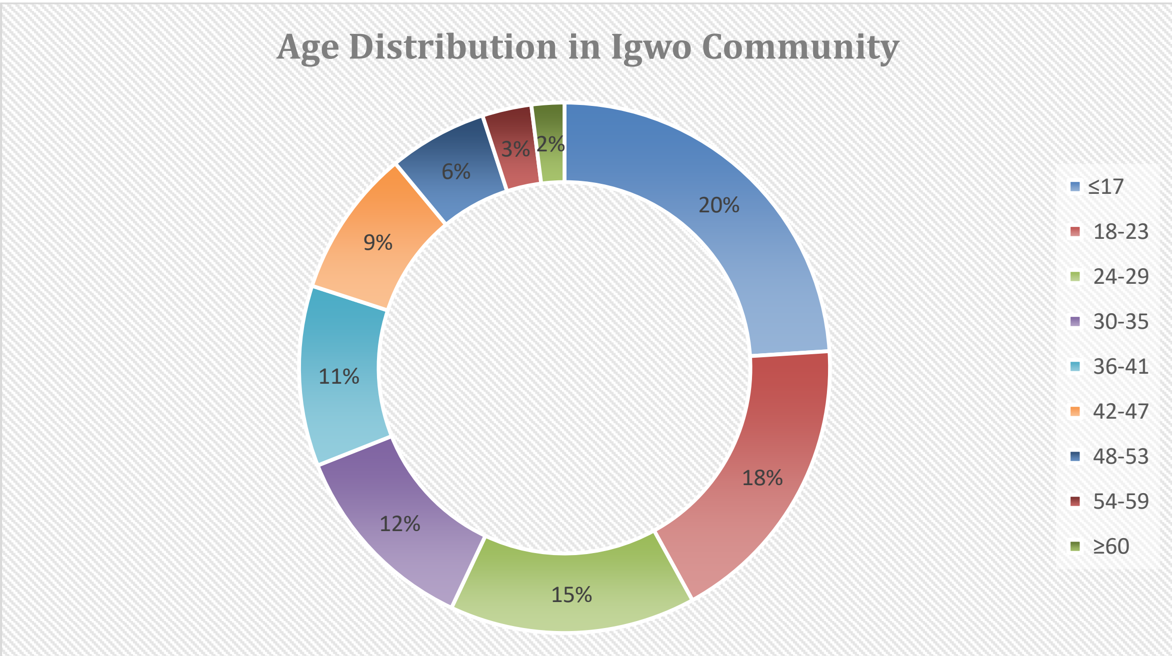

Figure 4.28: Chart showing age distribution in Igwo community

4.6.5.7.3 Okambi Population Characteristic

Okambi community population is estimated to be 6,000 distributed into 67.2% male and 32.8% female with eleven (11) persons per household. Gender ratio is about two (2) males to one (1) female.

Table 4.48: Population Distribution across Okambi Community

SEX			
	Male	4,032	(67.2%)
	Female	1,968	(32.8%)
	Total	**6,000**	**100**
AGE	≤ 17	1,440	(24%)
	18-23	1,080	(18%)
	24-29	900	(15%)
	30-35	720	(12%)
	36-41	660	(11%)
	42-47	540	(9%)
	48-53	360	(6%)
	54-59	180	(3%)
	≥ 60		(2%)
	TOTAL	**6,000**	**100**

Source: Field data gathering

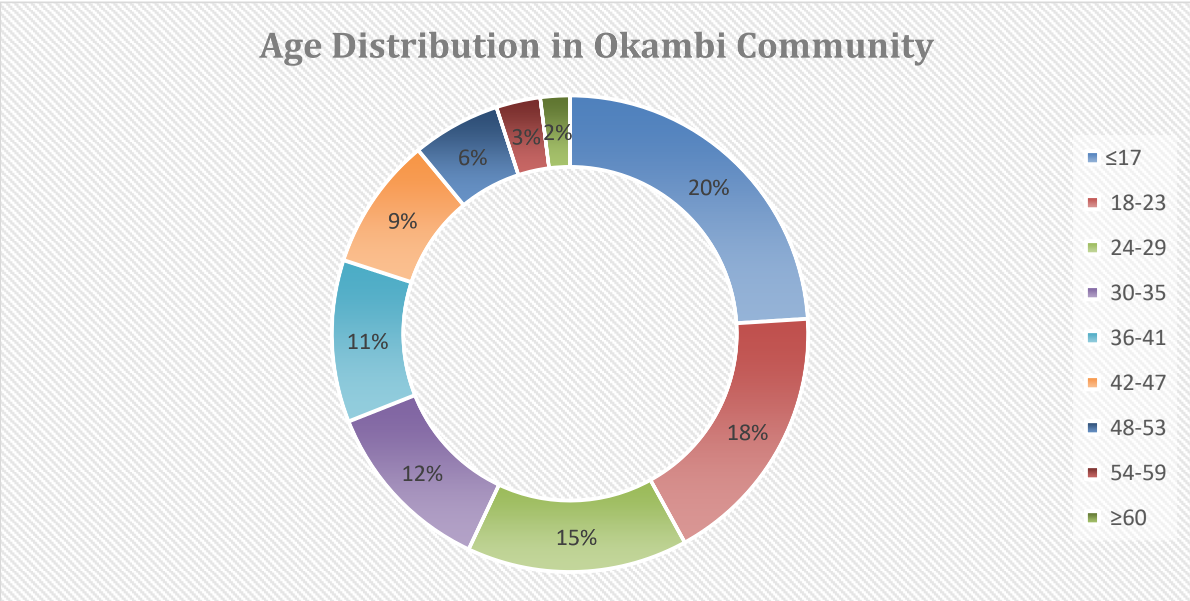

Figure 4.29: Chart showing age distribution in Okambi community

4.6.5.7.4 Ikwomikwu Population Characteristic

Ikwomikwu has an estimated population of 1,500 in population with a total number of 60.4% male gender and 39.6% female folks with nine (9) persons per household with a ratio of approximately one (1) male to two (2) females. Below is a breakdown of Ikwomikwu population.

Table 4.49: Population Distribution across Ikwomikwu Community

SEX			
	Male	906	(60.4%)
	Female	594	(39.6%)
	Total	**1,500**	**100**
AGE	≤ 17	360	(24%)
	18-23	240	(16%)
	24-29	255	(17%)
	30-35	195	(13%)
	36-41	195	(13%)
	42-47	120	(8%)
	48-53	60	(4%)
	54-59	45	(3%)
	≥ 60	30	(2%)
	TOTAL	**1,500**	**100**

Source: Field data gathering

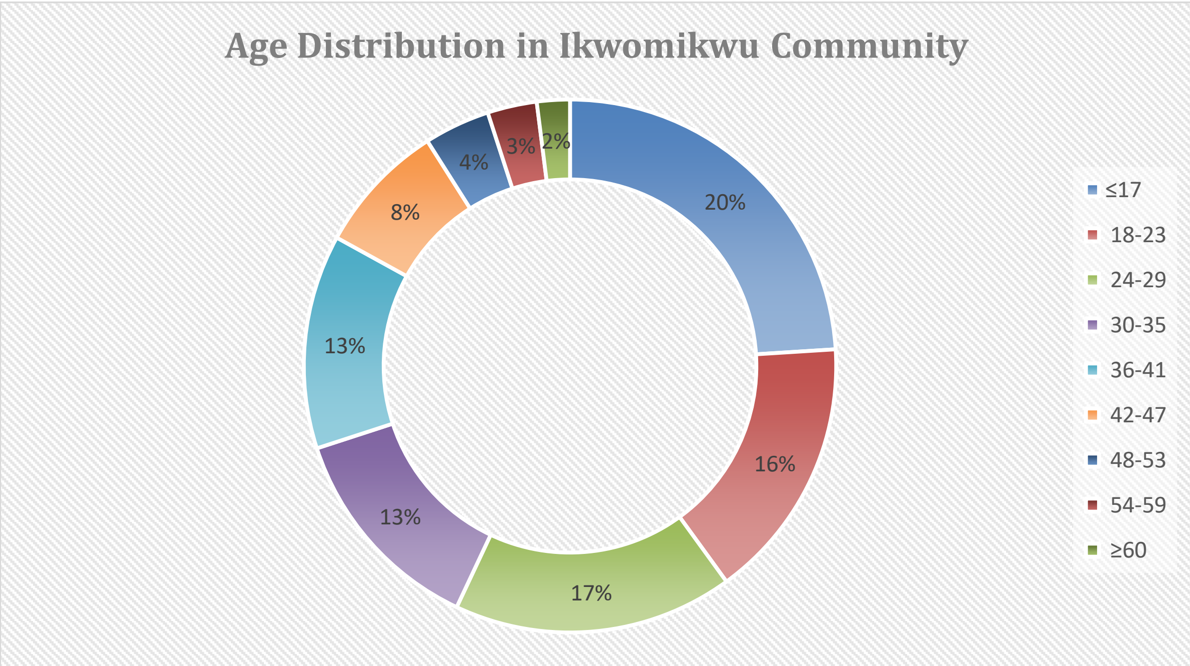

Figure 4.30: Chart showing population distribution across Ikwomikwo community

4.6.5.8 Transport and Traffic Effects

Access road to Obudu LGA is relatively in good condition considering the fact that Obudu is a Local Government headquarter. However, the access road to the proposed Airport site is not in a good state though fairly motorable. Traffic on the road is low with occasional passage of vehicles on the road at the proposed Airport. An increase in the volume of traffic is anticipated during the operational phase and as a result of this, there is need for expansion of the main road before and after the Airport as well as the rehabilitation of damaged sections of the road.

Plate 4.26: Road leading to the proposed airport project site

Plate 4.27: Temporary access road to the proposed site

Plate 4.28: Evidence of traffic flow in Obudu town

Current vehicular traffic on the Obudu-Abouchichi road is reported in Table 4.50. It is projected that these figures will increase when the Airport project finally commenced. On the average, 400 vehicles ply the road per day. The vehicular traffic on the roads and other access routes/tracks on the Obudu - Abouchichi road is dominated majorly by motocycles, cars and buses. A road vehicular traffic count conducted (as part of the socio-economic assessment) on the major road, shows that on the average, at peak periods, 98 cars ply the road per hour, with 30 buses per hour, 15 trucks per hour and 257 motorcycles per hour.

Table 4.50: Average peak hourly vehicular traffic for Obudu-Abouchichi Road

S/No.	Vehicles	No. Per Hour
1	Cars	98
2	Buses	30
3	Trucks	15
4	Motorcycles	257

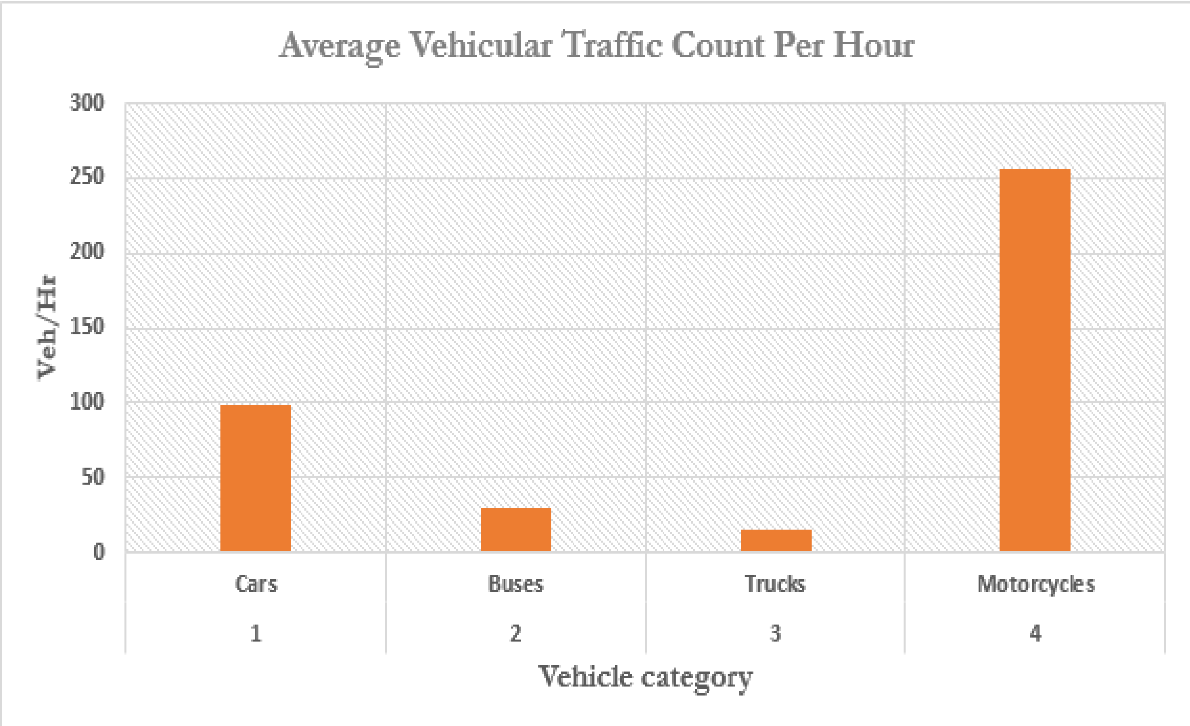

Figure 4.31: Average peak vehicular traffic (per hour) along Obudu-Calabar Road

4.6.5.9 Infrastructure and Utilities

The project affected communities possess some social infrastructural amenities like tarred roads, electricity, water facilities, telecommunication network service among others. However, in most areas of the communities, the roads are in a really bad shape. Also, power supply, according to respondents sampled is very erratic. Electricity supply is via the national grid (Port Harcourt Electricity Distribution Company-PHEDC). Water supply in the communities is from borehole, well and Rivers/streams. Furthermore, there is telecommunication service (As provided by the country's major telecom service providers) for mobile telecommunication in Obudu and across the project affected communities. Radio and television signals are equally available in the communities, which also have resort centers, filling stations etc.




Plate 4.29: Presence of boreholes and protected well as sources of drinking water in the host communities


Plate 4.30: Electricity and telecommunication facilities across the host communities

4.6.5.10 Landuse and Housing

The predominant landuse in the communities is agriculture (crop cultivation) followed by residential purposes. Others uses include public infrastructure (including schools, health facilities, roads, public water supply facilities, electrical utilities). Majority of the houses across the project affected communities are of mud brick and cement bricks, roofed with corrugated iron sheets. However, notable observation gathered from the socio-economic assessment is that houses are built reflecting the economic status of the owner.

Plate 4.31: Typical housing type across the project affected communities

4.6.5.11 Residents Perspective of the Project

The survey findings revealed that residents of the area hold different views about the project as shown in Table 4.51. 95% of the respondents were of the view that the project would provide jobs on completion, 5% were indifferent as to whether the project will create jobs. On the other hand, 87% of the respondents are of the view that the project would attract more people to work and live in the community while 13% feel it would not, as there are already enough manpower from the community to man all the operation phases of the project. 85% of the respondents feel that the project would have significant impact on the environment while 15%

think otherwise. 82% feel the project during operation would enhance the economic life of the host community while 13% think otherwise and 5% are indifferent.

Table 4.51: Respondent Perspective of the project

S/N	Respondent's Perspective	Number of Respondents	Percentage of Respondents (%)
1	**Potential to Provide Jobs**		
	Yes	380	95
	No	0	0
	Indifferent	20	5
	Total	400	100
2.	**Potential to Boost Influx of Immigrant to the Project Area**		
	Yes	350	87
	No	0	0
	Indifferent	50	13
	Total	400	100
3.	**Project will Negatively Impact the Environment**		
	Yes	340	85
	No	0	0
	Indifferent	60	15
	Total	400	100
4.	**Project will Positively Affect the Economy of the Project Host Community**		
	Yes	330	82
	No	20	13
	Indifferent	50	5
	Total	400	100

Source: Fielworkd, 2019

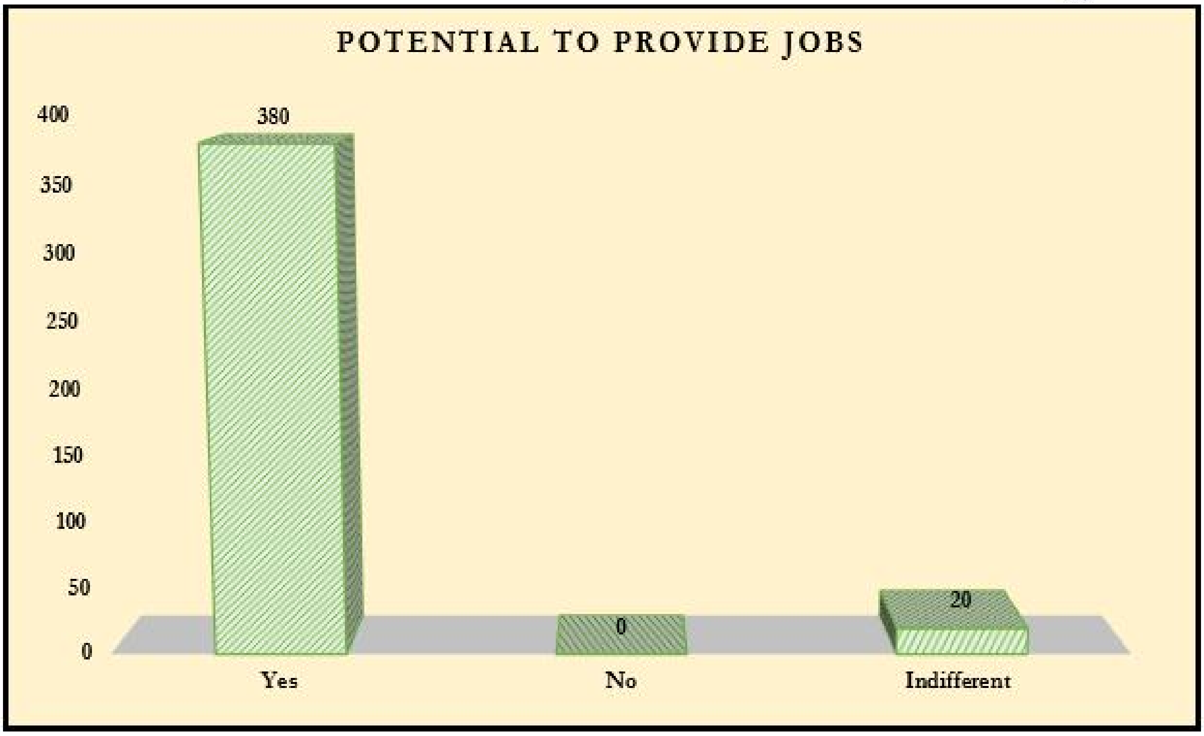

Figure 4.32: Bar chart showing respondents' view on the potentials of the project to provide jobs for community's inhabitants

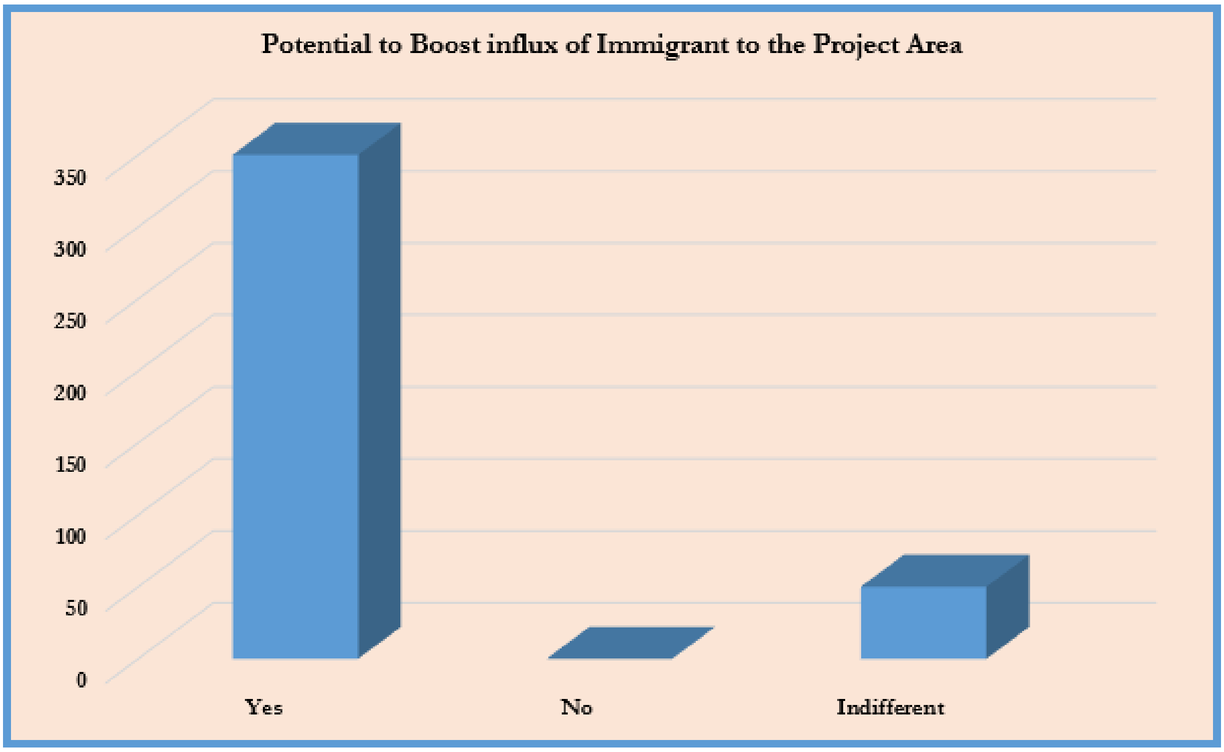

Figure 4.33: Bar chart showing respondents' view on the project's potential to boost influx of immigrants to the project area

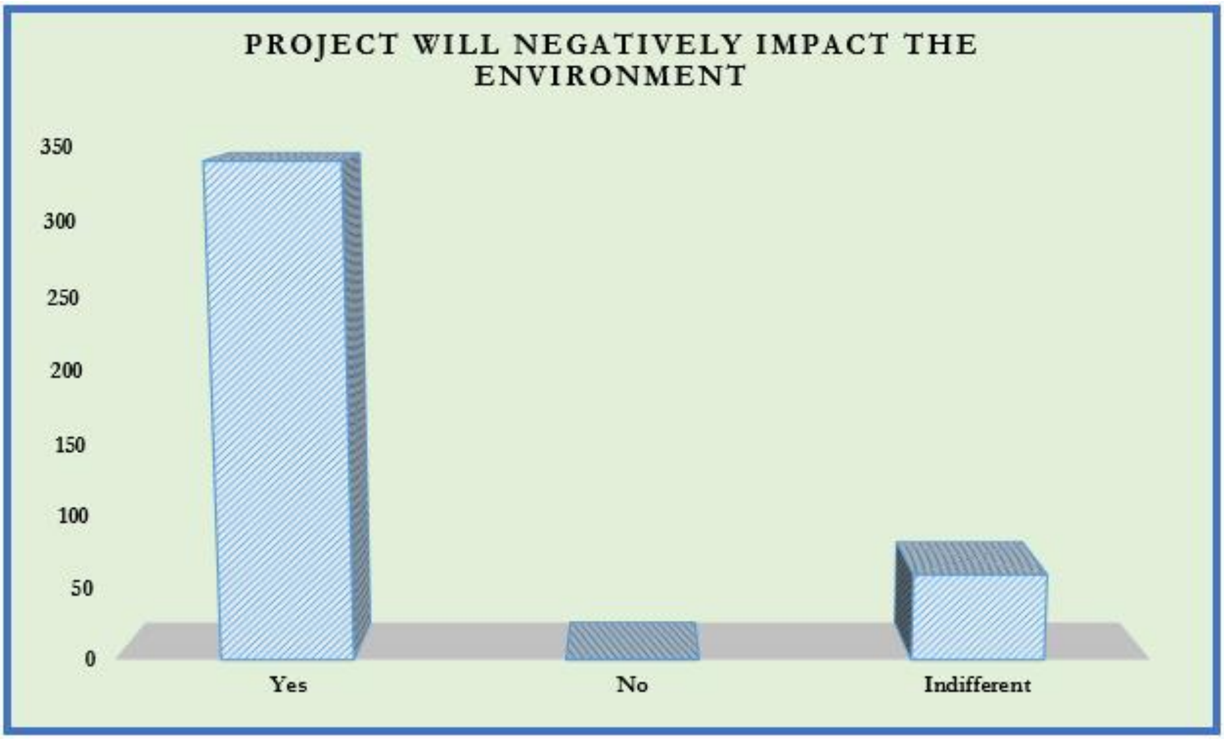

Figure 4.34: Bar chart showing respondents' view on the project's potential to negatively impact the environment

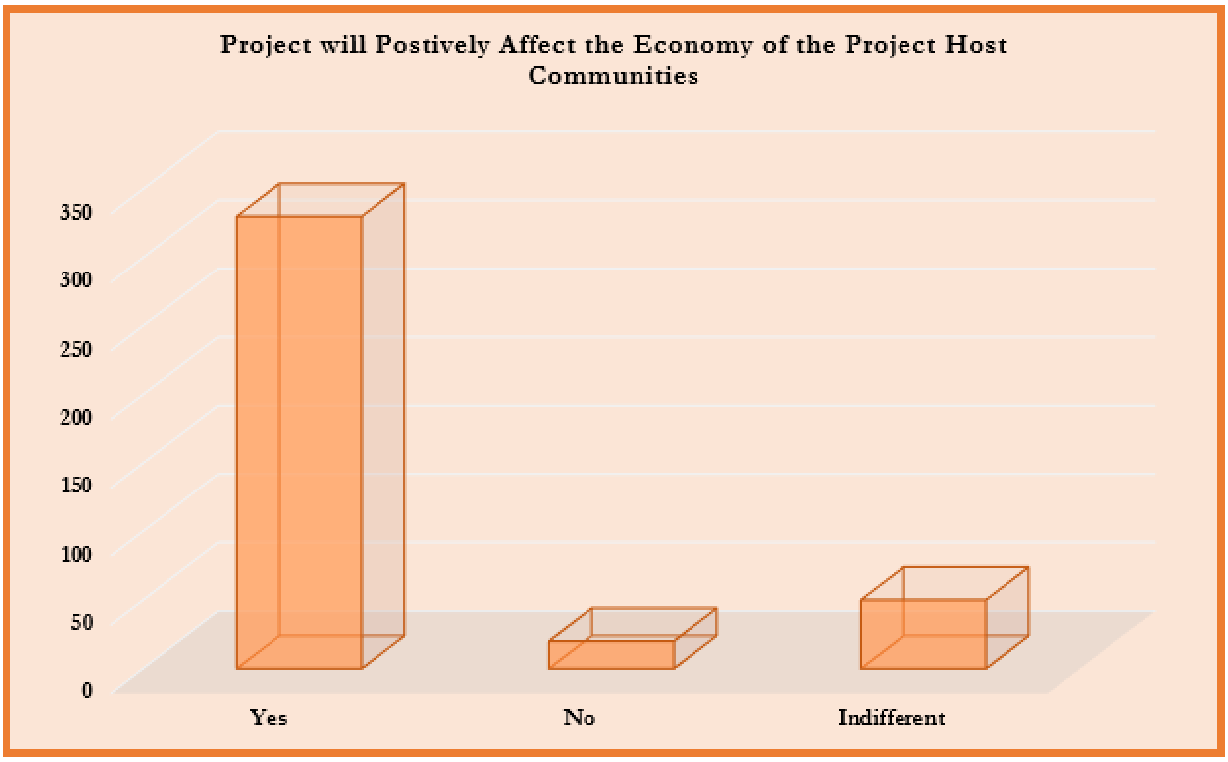

Figure 4.35: Bar chart showing respondents' view on the project's potential to positively affect the economy of the project host community

4.6.5.12 Feedback/Consultation Outcome

Highlighted below is a list of concerns as gathered from the consultation with the inhabitants of the project host communities. The Socio Economic Assessment was carried out across Atiekpe, Igwo, Okambi and Ikwomikwu at the instance of the representatives from both the Federal and State Ministries of Environment. Also in attendance were paramount rulers, community heads, council of chiefs/elders, community youth leaders, men, women, various groups etc from all the project affected communities.

- **Feedback from Atiekpe community Head**
  - He expressed joy at the possibility of seeing a project of this magnitude coming to Obudu in his time and encouraged the State Government to ensure timely completion of the project.
  - He pledged the unalloyed support of Atiekpe community to the project

- **Feedback from Atiekpe community Men**
  - They expressed worries about the community deities which resides on the project site land and solicited for their protection.
  - They said that the community youths should be considered for employment when the project commenced considering the fact that the community is blessed with degree holders in various fields of learning and technicians.
  - They advocated that the Government should ensure it fulfill her primary obligations to the community as there are no social amenities like good access roads, drainages, boreholes, hospitals, schools etc.
  - The land for the proposed Airport is for farming and considering the fact that the land will be used for this Airport project, they expressed that owners of the land should be positively engaged and/or adequately compensated.
  - They agitated that valuers should be adequately engaged to ensure that cultivated crops are properly evaluated and compensations made accordingly.
  - They strongly advocated for re-settlement option as the proposed land for the Airport is their ancestral land.
  - They appealed for adequate flow of information so as to enable them participate in every segment of the project.
  - There should be a signed MoU between the Government and the Atiekpe community with respect to the land take.

- **Feedback from Atiekpe Women**
  - They desire to see their children positively engaged and employed.
  - They are unanimously happy about the project and look forward to its operation.
  - They want women to be given a chance to own shops where they can sell provisions and other consumables.
  - The Government should provide social amenities like hospitals and pipe borne water;

- They pledged their total support to seeing to the success of the Airport project.
- Widows in the community should be adequately empowered and assisted.

- **Feedback from Atiekpe Youths**

i. They expressed that their roads are in deplorable condition.
ii. They support the project as it will create jobs for the community.
iii. They equally seek educational grants/scholarships from the project proponents/sponsors for their deserving indigenes.
iv. They want to feel the presence of good governance in the community.

Plate 4.32: Consultation with Atiekpe Community Men


Plate 4.33: Filling of socio economic questionnaires by Atiekpe women


Plate 4.34: Consultations with Atiekpe Youths

Feedback from Igwo Community Head

- He appealed that the community should be provided with boreholes and electricity seeing that, Igwo is the only community yet to be provided with electricity.
- He advocated that jobs should be created for the community youths as the community currently has a lot of unemployed Graduates and Technicians in every field of human endeavor.
- He also solicited for adequate compensation to avoid communal crisis.
- No medical facilities like good hospitals in the community, hence, appealed that Government should provide hospitals for Igwo people.
- Boundary lines for the proposed Airport project should be unambiguously demarcated.

Feedback from Igwo Men

- Economic tress should be properly evaluated
- Due process should be followed to ensure no one feels cheated

- Consultations should at all times be done through the community head not through individuals.
- Proper contouring should be done on the total land take to enable the community ascertain the extent of the runway considering the fact that the runway will pass through Igwo community.

Feedback from Igwo Women

- There should be gender equality
- Compensation should be adequate in relation to their farmlands

Feedback from Igwo Youths

- The community youth should be considered for employment
- There should be intervention programs
- The Cross River State Government should fulfill her primary obligation to the people of Igwo by providing basic amenities.


Plate 4.35: Consultations with Ikwomikwu community Head

Plate 4.36: Consultations with Igwo community men

Plate 4.37: Igwo Women filling socio economic questionnaires

Plate 4.38: Consultations with Igwo community Youths

Feedback from Okambi community Head

- He also made an appeal that a large number of the community youths be considered for employment when the project comes on board.
- The State Government (the proponent) should provide the people with boreholes, good access road, hospitals, electricity and potable water.

Feedback from Okambi Men

- They need electricity, good roads and schools
- Due process should be followed as this will help improve the already tensed atmosphere resulting from communal crisis.
- They advocated for re-settlement plan
- The land valuers should ensure unbiased evaluation process and significant compensation for the Project Affected Persons (PPA).
- They strongly desired to see people in the community positively engaged when the project comes on stream.

Feedback from Okambi Women

- As much as they appreciate the initiative of the Cross River State Government of choosing to build an Airport in Obudu, the women desired to be fully involved in the benefits embedded in the project.
- They need electricity, good road, modern market, potable water and employment for both their husbands and children.

Feedback from Okambi Youths

- Compensation should be done with evidence of receipts.
- Incentives for the youths should be directly disbursed to them for accountability purpose.
- Job employment for both the artisan and educated youths.
- Provision of social amenities.

Plate 4.39: Consultations with Okambi Community

Plate 4.40: Okambi women at the Consultation Ground

Plate 4.41: Consultations with Okambi Youths

Feedback from Ikwomikwu Community Head

- He made an appeal that a large number of the community youths be considered for employment when the project comes on stream.
- Provision of access road, hospital, electricity and water

Feedback from Ikwomikwu Men

- They expressed joy and anticipated for timely completion of the project.
- The community pledged unalloyed support for the project
- They expressed their desire to see the tarring of the roads
- Provision of electricity, hospital, schools etc.
- Creation of jobs for the community youths
- Proper value should be given to the land owners and appropriate compensation paid.

Feedback from Women

- There should be gender equality and opportunity for the women to own shops
- Compensation should be adequate in relation to their farmlands taken.
- Job employment for the community youths

- Provision of social amenities

Feedback from youth

- They are in support of the project as it will create jobs for the community youths.
- They seek educational grants/ scholarships from the project proponents/ sponsors for their deserving indigenes.
- They want to feel the presence of government in their community.

Plate 4.42: Consultations with Ikwomikwu Clan Head indicated with an arrow

Plate 4.43: Consultations with Ikwomikwu women

4.6.5.13 Health Impact Assessment (HIA)

This section presents the baseline health data based on information generated from sampled groups in the study area. The data here were as obtained from the government hospital and other health facilities within the project location.

4.6.5.13.1 Healthcare Facilities

From the assessment, it was gathered that Obudu town has a host of healthcare facilities which includes, Obudu General Hospital, Sacred Heart Catholic Hospital, traditional doctor/herbs etc. The assessment revealed that sacred heart catholic hospital which is managed by the catholic missionary is in operation with qualified medical doctors, registered nurses, community health workers and other groups of health personnel available to handle health cases. On the other hand, Obudu general hospital has not been in operation for the past two (2) years with evidence of no doctor on duty during site visit to the hospital.

However, it was gathered from the assessment that most of the severe health cases are refered to the misionary sacred heart catholic hospital. Some of the health cases handled by this hospital include but not limited to:

- Enteric fever
- Brochial pneumonia

- Diarrhoea
- Stroke
- Hypertension
- Hepatitis
- Peptic ulcer
- Gastric intestinial bleeding
- HIV
- Accident/surgical cases (Appendicitis, Hernia) etc

Also, some of the health services handled by this missionary sacred heart catholic hospital includes, consultation, ante natal care services, surgical services, continuous medical education, vaccination, TB services, eye services and X-ray service etc. However, in the event of extreme health cases, such cases are therefore refered to the Federal Teaching Hospital, Abakaliki which is about four (4) hours drive from Obudu. Other cases are refered to University of Calabar Teaching Hospital and NKST Rehab, Mkar Gboko, Benue State.

Plate 4.44: Consultations with Sacred Heart Hospital Medical Personnel

Plate 4.45: Selected view of Sacred Heart Hospital Pharmaceutical Stores.

Plate 4.46: Obudu General Hospital Center

4.6.5.13.2 Healthcare Facilities Assessment across the Project Affected Communities (PAC)

- **Atiekpe Community**

The socio economic assessment reveals that there exist a Primary Healthcare (PHC) center in Atiekpe community. It was however gathered that malaria, typhoid, diarrhoea, cholera and pneumonia etc are the prevalent health challenges experienced by the Atiekpe people and most of these health cases are handled by the Atiekpe primary healthcare center while extreme cases are refered to sacred heart hospital. The PHC was not opened for operation during site visit.

- **Igwo Community**

Healthcare facility assessment was carriedout across the entire Igwo community with key interest on the Primary Healthcare (PHC) center by a team of experts in order to establish and identify prevalent health cases in the community. The assessment reavealed that malaria, typhoid, diarrhea etc are the prevalent health cases across the entire land which are treated by Igwo PHC and other life-threatening cases refered to sacred heart hospital for proper attention. There were presence of both registered nurses and other health workers at the health center with presence of incinerator for incinerating medical wastes inline with standared practices. Focus group interaction with the head of facility reveals that malaria drugs are provided by the Cross River State Government while immunasation vaccines are provided by the Obudu Local Government. The head of health facility however solicited the Cross River State Government to provide the Igwo PHC mobility, electricity, water and manpower.

- **Okambi Community**

From the detailed healthcare assessement conducted on Okambi community, it was observed that Okambi primary healthcare center was in operation during the site visit. It was gathered from interview with the head of facility that the prevalent health cases treated by the PHC are malaria, typhoid, diarrhoea, pneumonia etc and other major health cases refered to sacred heart catholic hospital. Okambi PHC is blessed with certified nurses, N-power workers and other health personnel. The management of the PHC however implored the Cross River State Government to provide the Okambi PHC with mobility for referring emergency cases, electricity, drugs and other medical consumables/equipments, water supply, and qualified medical doctors.

- **Ikwomikwu Community**

The socio economic assessment revealed that Ikwomikwu community has Primary Healthcare (PHC) center where health challenges like malaria, typhoid, diarrhoea, cholera, pneumonia, cuts and bruises etc are treated while major health cases are usually refered to the catholic missionary sacred heart hospital for professional intervention and trearment. Interview with the head of facility revealed that malaria drugs and vaccines such as (BCG, Tetanus toxoide etc) are supplied by the Cross River State Government. There are certified community health officers, N-power staff and other health practitioners present in the PHC facility during the health impact assessment studies. However, the Ikwomikwu PHC management solicited the Cross River State Government for more qualified manpower, mobile ambulance for referring emergency cases, medical equipments like (Wheel chairs and BP apparatus etc).

4.6.5.13.3 Key Issues and Challenges

Inadequate and inequitable distribution of human resource for health, inadequate and poorly maintained health care infrastructures, and poverty are amongst key issues with respect to health services provision and utilization in the project area. The poor state of health management information and disease surveillance and control systems and inadequate funding are major challenges to effective planning, implementation and evaluation of the current health system.

a) Mortality Occurrence

As earlier appraised the prevalent health issues in the area include malaria, hypertension, typhoid, diabetes, cough, catarrh and fever. Reliable records on deaths were lacking in the study area. Based on survey findings, deaths are often not recorded. Since death is a very significant event which is not likely to be forgotten easily, the health institutions in the community were advised to keep record of death (as much as possible) for proper documentations.

b) The Practice of Traditional Medicine

The practice of traditional medicine is common in the study area. Their practice commonly involves the use of herbs. Traditional birth attendants are equally present in the community. Their functional forms of ante-natal and maternal services are available.

c) Nutrition and Health

Dietary pattern of the community consisted mainly of carbohydrates like yam/pounded yam, garri, rice and corn, which are eaten in various forms. Proteinous food such as beans, beef, bush meat, fish etc. are also consumed. Vitamins including fruits and vegetables are well consumed. Also oils such as vegetable and palm oil are used in the preparation of soups. The diet taken by a vast majority of the inhabitants of the project host communities can be said to be balanced.

4.6.5.13.4 Sanitation of the Living Environment

From the study, the general sanitary status of the living environments in the communities were rated as poor, fair, or good based on a set of criteria in the checklist shown in the table below. It is obvious from the table that the general condition of the environment is fair. It should be added that the community inhabitants usually dispose their waste by burning.

Table 4.52: General assessment of sanitary condition in the study area

Sanitary Condition	Assessment (%)
Good	39
Fair	50
Poor	11

Source: Fieldwork, 2019

a) Sewage Disposal

The most commonly used sewage disposal methods observed in the study area community were the use of pit latrines and open defeacation. There are however, a few houses across the project affected areas with water closet toilet facilities. The refuse generated in the studied area were mainly kitchen wastes, which included food remnants etc. There are also non-degradable wastes such as plastics, glass, polythene bags, ashes, metallic tins/can etc. The commonest refuse disposal method was open dumping on land which are mostly burnt when dried. This disposal method is largely unhygienic.

b) Disease Vectors

The common disease vectors in the communities include mosquitoes (anopheles and aedes), houseflies, cockroaches and rats. These disease vectors are mainly responsible for ill-health in the project area.

4.6.5.13.5 Health Risks Consequence of the Project

Airport operations do involve some level of health hazard, as a result of noise and traffic congestion. These challenges can be contained if modern technologies are employed during operation. Cross River State Government intends to use modern technologies so as to prevent any health hazard to its workers and the host communities.

General preventive measures include:

- Enforcement of occupational health standards.
- Surveillance of potentially exposed population groups, especially the vulnerable ones (children, pregnant women, elderly).
- Water treatment and compliance with FMEnv standards on Environment,
- Employmement traffic warders to control traffic.

4.6.5.14 Identification of Project Affected People (PAP) and Compliance to Resettlement Action Plan

The present scenario as witnessed by the socio-economic team and confirmed by the FMEnv officials and those of the Cross River State Ministry of Environment during the field visit shows that there are no settlements within the designated Obudu Cargo and Passenger Airport project site. The prevalent landuse of the area is farming. Since the land acquisition is being followed through by Cross River State Government with the payment of compensation for economic crops to the affected persons across the host communities, it is therefore expected that all concerned parties will respect the settlement terms and vacate the area. Going by the foregoing, all Project Affected Person (PAPs) are being adequately compensated monetarily for the land and economic crops on them.

CHAPTER FIVE

ASSOCIATED AND POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

5.1 Introduction

The construction and operation of an airport project have the potential to create a range of impacts on the environment. These potential impacts can be both positive (beneficial) and negative (adverse) depending on the resources and receptors involved along with other parameters such as geographical scope (magnitude and extent), temporal scope (duration) and reversibility. It is anticipated that this project will have positive impacts on sectors such as the economy, employment and foreign exchange earnings among others. Moreover, the project is expected to result in negative impacts of short-term duration and transient in nature.

The objective of this chapter and the preceding one is to assess the likelihood of those social and environmental impacts as far as possible and to propose measures which will be incorporated in the project design, construction and operation, to, if not eliminate, at least mitigate these impacts to as low as reasonably practicable (ALARP) and to meet national Nigerian standards and regulations, international industry standards, and quality standards requirements.

5.2 Potential Impact Generation Activities

The construction and operation phase of the proposed project comprises various activities each of which may have an impact on environmental parameters. The impacts of the project are envisaged during the design and planning, during pre-construction phase, construction phase and operational phase.

During the construction phase, the following activities may have impacts on the environment:

- Site preparation;
- Excavation and leveling;
- Hauling of earth materials and wastes;
- Cutting and drilling;
- Erection of concrete and steel structures;
- Road construction;
- Painting and finishing;
- Clean-up operations;
- Landscaping and afforestation.

The activities can be divided into two categories, viz. sub-structural and super-structural work. Moreover, construction work will involve cutting of trenches, excavation, concreting etc. All these activities attribute to dust pollution. The super-structural work will involve steel work, concrete work, masonry work etc. and will involve operation of large construction equipment like cranes, concrete mixers, hoists, welding sets etc. There will be emission of dust and gases as well as noise pollution from these activities. Mechanical erection work involves extensive use of mechanical equipment for storage, transportation, erection and on-site fabrication work. These activities will generate some air contaminants and noise pollution. The electrical activities are less polluting in general.

5.3 Impact Assessment Overview

The potential for an environmental impact exists where an environmental aspect has been identified i.e. where a project activity has been determined to have the potential to interact with the bio-physical and socio-economic environment. The significance of each impact is then determined.

The methodology used for assessing the potential and associated impacts of the proposed project consists of five (5) major steps:

Step 1: Identification of the proposed project activities and their interaction (directly or indirectly) with the identified environmental receptors/resources in the Project area;

Step 2: Comprehensive preliminary identification of potential impacts as a result of cause and effect relationship;

Step 3: Comparative assessment of impact importance, identification of impacts that are likely to be significant through application of a basic set of impact significance criteria based on the preliminary information available about each impact;

Step 4: Detailed assessment of the identified focus area impacts characterization techniques, quantification of impacts to the extent possible and rigorous qualitative characterization of impacts that cannot be quantified; and

Step 5: Final assessment of the severity levels of impacts through application of the results of the quantitative and qualitative characterization of impacts developed in

Step 4 to a set of objective impact severity criteria; identification of impacts warranting mitigation.

In determining the significance of impacts, the factors considered included: magnitude of impacts (which is a function of the combination of the following impact characteristics: extent, duration, scale and frequency); value/sensitivity/fragility and importance of relevant environmental and social

receptors; legal/regulatory requirements; and public perceptions (based on stakeholders' consultation).
The assessment of impact significance is qualitative and quantitative.

Qualitatively, the impact significance is ranked on the following accepted levels namely:

Major	4
Moderate	3
Minor	2
Negligible	1
Beneficial	+

These rankings are used for both bio-physical and socio-economic impacts. While for sensitivity of receptor, the following is used:

High	3
Medium	2
Low	1

The impact assessment undertaken for the proposed project covers the entire life cycle of the project i.e.:

- Pre-construction;
- Construction/Installation;
- Operation; and
- Decommissioning and Abandonment

5.4 Impact Prediction Methodology

Various impact prediction guidelines and methodologies have been developed and applied in various ESIA activities. Internationally acceptable methods of impact prediction and evaluation include the following:

- Checklist (Canter, 1977);
- Interaction Matrix (Leopold *et al.*, 1971);
- Overlays Mapping (Mc Harg, 1968);
- Networks; and
- Battelle Environmental Evaluation System (Dee *et al.*, 1972)

The Interaction Matrix method, when compared to the other approaches, provides the same level of details requires comparable knowledge of the environment and relies on limited data unlike the other methods that rely on availability of large historical data bank. It also has a wide range of application. Thus, a modified Leopold Interaction Matrix was selected for the purpose of impact screening for this ESIA.

5.4.1 Potential Impact Characteristics

The following characteristics were also used to define potential impacts that may be associated with the proposed project:

i) **Negative:** An impact that is considered to represent an adverse change from the baseline or to introduce a new undesirable factor.
ii) **Positive:** An impact that is considered to represent an improvement to the baseline or to introduce a new desirable factor.
iii) **Direct:** Impacts that result from the direct interaction between a planned project activity and the receiving environment.
iv) **Indirect:** Impacts that result from other activities that are encouraged to happen as a consequence of the project.
v) **Temporary:** Temporary impacts are predicted to be of short duration, reversible and intermittent/occasional in nature.
vi) **Short-term:** Short term impacts are predicted to last only for a limited period but will cease on completion of the activity, or as a result of mitigation measures and natural recovery.
vii) **Long-term:** Impacts that will continue for the life of the project, but cease when the project stops operating.
viii) **Permanent:** Potential impacts that may occur during the development of the Project and cause a permanent change in the affected receptor or resource that endures substantially beyond the project lifetime.
ix) **On-site:** These are limited to the project site.
x) **Local:** Impacts that affect locally important environmental resources or are restricted to a single (local) administrative area or a single community.
xi) **Regional:** Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries.
xii) **National:** Impacts that affect nationally important environmental resources; affect an area that is nationally protected; or have macroeconomic consequences.
xiii) **Reversible:** An impact that the environment can return to its natural state.
xiv) **Irreversible:** An impact that the environment cannot return to its original state, e.g. the extinction of an animal or plant species.
xv) **Cumulative:** Potential impacts that may result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project.
xvi) **Residual:** Both environmental and social impacts that will remain after the application of mitigation measures to project impacts during each of the project phases (preconstruction, construction, operation, decommissioning/post-decommissioning).

5.4.2 Screening and Scoping for Potential Impacts

A modified version of the Leopold Interaction-matrix technique was employed to screen and scope for the potential impacts of the proposed project on the environment. The basis for the screening was derived from the following:

- Knowledge of the project activities as summarized in Table 5.1.
- Detailed information on the environmental and socio-economic setting of the study area/project's area of influence.
- Review of other EIA/ESIA reports on similar projects/environments.
- Series of experts group discussions, meetings and experience on similar projects.

Table 5.1: Summary of proposed project phases and associated activities

S/No.	Project Phase	Associated Activity
1	Pre-construction	Design
		Acquisition of project site
		Mobilization of men, materials and equipments to site
		Site preparation
2	Construction	Mobilization and demobilization: Transportation of materials and workers
		Construction of runway, terminal and other airport facilities
		Vehicular movement
		Wastes generation and handling
3	Operation	Emission from vehicle and stationary equipment
		Aircraft operations-approach, landing and take-off
		Vehicular/traffic movement
		Waste generation and handling
		Aircraft maintenance service
4	Decommission/Abandonment	Dismantling of terminal buildings/removal of equipments/demobilisation of project personnel
		Rehabilitation of disturbed land

5.4.3 Determination of Impact Significance

Once all environmental aspects are identified, the level of impacts that may result from the proposed project activities are assessed. In assessing the level of impacts that an activity may cause, two key elements are considered namely:

- **Consequence:** The resultant effect (positive or negative) of an activity's interaction with the natural and/or socio-economic environments.
- **Likelihood:** The likelihood that an activity will occur.

5.4.3.1 Consequence

To assign a level of consequence to each environmental and socio-economic impact, criteria are defined for environmental and socio-economic consequence.

The environmental and socio-economic consequence criteria, categories and definitions are presented in Table 5.2 and Table 5.3 respectively. "Catastrophic" represents the most severe consequence.

Table 5.2: Categories and definition of consequence levels for natural environmental impacts

Category	Ranking	Definition

Catastrophic	5	• Transboundary and/or national scale impact resulting in:
		  o Long term and profound change and/or damage to the natural environment and its ecological processes
		  o Increase in threat category for rare and endangered species of fauna and flora identified in national and global listings.
		• Negative widespread national and international media coverage.
		• Significant long-term financial loss.

Major	4	• Regional to national scale impact resulting in:
		  o Medium term change and/or damage to the natural environment and its ecological processes.
		  o Reduction in regional habitat and species diversity
		  o Direct loss of habitat for endemic, rare and endangered species of fauna and/or flora and for species' continued persistence and viability nationally and regionally (for species unable to disperse).
		• Natural habitat restoration time 5-10 years and requiring substantial intervention.
		• Breach of environmental regulations and company policy and/or 100%-200% exceedance of international, national and industry and/or operator standard for an emission parameter.
		• Sustained adverse national media attention.
		• Significant medium term financial loss.

Moderate	3	• Local to regional scale impact resulting in:
		  o Short term change and/or damage to the natural environment and its ecological processes.
		  o Direct loss of habitat crucial for species' (including listed species) continued persistence and viability in the project area (for species unable to disperse).
		  o Introduction of exotic species of fauna in invasive floral species replacing resident 'natural communities' within the project area.
		  o Environmental stress lowering reproductive rates of species within the project area.
		• Natural restoration time 2-5years and requiring intervention.
		• Potential breach of environmental regulations and company policy and/or 50%-100% exceedance of international, national, industry and/or operator standard for an emission parameter.

Category	Ranking	Definition
		• Complaints from the public, authorities and possible local media attention. • Medium term financial loss.
Monitor	2	• Local scale impact resulting in: ○ Short-term change and/or damage to the local natural environment and its ecological processes. ○ Short-term decrease in species diversity in selected biotopes/areas within the project area. ○ Increased mortality of fauna species due to direct impact from project activities. • Public perception/concern. • short-term financial loss.
Negligible	1	• Impact largely not discernible on a local scale being absorbed by the natural environment; areas adjacent to disturbed areas absorb exodus of species able to disperse. • Restoration within 6months without intervention. • Up to 10% exceedance of international, national, industry and/or operator standard for an emission parameter. • public perception/concern. • Minimal financial loss.
None	0	• Impact absorbed by local natural environment with no discernible effects. • No restoration or intervention required. • No exceedance of international, national, industry and/or operator standard for an emission parameter. • No financial loss.
Positive	+	• Activity has net positive and beneficial effect resulting in environmental improvement for example: ○ Ecosystem health ○ Increase in magnitude or quality of habitat for rare and endangered species of fauna and flora as well as for those species known to naturally occur in the area. ○ Growth of 'naturally occurring' populations of flora and fauna. • Positive feedback from stakeholders. • Potential financial gains

Table 5.3: Categories and definition of consequence levels for socio-economic, environmental impacts

Category	Ranking	Definition
Catastrophic	5	• Emergency situation with harmful consequences to human health (e.g. fatalities) • Disastrous consequences on the livelihoods of individuals (e.g curtailment of access to primary income source). • Calamitous consequences on those seeking to access community facilities and utilities (e.g. resettlement of large numbers (1000s) of households). • Disastrous consequences on the national economy. • Breach of company social policy and/or legislation
Major	4	• Major impacts on human health (e.g. serious injury). • Significant impact on the livelihoods of individuals (i.e. access to income source restricted over lengthy period of time). • Serious impact on access to community facilities and utilities (e.g. resettlement of large numbers (10s-100s) of households). • Notable consequence on the economy, at a local, regional and/or national level (e.g. virtually no local sourcing of supplies or personnel). • Breach of economic social policy and/or regulation.
Moderate	3	• Modest impact on human health and well being (e.g. noise, light, odor, dust, injuries to individuals). • Moderate impact on individual livelihoods (e.g. restricted access to income source). • Medium impact on access to community facilities and utilities (e.g. access to utilities restricted for long periods (weeks) of time). • Moderate impact on the wider economy, at a local, regional and/or national scale (e.g only moderate levels of employment and supply sources within Nigeria). • Potential breach of company social policy and/or legislation
Minor	2	• Limited impact on human health and well being (e.g occasional dust, odors, traffic noise). • Some impact on the livelihoods of individuals (e.g. isolated incidents related to ethnic tensions and some restrictions on access to income source). Natural restoration within 2 years requiring minimal or no intervention. • Some impact on access to community facilities and utilities (e.g. access to cultural centers restricted to a limited extent, i.e. (days). • Sparse impact on the wider economy, at a local, regional, and national level (e.g. limited procurement).
Negligible	1	• Possible nuisance to human health and well being (e.g. occasional unpleasant odor). • Very limited disruption caused to those earning their livings (e.g. no noticeable impact on heralding operations).

Category	Ranking	Definition
		• Inconvenience experienced in accessing community facilities and utilities (e.g. electricity supply disruption for short (hours) period of time). • Very limited impact on the wider economy at a local, regional and/or national scale (e.g. no discernable indirect and induced development).
None	0	• No impact on human health. • No impact on livelihoods. • No impact on community facilities/utilities. • No impact on the wider economy
Limited positive	+	• Some beneficial improvement to human health. • Some benefits to individual livelihoods (e.g. additional employment opportunities). • Limited improvements to community facilities/utilities (e.g. no discernible improvement). • Some impact on the wider economy (e.g. limited local procurement).
Moderate positive	++	• Moderate beneficial improvement to human health • Medium benefits to individual livelihoods (e.g. employment impacts). • Modest improvements to community infrastructure/utilities. • Moderate impact on the wider economy (e.g. some local sourcing of supplies).
Significant positive	+++	• Major beneficial improvement to human health. • Large scale benefits to individual livelihoods (e.g. large scale employment). • Major improvements to community facilities/utilities. • Notable impact on the wider economy (e.g. extensive use of local procurement).

5.4.3.2 Likelihood

Likelihood in this assessment implies the possibility of an activity occurring. To assign likelihood to each activity, five criteria will be defined and ranked. The criteria for likelihood are shown in Table 5.4. Level five, "certain", represents the highest certainty that the activity will occur.

Table 5.4: Likelihood categories and rankings natural and socio-economic impacts

Category	Ranking	Definition
Certain	5	The activity will occur under normal operating conditions.
Very likely	4	The activity is likely to occur under normal operational conditions.
Likely	3	The activity is likely to occur at some time under normal operating conditions.
Unlikely	2	The activity is unlikely to occur at some time under normal operating conditions.
Very unlikely	1	The activity is very unlikely to occur under normal operating conditions but may occur in exceptional circumstances.

5.4.3.3 Significance

The significance of the impact is determined by calculating the product of an environmental aspect's consequence and likelihood of occurrence. Fig 5.1 below illustrates all possible product results for the five consequence and likelihood categories.

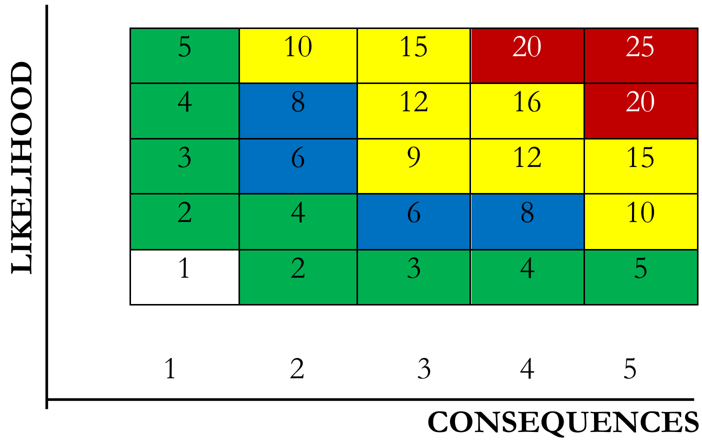

Figure 5.1: Consequence likelihood product results

Based on its consequence-likelihood score, each environmental impact was again ranked into five categories or orders of significance as illustrated in Table 5.5.

Table 5.5: Environmental impact significance rankings

Ranking (consequence x likelihood)	Significance
>16	Catastrophic
9-16	Major
6-8	Moderate
2-5	Minor
<2	Negligible

To assist in determining and calculating the significance of the impact, impact assessment matrices were developed. Activities were listed on the y-axis and receptors on the x-axis.

A second matrix was compiled to calculate the overall significance of each of the identified potential impacts. In the 'significance' impact matrix, the significance of each impact on the receptor (i.e. Consequence x likelihood) was calculated. From this matrix, those impacts that fell into "minor" and above (i.e. >5) were identified. These impacts were subjected to further examination and analysis in terms of identifying activities for which additional restoration measures may be required.

A panel of experts have be engaged independently to carry out all quantitative rankings on a scale of 1-5. Independent scores thereafter statistically analysed and the results of the scores judged as follows:

- If variance, s^2<5% of the mean, subjectively is minimal and the score is good.
- If s^2>5% but <10% of the mean, then the score is fair.

5.5 Impact Evaluation

5.5.1 Identifying Environmental and Socio-economic Receptors

- Following the provision of detailed project activities and the characterization of environmental and socio-economic baseline of the project area in this report, the environmental and socio-economic receptors were identified and grouped as follows:

Physical	:	7 receptors
Biological	:	2 receptors
Socio-economic	:	6 receptors
Others (Health and Safety)	:	3 receptors

Table 5.6 presents a list of receptors identified for this assessment. A brief explanatory comment is also provided.

Table 5.6: Identified Project Environmental and Socio-Economic Receptors

Environmental Receptor	Comment	Impact Indicators
Physical		
Air quality	Air quality in and around the proposed project site	Increased concentration of gaseous and particulate pollutants (such as NOx, SOx, CO, VOC, PM10, PM2.5, CO2)
Noise and vibration	Ambient noise level in and around the proposed project site.	Increased ambient noise and vibration level, night and day-time disturbance, hearing loss, communication impairment etc
Soil	The soil of the area in which project activities are proposed to occur.	Changes in physical, chemical and biological

Environmental Receptor	Comment	Impact Indicators
		properties, loss of soil ecology and fertility, compaction, erosion etc.
Groundwater/Aquifers	The geomorphologic land forms and terrain of area in which project activities are proposed to occur	Ground water level, changes in physical, chemical and biological properties, contamination and availability of portable water.
Surface water	Plant specie that occur in the area in which project activities are proposed to occur	Changes in surface water quality indices such as hydrocarbons, total suspended solid, turbidity, metals and hydrobiology. Destruction of aquatic habitats.
Hydrological systems	The terrestrial physical system of streams in area in which project activities are proposed to occur	Alteration in hydrology, sedimentation, erosion
Landscape/Topography	The geomorphologic land forms and terrain of area in which project activities are proposed to occur	Alteration in drainage pattern, changes in landscape
Biological		
Terrestrial Flora	Plant specie that occur in the area in which project activities are proposed to occur	Loss of terrestrial flora (economic plants, rare or endangered species), introduction of new species.
Terrestrial Fauna	Terrestrial fauna such as reptiles, birds etc that rely on the project area as a habitat and/or food source.	Loss of terrestrial fauna; involuntary migration.
Socio-economic		
Land use	Existing use of the land area in which project activities are proposed to occur.	Loss of land value
Population	The people living in area in which project activities are proposed to occur.	Changes in total population, gender ratio, sex ratio, age distribution etc
Utilities	The utilities (e.g. power supply, water, sewage services etc) of area in which project activities are proposed to occur.	Changes in existing utilities, damage to public utilities e.g. pipes, cables.
Infrastructure	The buildings and general infrastructure (e.g. schools, hospitals, road, waste handling facilities etc) of area in which project activities are proposed to occur.	Access to education facilities, access to health facilities, access to communication facilities, access to road, access to waste management facilities, access to emergency services
Employment	The employment situation in the project area and area beyond.	Opportunities for local and national employment; changes in income level.
Community relations	The cordial relationship between the project proponent and the communities around the project area	Hostility toward the proponent facilities and its workforce resulting to down-time and subsequent loss in productivity.
Other (Health and safety)		
Construction workers	The health and safety of workers involved in the construction phase of the proposed project activities	Accidents, injury, fatality from height, exposure to nuisance (dust, noise), fire, explosion, exposure to dangerous chemicals.

Environmental Receptor	Comment	Impact Indicators
Workplace health and safety	The health and safety of employees involved with the operational phase of the proposed project activities	Accidents, injury, exposure to nuisance (dust, noise), fire, explosion, exposure to radiation, ergonomics.
General public	The health and safety of general public including people residing or working within the proximity of the proposed project site.	Level of disease vectors, exposure to disease, exposure to radiation, accident, fire, explosion, injuries from falling of tower/mast.

Identified project activities and environmental and socio-economic receptors were integrated into a matrix with the activities on the y-axis and environmental receptors on the x axis, and the matrix was completed for each of the project elements. The matrix was subsequently assessed to identify every possible case of activity-receptor interaction. Where it was considered that an activity-receptor interaction was possible, the cell was marked denoting an identified environmental aspect.

The completed environmental and socio-economic aspect matrix is presented in Table 5.7.

Table 5.7: Environmental and Socio-economic Aspects

Summary of Project Activities at Phases	Receptors																	
	Physical							Biological		Socio-economic						Others (Health & Safety		
	Air Quality	Noise and vibration	Soil	Ground Water	Surface water & Aquifer	Hydrological System	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land use	Population	Utilities	Infrastructure	Employment/ Income	Community relation	Construction workers	Workplace health & safety	General Public
Pre-construction																		
Design														●				
Site acquisition										●				●				
Mobilization of men, materials and equipment	●	●	●				●				●		●	●	●		●	●
Site preparation	●	●	●	●	●	●	●	●	●	●				●		●		●
Construction																		
Mobilization and demobilization: Transportation of materials and workers	●	●	●			●	●				●		●	●			●	
Construction of runway, terminal and other airport facilities	●	●	●	●	●	●	●	●	●	●				●		●	●	
Vehicular movement	●	●							●			●		●				●
Wastes generation and handling			●	●	●						●			●				●
Operation																		
Emissions from vehicle and stationary equipment	●							●	●									
Airport Operations: Approach landing & take-off	●	●	●											●	●		●	
Vehicular/traffic movement	●	●	●						●		●	●		●				●
Wastes generation and handling			●	●	●				●		●			●		●	●	
Aircraft maintenance service			●	●	●									●			●	
Decommissioning																		
Dismantling of terminal buildings/removal of equipments/demobilization of project personnel	●	●	●				●			●	●	●	●	●			●	
Rehabilitation of disturbed land			●				●			●								

Following the completion of the environmental aspect identification process, a process of impact assessment was completed. This involves the computation of the potential impact of the project activities on the recipient environment using a modification of the Leopold interaction matrix based on consequence and likelihood as defined in Table 5.8, and 5.9. Every identified aspect was assessed and ranked in terms of its consequence and likelihood thus enabling the determination of the overall significance of the aspects. In evaluating the environmental and socio-economic aspects, emphasis is placed on specific cause and effect relationships.

The value assigned to each cell in the matrix is in the form "x(y)": where "x" denotes the consequence and "y" the likelihood of the impact. A final impact significance matrix was completed containing products of the consequence and likelihood values. It is important to note that in compiling the tables, no additional mitigation measures have been considered other than those incorporated in the original project design.

Table 5.8: Leopold's Activity-Receptor Interaction Matrix

Summary of Project Activities at Phases	Receptors																	
	Physical							Biological		Socio-economic						Others (Health & Safety		
	Air Quality	Ambient Noise	Soil	Ground Water	Surface water & Aquifer	Hydrological System	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land use	Population	Utilities	Infrastructure	Employment/ Income	Community relation	Construction workers	Workplace health & safety	General Public
Pre-construction																		
Design														+				
Site acquisition										2(2)				++				
Mobilization of men, materials and equipment	2(3)	2(3)	2(2)				2(2)				2(2)	3(2)	2(2)	++	3(2)		2(3)	3(2)
Site preparation	2(3)	2(3)	2(3)	2(2)	2(2)	2(3)	2(2)	2(4)	2(3)	2(2)				++		2(2)	2(3)	
Construction																		
Mobilization and demobilization: Transportation of materials and workers	2(3)	2(3)	1(2)			1(2)	2(2)				2(2)		2(2)	++			2(3)	
Construction of runway, terminal and other airport facilities	2(3)	2(3)	2(3)	2(2)	2(2)	1(3)	2(2)	2(4)	2(3)	2(2)				+++		2(3)	2(3)	
Vehicular movement	2(3)	2(3)							1(1)			2(2)		+				2(2)
Wastes generation and handling			2(2)	2(2)	2(2)						2(2)			+				2(3)
Operation																		
Emissions from vehicle and stationary equipment	3(3)							2(2)	2(2)									
Airport Operations: Approach landing & take-off	2(3)	3(4)	2(3)											+++	3(2)		2(4)	
Vehicular/traffic movement	2(3)	4(2)	2(2)						2(2)		2(2)	2(2)		++				2(2)
Wastes generation and handling			2(2)	2(2)	2(2)				2(2)		2(2)			++		2(2)	2(3)	
Aircraft maintenance service			2(2)	2(3)	2(3)									++			2(2)	
Decommissioning																		
Dismantling of terminal buildings/removal of equipments/demobilization of project personnel	2(2)	2(3)	2(2)				2(2)			2(2)	2(3)	2(3)	3(3)	4(4)			3(3)	
Rehabilitation of disturbed land			2(2)				3(2)			2(2)								

***x(y) = impact magnitude (sensitivity of receptor)**

Table 5.9: Unmitigated Potential Environmental and Socio-Economic Impacts Significance

Summary of Project Activities at Phases	Receptors																	
	Physical							Biological		Socio-economic						Others (Health & Safety		
	Air Quality	Ambient Noise	Soil	Ground Water	Surface water & Aquifer	Hydrological System	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land use	Population	Utilities	Infrastructure	Employment/ Income	Community relation	Construction workers	Workplace health & safety	General Public
Pre-construction																		
Design														+				
Site acquisition										4				++				
Mobilization of men, materials and equipment	6	6	4				4				4	6	4	++	6		6	6
Site preparation	6	6	6	4	4	6	4	8	6	4				++		4	6	
Construction																		
Mobilization and demobilization: Transportation of materials and workers	6	6	2			2	4				4		4	++			6	
Construction of runway, terminal and other airport facilities	6	6	6	4	4	3	4	8	6	4				+++		6	6	
Vehicular movement	6	6							1			4		+				4
Wastes generation and handling			4	4	4						4			+				6
Operation																		
Emissions from vehicle and stationary equipment	9							4	4									
Airport Operations: Approach landing & take-off	6	12	6											+++	6		8	
Vehicular/traffic movement	6	8	4						4		4	4		++				4
Wastes generation and handling			4	4	4				4		4			++		4	6	
Aircraft maintenance service			4	6	6									++			4	
Decommissioning																		
Dismantling of terminal buildings/removal of equipments/demobilisation of project personnel	4	6	4				4			4	6	6	9	16			9	
Rehabilitation of disturbed land			4				6			4								

Colour legend: **Catastrophic** **Major** **Moderate** **Minor** **Negligible**

5.6 Project associated Environmental and Social Impact

5.6.1 Environmental and Social Impacts during Pre-Construction Phase

The potential adverse/beneficial environmental and social impacts of this proposed project during pre-construction stage are aptly captured in Table 5.10. In Table 5.10, the major preconstruction activities vis-à-vis impact receptors are highlighted.

Table 5.10: Identification of activities & impact receptors (pre-construction phase)

S/No.	Pre-construction Activities	Receptors
	Design	Socio-economics
	Site acquisition	Land
		Socio-economics
	Mobilisation of men, materials and equipments to site	Air
		Water
		Public Utilities
		Health & Safety
	Site preparation	Air
		Water
		Land
		Ecology
		Health & Safety

Table 5.11: Identified environmental and social impacts with impact significance during pre-construction phase

Receptors	Identified impacts	Impact Significance
Biophysical Impacts		
Air	Fugitive dust emissions due to vehicular movement	Moderate (-ve)
	Gaseous emissions from construction equipment and machinery	Moderate (-ve)
Water	Run-off from storage areas of construction materials	Minor (-ve)
Land	Loss of top soil	Minor (-ve)
Ecology	Loss of vegetation/habitat	Moderate (-ve)
Socio-economic impacts		
Land and natural resources	Impact due to rehabilitation	Minor (-ve)
Public utilities	Increased flow of traffic	Minor (-ve)
Economic impacts	Generation of direct, indirect and induced employment and income	Moderate (+ve)
Health and Safety	-	Negligible

5.6.2 Environmental and Social Impacts during Construction Phase

The environmental and social impact during construction phase is mostly localized and of short term magnitude. Impact is primarily related to the civil works and some intensive impact due to erection of the equipment. The details of the activities and probable impact are brought out in the tables below:

Table 5.12: Identification of activities & impact receptors (construction phase)

S/No.	Construction Activities	Receptors
1.	Mobilisation and demobilization: Transportation of materials and workers	Socio-economics
		Health, safety, and welfare of construction workers
		Population & demographic movement
		Economic impact
2.	Construction of runway, terminal and other airport facilities	Visual and air quality
		Soil/land capability & landuse
		Water resources
		Ecology & biodiversity
		Terrestrial fauna
		Noise & vibration
		Health & Safety
	Vehicular movement	Air quality
		Noise
		Traffic
		Health and Safety
3.	Waste generation and handling	Air
		Soil
		Traffic
		Health & Safety

Table 5.13: Identified environmental and social impacts with impact significance during construction

Receptors	Identified impacts	Impact Significance
Visual	Loss of sense of place affecting local communities due to site clearing and construction activities	Moderate (-ve)
Soils, land capability & land use	Placement of permanent project infrastructure, resulting in a permanent loss of soil resource, and change in soil characteristics, land capability and land use	Moderate (-ve)
	Spillage of chemicals and seepage from waste resulting in permanent loss of soil resource, and change in soil characteristics, land capability and land use	Moderate (-ve)
	Site clearance resulting in a permanent loss of soil resource, and potential change in soil characteristics, land capability and land use as a result of increased erosion	Moderate (-ve)
Air quality	Increase in Particulate Matter (PM) emissions resulting from land clearing, earthworks, and vehicular	Minor (-ve)
	Increase in gas (SO_2, NOx, CO and VOCs) emissions resulting from vehicle exhaust emission and biomass burning	Minor (-ve)
Water resources	Chemical contamination of surface water resulting from accidental spills during transportation and handling, and seepage from waste	Minor (-ve)
	Sedimentation of surface water resulting from erosion and runoff from exposed surfaces and roads	Moderate (-ve)
	Contamination of groundwater resulting from seepage from sewage and other waste	Moderate (-ve)
Noise	Continuous noise impact on project communities resulting from construction works	Moderated (-ve)
Ecology & biodiversity	Loss of forest and savanna habitat due to site clearing and earthmoving activities	Moderate (-ve)
	Loss of aquatic habitat due to site clearing and earthmoving activities	Moderate (-ve)
	Loss or disturbance of species of special concern due to site clearing and construction activities	Moderate (-ve)
	Loss or degradation of ecological processes due to site clearing and construction activities	Moderate (-ve)
	Fragmentation of habitats and ecological processes due to positioning of project infrastructure	Moderate (-ve)
	Modification or degradation of aquatic habitats due to altered hydrological regimes and surface or groundwater quality	Moderate (-ve)
	Impeded photosynthesis and transpiration rate of plants due to dust generation	Minor (-ve)
Traffic	Impact of construction related traffic on utilisation capacity project host communites road	Moderate (-ve)
	Safety impacts on local communities and other road users due to increased road accident rates during construction	Moderate (-ve)
Population & demographic movement	Influx of potential job seekers into the area and associated risks	Moderate (-ve)

Receptors	Identified impacts	Impact Significance
Health & Safety	Increased chances of the spread of communicable diseases such as HIV/AIDS and STDs linked to influx of predominantly male job-seekers and workers	Moderate (-ve)
	Increased pressure on healthcare infrastructure due to project related influx	Moderate (-ve)
	Increased risk of accidents and injuries to communities from improved roads and additional traffic	Minor (-ve)
Economic Impacts	Local and regional benefits resulting from increased revenue to Government	Minor (+ve)
	Stimulation of increased regional investment in the Nigerian economy	Moderate (+ve)
	Generation of direct, indirect and induced employment and income	Major (+ve)
Ecosystem Services	Reduced availability of natural resources and ecosystem services to local communities	Moderate (-ve)

5.6.3 Environmental and Social Impact during Operation Phase

Various activities of the operation phase and their probable impacts on various environmental and social aspects are presented in the tables below.

Table 5.14: Identification of Activities and Probable Impacts (Operation Phase)

S/No.	Operation Activities	Receptors
1.	Emission from vehicle and stationery equipments	Air
		Ecology & biodiversity
2.	Airport operation: Approach landing and take-off	Air quality/Greenhouse gases
		Ecology & biodiversity
		Soil & landuse
		Community relation
		Health & safety
		Economic impacts/employment
3.	Vehicular /traffic movement	Air quality
		Noise
		Public utilities
		Traffic
		Water
		Health & Safety
4.	Waste generation and handling	Air
		Soil
		Traffic
		Health & Safety
5.	Aircarft maintenance service	Soil
		Water
		Health and Safety

Table 5.15: Identified environmental and social impacts with impact significance during operation

Receptors	Identified impacts	Impact Significance
Biophysical Impacts		
Air quality	Increase in gaseous emissions (SO_2, NO_x and CO etc.) from airplanes, vehicles and some other airport equipments	Major (-ve)
	Aircraft engines emit heat, particulates, lead Pb, black carbon, gases (such as Carbon dioxide CO_2, Dust, Cardon monoxide CO, Methane CH_4, Water vapour, Nitrous oxide N_2O and Ozone O_3) as well as condensation trails which contribute to climate change	Major (-ve)
Noise	Continuous noise resulting from taking off and landing operations of aircraft	Moderate (-ve)
Ecology and biodiversity	Introduction of alien invasive flora and fauna	Moderate (-ve)
	Dust particulates from aircraft operations settling on surrounding flora and impeding photosynthesis as well as transpiration rate of plants	Moderate (-ve)
Soil, land capability and landuse	Fuel and chemical spills during fueling and maintenance operations resulting in degradation of soil quality, and change in soil characteristics as well as land capability	Moderate (-ve)
Water resources	Contaminated stormwater runoff from roads, runway and other surfaces affecting surface and groundwater quality	Major (-ve)
	Seepage from waste affecting surface and groundwater quality	Moderate (-ve)
	Wastewater effluent discharge to streams, affecting water quality for downstream users	Major (-ve)
Visual	Enhancement of architectural aesthetics	Moderate (+ve)
Traffic	Impact on utilisation capacity on the project affected and neighboring community roads	Moderate (-ve)
	Increased road accident rates and road safety of other road users	Major (-ve)
Socio-economic impacts		
Economic impacts	Source of employment for especially for indigenes of the project host area	Major (+ve)
	National economic growth and reduction in the migration rate from rural to urban areas.	Major (+ve)
	Serve as a basis for technological advancement	Major (+ve)
Ecosystem services	Reduced availability of natural resources and ecosystem services to local communities due to use by the project and impacts on these resources	Minor (-ve)
Population & demographic movement	Influx of potential job seekers into the area and associated risks	Major (-ve)

Receptors	Identified impacts	Impact Significance
Health and safety	Increased chances of the spread of communicable diseases such as HIV/AIDS and STDs linked to influx of predominantly male job-seekers and workers	Major (-ve)
	Increased pressure on healthcare infrastructure due to project related influx	Moderate (-ve)
	Increased risk of accidents and injuries to communities from improved roads and additional traffic	Major (-ve)
	The visible presence of Nigerian police/army within the project area for the security of the project	Moderate (+ve)

5.6.4 Environmental and Social Impacts during Decommissioning Phase

Once the facility reaches the end of its lifespan, the production equipment may be refurbished, replaced or upgraded to a newer technology to continue operation or the facility could be closed and decommissioned. If decommissioned, all components and equipment would be removed and the site rehabilitated, returning to its current land use or better. The decommissioning and restoration of the site will involve many activities that may have some environmental and social impacts as highlighted in the tables below.

Table 5.16: Identification of activities and probable impacts during decommissioning

S/No.	Decommissioning Activity	Receptors
1.	Dismantling of terminal building/Removal of equipments	Water resources
		Air quality
		Visual
		Social and economic
		Health & Safety
2.	Rehabilitation of disturbed land	Ecology & biodiversity
		Soils, land capability & landuse
		Health & Safety

Table 5.17: Identified environmental and social impacts with impact significance during decommissioning

Receptors	Identified impacts	Impact Significance
Ecology and biodiversity	Re-establishment of habitats or creation of new habitats via rehabilitation	Moderate (+ve)
	Introduction of alien invasive flora and fauna	Moderate (-ve)
	Loss or disturbance of fauna species of special concern due to collisions and noise disturbance	Moderate (-ve)
	Increased hunting/poaching of wildlife and loss of habitats for crop production	Moderate (-ve)
Social and economic	Loss of jobs	Major (-ve)
Water resources	Chemical contamination of surface water resulting from accidental spills during transportation and handling, and seepage from waste	Minor (-ve)
	Sedimentation of surface water resulting from erosion and runoff from exposed surfaces and roads	Minor (-ve)
	Contamination of groundwater resulting from seepage from hazardous materials and waste	Minor (-ve)
Soils, land capacity & landuse	Remediation of contaminated soils and demolition of project infrastructure, resulting in re-establishment of baseline soil characteristics and land capability	Moderate (-ve)
Air quality	Increase in Particulate matter emissions resulting from land clearing, earthworks, and vehicular movement	Minor (-ve)
Visual	Dust generation and site disturbance due to earth moving and removal of project infrastructure, affecting the visual character for communities	Moderate (-ve)
Health & Safety	Reduced chances of the spread of communicable diseases such as HIV/AIDS and STDs due to decommissioning	Minor (+ve)
	Reduced pressure on healthcare infrastructure due to decommissioning	Minor (+ve)
	Increased risk of accidents and injuries to workers due dismantling of equipment	Minor (-ve)

5.7 Cumulative Impacts Arising from the Proposed Project

Cumulative impacts are those impacts resulting from the combined effects of past, present or reasonably foreseeable actions owing to the project aspects and activities outside the project (GSI, 2003). The concept of cumulative effects is an important one. It holds that, while impacts may be small individually, the overall impact of all environmental changes affecting the receptors taken together can be significant. When a resource is nearing its tolerance threshold, a small change can push it over.

The cumulative impacts associated with the proposed airport project are as highlighted in Table 5.18.

Table 5.18: Cumulative impact of the proposed cargo and passenger airport

Receptors	Identified impacts	Impact Significance
Air quality	The air is one of the major environmental impact receptor in aviation operations. Therefore, by standards, the cumulative impact of the proposed project on the environment is expected to look thus: o CO – 0.0-0.01% increase o SO_2 – 0.03-0.97% increase o NOx – 0.03-0.47% increase o Particulate Matter – 0.04-2.84% increase	Moderate (-ve)
Noise	The average maximum noise level currently as measured is 48.4 dB for dry season and 46.4 dB for wet season. The major sources of noise as observed from the field are from vehicular movement and little pockets of lumbering activites around the site. However, according to international aviation authorities, aircrafts taking off and landing operations (which are usually the noisiest) generate noise levels of between 80dB to 140 dB. Thus, the coming of this proposed cargo and passenger airport project will result in an increase of the average noise level of the area by between 68.8% and 195.3%.	Major (-ve)
Water Resources	The cumulative adverse impact of the proposed project on surface water will be largely from surface water run-off which may be contaminated in certain instances. However, the resulting stormwater from the airport shall be well managed by the drainages which will be put in place and chanelled into a sump.	Moderate (-ve)
Traffic	The current traffic volume along the major road through the project area (Obudu-Abouchichi road), from the field traffic count conducted show that there is an average peak traffic of 98 cars per hour, 30 buses per hour, 15 trucks per hour, and 257 motocycles per hour. During the operation of this proposed project, the traffic volume will increase by an average of between 20% and 40%.	Major (-ve)
Population & demographic movement	The current population estimate of the project host communities is: Atiekpe – 11,000, Igwo – 7,000, Okambi – 6,000 and Ikwomikwu – 1,500. The operation stage of this project will bring in approximately an additional 100 direct and over 250 indirect project staff (truck drivers, food vendors and other commercial merchants). This shall significantly increase the population of the project host communities.	Moderate (-ve)

5.8 Risk and Hazard Assessment

5.8.1 Overview

Risk assessment is the determination of quantitative or qualitative estimate of risk related to a concrete situation and a recognized threat (also called hazard). The assessment of the risks and hazards associated with the proposed project involves the following steps:

- Identification of hazards/risks
- Likelihood of occurrence
- Consequence/severity of the hazards

The risk assessment matrix is then developed as presented in the Table 5.19.

Table 5.19: Risk assessment matrix

0-5 = Low Risk		**Severity of the potential injury/damage**				
6-10 = Moderate Risk **11-15 = High Risk** **16-25 = Extremely High (Unacceptable Risk)**		Insignificant damage to Property, Equipment or Minor Injury 1	Non-Reportable Injury, Minor loss of Process or slight damage to Property 2	Reportable Injury moderate loss of Process or limited damage to Property 3	Major Injury, Single Fatality critical loss of Process/damage to Property 4	Multiple Fatalities Catastrophic Loss of Business 5
Likelihood of the Hazard Happening	Almost Certain 5	**5**	**10**	**15**	**20**	**25**
	Will probably occur 4	**4**	**8**	**12**	**16**	**20**
	Possible occur 3	**3**	**6**	**9**	**12**	**15**
	Remote possibility 2	**2**	**4**	**6**	**8**	**10**
	Extremely unlikely 1	**1**	**2**	**3**	**4**	**5**

5.8.2 Project Specific Risks and Hazards

The potential risks and hazards associated with the construction and operation of the proposed cargo and passenger airport are described below:

Fire and Explosion

One major risk associated with aviation operations is fire and explosion. Aviation fuel, petrol and diesel required to run aircrafts, vehicles and trucks respectively are highly inflammable. These petroleum products if wrongly handled or a mishap occurs around its storage area, could result in serious conflagration. Aircraft crashes are also another major occurrence in the aviation sector.

Any outbreak of uncontrolled fire in the airport can escalate to dangerous dimensions which could lead to multiple fatalities and catastrophic loss of lives and properties. The overall significance is extremely high. Careful handling is necessary to mitigate fire and explosion risks.

Security Threat and Attack

Security systems are essential for a suitable operation of an airport in order to avoid damage and possible loss of lives and properties from theft and vandalism. The airport may be subject to sabotage or attack. Although, the farmer – herders conflict, land tussle between the tivs from Vandekiya and Obudu indigenes as well as boko haram insurgency which is common in the northern part of Nigeria are factors that calls for concern. The likelihood of such attacks cannot be discountenanced. However, adequate security measures shall be put in place to avert any security threat. The severity of such attacks if it happens would result in major injury and critical loss of lives and properties. The risk significance is rated high risk.

Occupational Hazards

Workers may be exposed to occupational hazards when working at elevation during construction. The use of elevated platforms during installation pose a physical hazard to workers. Also, there could be electrical hazards to workers. Common electrical accidents result in shocks and/or burns, muscle contractions, and traumatic injuries associated with falls after a shock. The likelihood of the hazards occurring is considered to be possible while its severity may lead to reportable injury and limited damage to property. The overall significance is rated moderate.

CHAPTER SIX

MITIGATION MEASURES/ALTERNATIVES

6.1 Introduction

This chapter identifies and defines socially, environmentally and technically acceptable and cost effective mitigation measures and enhancement measures to the impacts presented in Chapter 5. Generally, the acceptability and/or suitability of a particular project is premised on several considerations, not the least of which is the reduction of adverse environmental and social impacts to tolerable levels. Impact significance reduction is usually achieved by introducing mitigation/amelioration measures to cater for the adverse impacts identified.

In this section of the report, we present a summary of those measures that are deemed adequate to achieve this objectives. Also, in this chapter no mitigation measures are provided for positive impacts as they are desirable.

6.2 Basis for Development of Mitigation Measures

Mitigation measures are options that can be used to either completely eliminate or minimize identified adverse impacts of a development project to levels that can be acceptable. The traditional approach to the design and operation of facilities such as that for which this ESIA has been prepared, is to ensure compliance with the applicable safety codes and standards during design. However, compliance with regulations, codes and standards may not be sufficient to achieve an appropriate level of Health Safety and Environmental (HSE) performance in design. Design codes are generic and applicable to facilities in a number of geographical areas that face a wide range of technical challenges unique to the project. The design of the proposed project will be based on the strictest of international codes and best-practices.

The HSE objective, with respect to the design and construction plan for the proposed Airport project is to implement all cost effective measures to reduce the risk and effects from major hazards, including accidents. The approach has been to use this as a goal rather than a prescriptive objective that cannot be achieved without following a documented process of identification, assessment, reduction and continuous monitoring.

Thus the steps to be taken in the HSE process for the project shall include the following:

- Design based on Codes, Standards and Regulations;
- Improved design based on Quantitative Risk Assessment and Environmental Impact Assessment; and
- Improved design from human factors evaluation.

6.3 Mitigation Measures for the Identified Project Risks and Hazards

The mitigation measures for the identified project risks and hazards are highlighted below:

Fire and Explosion

- Fuel storage facilities which comply with international and local standards for performance and safety shall be used.
- Only suitable electrical cables shall be used.
- Unauthorized and unlicensed pilot will not be allowed to fly any airplane.
- An internal firefighting department equipped with the requisite equipment shall be set up.
- The local fire department shall be informed of and familiarized with the project facility.
- Project equipment and facilities shall only be installed by qualified contractors.
- Facility shall be inspected regularly by qualified professionals.
- Periodic checks shall be regularly carried out to look out for damages from rodents and other pests, which could compromise electrical wiring or insulation.
- Emergency response plan shall be developed and implemented.
- Fire suppression system and equipment (such as fire extinguishers, fire notices, and warning signs) shall be installed at different locations within the airport.

Security Threat and Attack

- Securities like the Nigerian Police, Immigration personnel, Army and others will be available to control and regulate passengers/traffic level.
- Security cameras will be mounted all around the aiport to monitor activities within the airport.

Occupational Hazards

- Installation of fixtures on tower components to facilitate the use of fall protection systems.
- Provision of an adequate work-positioning device system for workers.
- Hoisting and lifting equipment shall be rated and maintained and operators trained in their use.
- Appropriate Personal Protective Equipment (PPEs) shall be worn.
- Electrical installation shall be carried out by trained personnel in line with the approved procedures.

6.4 Mitigation Measures

Table 6.1 below highlights the mitigation measures for the predicted potential and associated impacts for the different phases of the project lifespan.

Table 6.1: Proposed mitigation measures for the identified potential impacts associated with the airport project

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Pre-construction Phase				
Air	Fugitive dust emissions due to vehicular movement	Moderate (-ve)	• Application of dust suppressants (Water sprinkling) • Speed limits shall be set to minimize the generation of fugitive dust	Minor (-ve)
	Gaseous emissions from construction equipment and machinery	Moderate (-ve)	• Regular and effective maintenance will be carried out to keep vehicles in good working condition and limit the release of noxious gases	Minor (-ve)
Water	Run-off from storage areas of construction materials	Minor (-ve)	• Construction materials shall be properly stored in an enclosed warehouse and metallic containers	Negligible (-ve)
Land and natural resources	Loss of top soil	Minor (-ve)	• There shall be the undertaking of stripping and effective stockpiling management	Negligible (-ve)
Ecology	Loss of vegetation/habitat	Moderate (-ve)	• A programme for the control of alien invasive plants in the concession shall be developed and implemented • Access roads to the site for preliminary studies shall be made in a way that sensitive ecosystems are avoided • No fauna shall be hunted or destroyed by any project personnel	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Public utilities	Increased flow of traffic	Minor (-ve)	• Clear signage and traffic calming measures on the intersection between the facility's access road and the main expressway (Obudu-Abouchichi road) • Prohibit parking of trucks along the Obudu-Abouchichi road and enforce the use of truck parking lot to be constructed within the project facility	Negligible (-ve)
		Construction Phase		
Visual	Loss of sense of place affecting local communities due to site clearing and construction activities	Moderate (-ve)	• Vegetation shall be cleared in phases so that only those areas required for immediate development are cleared • There shall be the use of directional lighting in areas operating at night, if communities are affected by lighting	Minor (-ve)
Soils, land capability & land use	Placement of permanent project infrastructure, resulting in a permanent loss of soil resource, and change in soil characteristics, land capability and land use	Moderate (-ve)	• Community members shall be assisted where livelihood is impacted with establishing new agricultural areas on land of equal or better land capability	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Spillage of chemicals and seepage from waste resulting in permanent loss of soil resource, and change in soil characteristics, land capability and land use	Moderate (-ve)	• There shall be the provision of appropriate secondary containment (to hold 110% of the stored volume) in areas where hydrocarbons, solvents and other potentially hazardous materials are stored • There shall be the preparation of procedures to ensure that spillage during mobile equipment maintenance is minimized, and that only designated areas will be used for this purpose	Minor (-ve)
	Site clearance resulting in a permanent loss of soil resource, and potential change in soil characteristics, land capability and land use as a result of increased erosion	Moderate (-ve)	• Stripping, stockpiling and stockpile management shall be undertaken • Community members shall be assisted where livelihood is impacted with establishing new agricultural areas on land of equal or better land capability	Minor (-ve)
Air quality	Increase in Particulate Matter (PM) emissions resulting from land clearing, earthworks, and vehicular movementmovement	Minor (-ve)	• Speed limits shall be set to minimize the generation of fugitive dust. • Vehicles carrying dusty materials shall be covered to prevent materials being blown from off from the vehicles • There shall be the application of dust suppressants (water sprinkling) to sections of roads used routinely by vehicles that pass through and close to communities	Negligible (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Increase in gas (SO_2, NOx, CO and VOCs) emissions resulting from vehicle exhaust emission and biomass burning	Minor (-ve)	• Vehicle idling shall be limited and vehicles well maintained to minimize particulate and gaseous emissions • As much as possible, biomass burning shall be discouraged. • Discharge water from Spray Bars shall be adequately treated and channeled for safe disposal.	Negligible (-ve)
Water resources	Sedimentation of surface water resulting from erosion and runoff from exposed surfaces and roads	Moderate (-ve)	• There shall be the construction of access roads and infrastructure in a way that sensitive ecosystems are avoided • Proper designs shall be prepared and implemented to manage storm water runoff in a manner that minimizes sediment transport to the receiving water resource and minimizes erosion along runoff channels • There shall be the construction of concave surfaces to ensure run-off is directed • Effective storm water management shall be developed for all project components to address storm water run-off volumes, velocity, water quality to minimize impacts on natural areas, focusing on minimizing increased sedimentation	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Contamination of groundwater resulting from seepage from sewage and other waste	Moderate (-ve)	• There shall be an effective waste collection mechanism including proper waste sorting, storage and disposal at approved dumpsites • Properly constructed toilets with septic tanks shall be made available for construction staff to take care of sewage and minise seepage	Minor (-ve)
Noise	Continuous noise impact on project communities resulting from construction works	Moderated (-ve)	• There shall be the restriction of construction activities at the facility to daytime hours 07:00 am to 07:00 pm • Noise screening measures e.g sound insulation and damping shall be implemented	Minor (-ve)
Ecology & biodiversity	Loss of forest and savanna habitat due to site clearing and earthmoving activities	Moderate (-ve)	• A rehabilitation plan shall be developed and implemented (overseen by an appropriately qualified botanist/ ecologist), with different objectives and rehabilitation approaches established for each habitat/ecosystem	Minor (-ve)
	Loss of aquatic habitat due to site clearing and earthmoving activities	Moderate (-ve)	• Aquatic habitats and areas immediately adjacent to them that have been degraded during the construction phase shall be restored to their pre-construction condition	Minor (-ve)
	Loss or disturbance of species of special concern due to site clearing and construction activities	Moderate (-ve)	• Construction in or near to gallery forests, wetlands, streams and rivers shall be avoided to the greatest practical extent possible	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Loss or degradation of ecological processes due to site clearing and construction activities	Moderate (-ve)	• Site clearing shall be limited to the area acquired for the project. Ajacent land shall not be encroached upon	Minor (-ve)
	Fragmentation of habitats and ecological processes due to positioning of project infrastructure	Moderate (-ve)	• Site clearing shall be limited to the area acquired for the project. Ajacent land shall not be encroached upon	Minor (-ve)
	Modification or degradation of aquatic habitats due to altered hydrological regimes and surface or groundwater quality	Moderate (-ve)	• Aquatic habitats and areas immediately adjacent to them that have been degraded during the construction phase shall be restored to their pre-construction condition	Minor (-ve)
	Impeded photosynthesis and transpiration rate of plants due to dust generation	Minor (-ve)	• A programme for the control of alien invasive plants in the concession shall be developed and implemented as a component of the Biodiversity Action Plan	Negligible (-ve)
Traffic	Impact of construction related traffic on utilisation capacity project host communites road	Moderate (-ve)	• Prohibit trucks from parking along the Obudu – Abouchichi road • Clear signage and traffic calming measures on the intersection between the airport's access road and the main expressway. This will warn motorists of the intersection and would reduce potential traffic safety impacts at this intersection	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Safety impacts on local communities and other road users due to increased road accident rates during construction	Moderate (-ve)	• There shall be the provision of temporary on-site accommodation for construction personnel to limit the volumes of daily commuter traffic to the project site • There shall be the provision of dedicated buses for construction personnel not accommodated on the site to reduce daily commuter traffic to the project site • Rest area for drivers shall be implemented, and maximum driving hours per driver established and enforced	Minor (-ve)
Population & demographic movement	Influx of potential job seekers into the area and associated risks	Moderate (-ve)	• There shall be optimization of the use of local labour as far as practically possible • There shall be the development of a code of conduct with which contractors and their employees must comply. The code shall deal with the interaction with local communities and substance abuse among other things • There shall be the development and communication of a clear and concise employment and recruitment policy to prevent opportunistic job seekers from settling in the area	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Health & Safety	Increased chances of the spread of communicable diseases such as HIV/AIDS and STDs linked to influx of predominantly male job-seekers and workers	Moderate (-ve)	• There shall be the development of a comprehensive HIV/AIDS program to employees through employee wellness programmes which should include the following: - Awareness campaigns targeting project workers, senior management, contractors, sub-contractors and their spouses, communities near project facilities, risk groups (commercial sex workers, truck drivers) - Prevention, voluntary counselling for HIV testing, as well as anti-retroviral treatment for employees and surrounding communities	Minor (-ve)
	Increased pressure on healthcare infrastructure due to project related influx	Moderate (-ve)	• A clinic will be built to handle health care service delivery to project staff. • There shall be the development of an MOU with the Sacred Heart Hospital in Obudu, for service provision to the local workforce and their dependents • There shall be the development and implementation of community development/sustainability plans to support infrastructure development in the area	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Increased risk of accidents and injuries to communities from improved roads and additional traffic	Minor (-ve)	• Awareness campaigns shall be carried out in Obudu, Atiekpe, Ikwomikwu, Igwo, Okambi and other neighbouring communities, with a focus on school children, women and the elderly, about risks related to traffic • Enforcement of speed limits and sanctions **for** any personnel found in violation of speed limits, including senior staff and contractors' as well as sub-contractors' employees • There shall be appropriate signaling of moving heavy machinery, and escort vehicles where needed • All drivers shall be given safety education focusing on speed and conflicts between pedestrians and cyclists • Advanced warning signs including sirens shall be erected at locations of high pedestrian and cyclist activity	Negligible (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Ecosystem Services	Reduced availability of natural resources and ecosystem services to local communities	Moderate (-ve)	• Remaining Forest habitat that has been degraded shall be restored to their pre-construction condition • A Rehabilitation Plan shall be developed and implemented (overseen by an appropriately qualified botanist/ecologist), with different objectives and rehabilitation approaches established for each habitat/ecosystem	Minor (-ve)
Operation Phase				
Air quality	Increase in gaseous emissions (SO_2, NO_x and CO etc.) from airplanes, vehicles and some other airport equipments	Major (-ve)	• Gaseous emission reduction measures will be implemented. These include: - Reduction of aircraft taxi time - Derated take off - Reduced reverse thrust - Dispatch towing - Ground congestion reduction measures - Decentralised gates - Reduction of power output during taxi, takeoff and landing - Improving airlines overall operational efficiency	Moderate (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Aircraft engines emit heat, particulates, lead Pb, black carbon, gases (such as Carbon dioxide CO_2, Dust, Cardon monoxide CO, Methane CH_4, Water vapour, Nitrous oxide N_2O and Ozone O_3) as well as condensation trails which contribute to climate change	Major (-ve)	• Aviation air pollution reduction measures will be implemented. These include: - Reduction of aircraft taxi time - Derated take off - Reduced reverse thrust - Dispatch towing - Ground congestion reduction measures - Decentralised gates - Reduction of power output during taxi, takeoff and landing - Improving airlines overall operational efficiency	Moderate (-ve)
Noise	Continuous noise resulting from taking off and landing operations of aircraft	Major (-ve)	• Noise management procedures such as flight path alteration and noise sharing are effective mitigation measures that shall be implemented • Other noise improvement measures that shall be implemented include: - Automoted tug - Thrust reverse limitations - Low power/lowdrag operations - Departure and arrival management - Thrust managed climb profiles	Moderate (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Ecology and biodiversity	Introduction of alien invasive flora and fauna	Moderate (-ve)	• The ecological water requirements of the aquatic ecosystems shall be determined. Water abstraction from any of the rivers and from groundwater must not exceed levels that result in the ecological water requirements of the aquatic ecosystems being compromised. Abstraction from wetlands and swamps shall not be allowed • Sessile fauna present at construction sites will be relocated by appropriate experts prior to the commencement of site clearing	Minor (-ve)
	Dust particulates from aircraft operations settling on surrounding flora and impeding photosynthesis as well as transpiration rate of plants	Moderate (-ve)	• Reduction of dust particle generation from aircraft operations shall be minised by implementing the following measures: - Reduction of aircraft taxi time - Derated take off - Reduced reverse thrust - Improving airlines overall operational efficiency	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Soil, land capability and landuse	Fuel and chemical spills during fueling and maintenance operations resulting in degradation of soil quality, and change in soil characteristics as well as land capability	Moderate (-ve)	• Bunded wall shall be constructed around fuel dump in compliance with DPR standards • There shall be the preparation of procedures to ensure that spillage during aircrafts, vehicles and equipment maintenance is minimized, and that only designated areas are used for this purpose	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Water resources	Contaminated stormwater runoff from roads, runway and other surfaces affecting surface and groundwater quality	Major (-ve)	• Where contaminants are transported along construction roads, emergency contaminant and mitigation measures shall be developed to minimize impacts should accidental spillages occur along the transport routes • There shall be equipping of all trucks and equipment carrying fuels or oil with spill response materials and train personnel in the use of such materials • All potential sources of contamination shall be stored up in secure facilities with appropriate Storm Water management systems in place to ensure that contaminants are not released to the water resource through Storm Water runoff • There shall be the use of oil & silt traps to remove these types of contaminants from storm water, and designated areas used for equipment servicing • It will be ensured that proper designs are prepared and implemented to manage storm water runoff in a manner that minimizes sediment transport to the receiving water resource and minimizes erosion along runoff channels	Moderate (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Seepage from waste affecting surface and groundwater quality	Moderate (-ve)	• Wastes shall be well and properly managed to limit the incidence of seepage	Minor (-ve)
Traffic	Impact on utilisation capacity on the project affected and neighboring community roads	Moderate (-ve)	• Trucks parking along the Obudu-Abouchichi road will be prohibited for truck drivers. Truck drivers will all be compelled to utilize the truck car park • Clear signage and traffic calming measures shall be put in place on the intersection between the airport's access road and the main expressway. This will warn motorists of the intersection and would reduce potential traffic safety impacts at this intersection • Scheduling the delivery of cargo outside peak traffic times shall be implemented	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Increased road accident rates and road safety of other road users	Major (-ve)	• There shall be awareness campaigns in host & neighbouring communities, with a focus on school children and mothers, about risks related to traffic • There shall be enforcement of speed limits and sanctions for violation of speed limits • Appropriate signalling of moving vehicles and trucks where needed shall be implemented • All drivers shall be given safety education focusing on speed and conflicts between pedestrians & drivers • There shall be scheduling of the delivery of materials outside peak traffic times	Moderate (-ve)
Ecosystem services	Reduced availability of natural resources and ecosystem services to local communities due to use by the project and impacts on these resources	Minor (-ve)	• A Biodiversity Action Plan shall be developed to inform the protection and management of biodiversity in the entire project area	Negligible (-ve)
Population & demographic movement	Influx of potential job seekers into the area and associated risks	Major (-ve)	• Optimizing the use of local labour as far as practically possible • Developing and communicating a clear and concise employment and recruitment policy to prevent opportunistic job seekers from settling in the area shall be pursued	Moderate (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Health and safety	Increased chances of the spread of communicable diseases such as HIV/AIDS and STDs linked to influx of predominantly male job-seekers and workers	Major (-ve)	• There shall be the development of a comprehensive HIV/AIDS program to employees through employee wellness programmes which shall include the following: - Awareness campaigns targeting project workers, senior management, contractors, sub-contractors and their spouses, communities near project facilities, risk groups (commercial sex workers, truck drivers) - Prevention, voluntary counselling for HIV testing, as well as anti-retroviral treatment for employees and surrounding communities	Moderate (-ve)
	Increased pressure on healthcare infrastructure due to project related influx	Moderate (-ve)	• The airport shall be equipped with a clinic to provide healthcare service delivery to both staff and customers	Minor (-ve)
	Increased risk of accidents and injuries to communities from improved roads and additional traffic	Moderate (-ve)	• There shall be the enforcement of speed limits and sanctions for violation • There shall be appropriate signalling of moving vehicles where needed • All drivers shall be given safety education focusing on speed and conflicts between pedestrians and drivers	Minor (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Decommissioning Phase				
Ecology and Biodiversity	Introduction of alien invasive flora and fauna	Moderate (-ve)	• A Rehabilitation Plan shall be developed and implemented (overseen by an appropriately qualified botanist/ ecologist), with different objectives and rehabilitation approaches established for each habitat/ecosystem • A programme for the control of alien invasive plants in the concession shall be developed and implemented	Minor (-ve)
	Loss or disturbance of fauna species of special concern due to collisions and noise disturbance	Moderate (-ve)	• Areas immediately adjacent to important habitats (e.g. wetlands, swamps, Gallery and Swamp Forest) that have been degraded shall be restored to their natural, pre-construction condition	Minor (-ve)
	Increased hunting/poaching of wildlife and loss of habitats for crop production	Moderate (-ve)	• As a management policy for staff, hunting/ poaching shall be vehemently prohibited for project staff and sub-contractors. Defaulters shall be severely penalized	Minor (-ve)
Social and economic	Loss of jobs	Major (-ve)	• Project staff will given due notice before project closure • Project staff shall either be adequately compensated or transferred to other projects	Moderate (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Water resources	Chemical contamination of surface water resulting from accidental spills during transportation and handling, and seepage from waste	Minor (-ve)	• There shall be the equipping of all trucks and equipment carrying fuels or oil with spill response materials and train personnel in the use of such materials • Oil & silt traps shall be used to remove these types of contaminants from stormwater, and use designated areas for equipment servicing • Where contaminants are transported, emergency contaminant and mitigation measures shall be developed to minimize impacts should accidental spillages occur along the transport routes • All potential sources of contamination shall be stored in secure facilities with appropriate Storm Water management systems in place to ensure that contaminants are not released to the water resource through Storm Water runoff	Negligible (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
	Sedimentation of surface water resulting from erosion and runoff from exposed surfaces and roads	Minor (-ve)	• All cleared spaces and land after decommissioning shall be massively revegetated to prevent the direct exposure of the surface to rain and run off	Negligible (-ve)
	Contamination of groundwater resulting from seepage from hazardous materials and waste	Minor (-ve)	• All harzardous materials shall be removed in line with international best practices	Negligible (-ve)
Soils, land capacity & landuse	Remediation of contaminated soils and demolition of project infrastructure, resulting in re-establishment of baseline soil characteristics and land capability	Moderate (-ve)	• Phytoremediation and bioremediation shall be carried out on contaminated soils	Minor (-ve)
Air quality	Increase in Particulate matter emissions resulting from land clearing, earthworks, and vehicular movement	Minor (-ve)	• Dust suppressants (Water sprinkling) shall be applied to sections of roads used routinely by vehicles that pass through and around neighboring communities • Vehicles carrying dusty materials will be covered to prevent materials being blown from the vehicles • Speed limits shall be set to minimize the creation of fugitive dust within the project boundary	Negligible (-ve)

Receptors	Identified impacts	Impact Significance	Mitigation Measures	Residual Impact
Visual	Dust generation and site disturbance due to earth moving and removal of project infrastructure, affecting the visual character for communities	Moderate (-ve)	• There shall be the revegetation and landscaping of disturbed areas as soon as possible, to reflect the surrounding topography and vegetation	Minor (-ve)
Health and Safety	Increased risk of accidents and injuries to workers due dismantling of equipment	Minor (-ve)	• Professionals shall be engaged to carryout equipment dismantling • Standard health and safety guidelines will also be strictly observed in carrying out the exercise	Negligible (-ve)

CHAPTER SEVEN
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) AND PERFORMANCE ASSESSMENT

7.1 Introduction

Environmental and Social Management Plan (ESMP) for environmental protection/remediation is an important component which must necessarily be integrated into the ESIA process as it provides the means for continuous self-assessment of the predictive accuracy of the impact and the management effectiveness of project implementation and operation. The objectives of this Environmental and Social Management Plan (ESMP) are to:

- Ensure compliance with relevant legislations Cross River State Government policy.
- Integrate environment fully into business.
- Rationalize and streamline environmental activities to add value to efficiency and effectiveness.
- Achieve, enhance and demonstrate sound environmental performance built around the principle of continuous improvement.
- Encourage and achieve the highest performance and response from individual employees and company.
- Provide standards for overall planning, operation, audit and review.

7.2 EMP during Planning and Design/Pre-construction Phase

The environmental issues during pre-construction stage generally involve land acquisition, facility layout design, requisite quantity for construction raw materials, and avoiding encroachment into sensitive ecological areas. The summary of the EMP is given below:

Table 7.1: Summary of environmental and social management plan during pre-construction phase

Mitigation Measure	Purpose	Failure consequence	Responsible Organization
Selection of lands adhering to local laws and regulations. Construction facilities shall be placed at least 1 km away from water bodies, natural flow paths, important ecological	To combat adverse impact to the existing environment.	Environmental Degradation	Cross River State Government

Mitigation Measure	Purpose	Failure consequence	Responsible Organization
habitats and residential areas.			
Maintain adequate clearance, construction of retaining structures, minimise cut and fill operations adjoining to the dwellings.	To avoid disturbance to the adjacent lands and the people due to cut and fill operations.	Impacts on nearby dwellings	Cross River State Government
Consideration of site location to avoid water bodies or agricultural land as much as possible. Careful site selection to avoid existing settlements/archeological/ traditional heritage sites (Shrines etc).	To ascertain site location, (distance to dwelling, water and/or agricultural land, archeological/ traditional heritage sites) to minimize adverse impacts on environmental attributes.	Environmental degradation	Cross River State Government
Avoid encroachment by careful site and alignment selection and reconnaissance before final sitting of activities. Utilizing existing power transmission line for power evacuation.	To monitor the impacts on ecological environment	Floral and faunal habitats loss	Cross River State Government

7.3 EMP during Construction Phase

The problems envisaged during construction phase can mainly be due to accident and noise. To overcome these problems, the EPC contractors in charge of construction and erection activities have to maintain noise levels within threshold limit values and the workers shall also be made to be provided with personal protective equipment (PPE).

7.3.1 Air Environment

At the project construction phase, there will be increase of dust concentrations due to fugitive dust emission from vehicular movement and other such associated work activities. Frequent water sprinkling in the vicinity of the site shall be undertaken to mitigate dust emission. It shall also be ensured that both gasoline and diesel powered vehicles are properly maintained to comply with exhaust emission standard limits.

7.3.2 Noise Level

There will be marginal increase in noise levels during construction phase from vehicular use, operation of equipment such as concrete mixers, borehole drilling rig, generators etc. This however will be temporary and shall be approached with the aim of suppressing impacts especially on humans working within the site area by adequately providing Personnel Protective Equipment (PPEs) such as ear mufflers. Also regular servicing of generators and vehicles shall be imbibed to reduce noise from these.

7.3.3 Water Quality

During construction, water shall be sourced from both ground water (construction of boreholes) and water bodies in the community(ies). However, drilling shall be done to fulfill standard industrial best practices and water from streams/rivers shall be collected with the aid of a water pump via water tankers or pipes in a way that will least pollute the water body or even endanger the aquatic ecosystem contained therein.

7.3.4 Land

Generally, the cutting of herbaceous vegetation, during construction phase results in the loosening of the topsoil. However, after the construction work, there shall be massive re-vegetation by way of vigorously planting greeneries to check soil erosion and enhance aesthetics.

7.3.5 Socio-economics Environment

Construction work will be made to benefit the local population in a number of ways. The airport project management will give preference to local eligible people through both direct and indirect employment in the area of working as labourers, drivers, security personnel, machine operators etc. All these will be in an attempt to provide ample opportunities for the indigenes to enjoy improved living standards and also to demonstrate the State Govrnment's readiness to make them a part of the project and not just to fulfill its corporate social responsibility.

Table 7.2: Environmental Impact and Mitigation Measures during construction and erection

S/No.	Possible Impact	Mitigation During Operation
1.	Air impact	• Dust suppression such as use of water sprinklers. • Construction machinery shall be properly maintained to minimize exhaust emissions of CO, SPM and Hydrocarbons. • Construction activity shall be restricted to daytime as far as possible to avoid disturbance to surrounding areas.
2.	Noise	• All noise generating equipments used during the construction shall be provided with noise control devices and properly maintained. • Wherever required, personal protective equipment such as ear plugs, earmuffs etc. shall be provided for workers in high noise areas.
3.	Hazardous materials	• Hazardous materials stored at the construction site like acetylene cylinders, petroleum, spirit, diesel, lubricating oil, paints etc. shall be stored as per the statutory provisions of manufacturers, National Environmental protection (Management of Hazardous and Solid Wastes Regulation) Regulations of 1991.
4.	Safety of workers	• Security arrangements to prevent entry of unauthorized personnel and proper control of hazardous materials on site. • Training on safety for all the employees as well as contractor's labour. • All the personnel shall be provided with safety appliances such as face shields, helmets, safety goggles, safety shoes, hand gloves etc., as per the job requirement. • To ensure that the local inhabitants are not exposed to these hazards, the site shall be secured by fencing and manned at entry points.

7.4 EMP during Operation Phase

During the operation phase of the proposed project, pollution impacts are projected to be major. The major pollution sources envisaged include vehicles moving in or going out of the airport, gaseous emission and noise from flight operations of the aircrafts. However, in order to limit within predicted impact levels and to further mitigate the impacts wherever possible on individual environment components, the following mitigation measures are recommended in Table 7.3.

7.4.1 Air Environment

The major pollution sources envisaged at the operation phase of the airport include (but are not limited to) the following:

- Combustion of aviation fuel – aviation fuel is composed mostly of kerosene which produces nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2), sulphur oxides (SOx), hydrocarbons and particulates when it burns.
- When airplanes are on descent or approach, their engines tend to work inefficiently because they only make use of 30% of the available power which leads to a certain amount of unburnt kerosene being released. These unburnt fuel droplets are a source of volatile organic compounds (VOCs) which in turn gives rise to odours.
- During take offs and especially landing, aircraft tyres get worn and burnt which leads to a release of particulate matter (PM).
- Vehicles travelling to and from the airport, and ground service equipment generate NOx, CO_2, particulates and indirectly ozone through the burning of petrol and diesel fuel.
- During aircraft and airfield maintenance (painting, metal cleaning, de-icing etc.), and emergency and fire training use complex chemicals which can release VOCs.

7.4.2 Noise Level

Noise is one of the major pollution issue with airports expecially during operation. The taxing, taking off and landing of aircrafts are usually accompanied by very high noise level which often time affect neighboring dwellings, especially if they are located really close to the airport. To minise noise pollution on neighbouring communities, a safe distance (in line with international standard recommendation) shall be maintained between the proposed Obudu Cargo and Passenger Airport and the neighbouring communities. Furthermore, technical staff (especially those working around the run way area, maintenance hub and the cargo warehouse shall be compelled to use the appropriate PPEs (such as ear mufflers etc). Air line operators shall also has a safety and standard operating procedure, will be required to constantly maintain their aircrafts and other operational vehicles by qualified and experienced engineers/technicians. By these measures, it is anticipated that noise level will be highly checked.

7.4.3 Socio-economics Environment

Cross River State Government, at project operation phase shall take measures to put in place various amenities and socio economic benefits in a bid to improve the general living standards of the indigenes of the host community(ies). Some of these include;

- Provision of employment to indigenes as both casual and permanent staffs.
- Provision of basic infrastructures where necessary, etc.

7.4.4 Water Management

Water shall be sourced from borehole at the project site. Ground water shall be adequately and continuously monitored to prevention pollution and minimize wastewater generation. Periodic water audits shall be conducted to engender water use management and also check water quality.

Based on the rainfall intensity of project site area, storm water drainage system will be designed to consist of well-designed network of surface drains and rainwater harvesting pits along the drains and channelled to the receiving body.

7.4.5 Waste Management

The following include plans that shall be put in place for the effective management of all classes of wastes generated during the operation phase of the project.

- Spent oil shall be collected in collection trays, stored in leak-proof steel drums and resold to authorized buyers.
- Oil drums would be collected and stored properly for re-cycling.
- Dust bins with lids shall be strategically placed at requisite locations with appropriate signage urging people to use them.
- Metal scrap wastes shall be collected and stored either to be reused/re-cycled.
- Paper waste will be collected in waste bins and frequently evacuated by company trucks to approved dumpsites.
- Used plastics bottles shall be collected in waste bins and disposed at approved dumpsites.
- Used cartons, empty cans and bags shall be collected and disposed at aqpproved dumpsites.

Table 7.3: Environmental Impact and Mitigation Measures during operation phase

S/No.	Possible Impact	Mitigation during Operation
1.	Air impact	• Reduction in the total number of vehicles that commute to and from the airport. • A system of penalties for polluting vehicles. • Introduction of charges to promote the use of lower emission aircraft.

		• Minimizing dust emissions by wheel washing, damping down and employing the use of covered vehicles for transportation. • Conducting a code of construction practice relating to air emission. • Carrying out air quality assessments periodically.
2.	Soil quality degradation	• Bunded wall shall be constructed in the fuel dump section to contain fuel/oil spill. • The preparation of procedures to ensure that spillage during mobile equipment maintenance is minimized, and that only designated areas are used for this purpose shall be pursued.
3.	Occupational health hazard	• Periodic health check-up.
4.	Safety of workers	• Workers in technical areas would be provided with PPEs: hand gloves ear muffs, safety boots, safety goggles, helmets etc. • Workers shall be trained to follow safe working practices

Note: Cross River State Government shall have the responsibility to implement mitigation measures during operation phase

7.5 EMP during De-Commissioning Phase

This project involves a huge investment. While in Operation, the airport project management will employ the best maintenance techniques and systems. These efforts will help to engender sustainability of the airport project. Similarly efforts and investment for renovation and modernization will result in further life extension of the project. From the present trends, the life of the airport would not be less than 100 years. However when the airport facility becomes unviable due to major technological changes or due to regulations, decommissioning of the facility will be undertaken. This involves a series of steps to be planned and executed. The total operation can be broadly categorized in to De-operationalization and dismantling phases. De-operationalization is a technical activity carried out by experts. Dismantling operation however will have impact on environment due to noise and dust arising out of it.

7.6 Waste Management

7.6.1 Waste Management during Construction Phase

Cross River State Government's EPC contractor shall be responsible for monitoring, quantifying, transportation and disposal of all wastes generated during the construction phase. Waste generated within the airport shall be disposed by Cross River State Waste Management Agency in accordance with regulatory requirements using identified existing government approved waste disposal/treatment/recycling facilities. Each waste movement shall be accompanied by a Waste Consignment Note (WCN) appropriately signed by the facility's HSE manager or the EPC contractor's supervisor and dumped at the government approved site.

7.6.2 Waste Management during Operational Phase

Cross River State Government shall be responsible for monitoring, controlling and disposal of all waste generated during the operational phase. A waste inventory shall be kept and approved by the HSE manager to guarantee data integrity. The airport facility HSE manager shall ensure that the waste segregation scheme is fully implemented. Vehicular waste oil shall be collected and properly managed.

7.6.2.1 Waste Generation Forecast

This proposed Obudu Cargo and Passenger Aiport aims at a maximum of 100 personnel at the peak of the project. Allowing for occasional visitors, waste generation has been estimated with 100 personnel working all – time – across the project site. Using a weighted average waste generation of 1kg/capital/day, the rate of waste generation is estimated.

Table 7.4: Estimated Rate of Wastes Generated

Waste Type	Rate of Waste Generated
Domestic	
Food/Kitchen Wastes	30 kg/day
Garden Waste	15 kg/day
Garbage	5 kg/day
Plastic bottles Waste Polyethylene etc	5 kg/day
OFFICE	
Toner Cartridge	5 kg/Month
Paper	2 kg/day
INDUSTRIAL	
Glass	1 kg/day
Scrap Metal	2 kg/day
Cans and Tins	3 kg/day
Computer Scraps & Consumables	1 kg/day
Oil/Fuel Filters	5 kg/month
Cables	2 kg/month
Spent Oil	10 lit./day/capita
Clinical Waste	2 kg/month
Fluorescent/tube bulbs	5 kg/month
Sewage	15 lit./day/capita
Metallic and Plastic Drums	40 kg/week
Batteries from cars, calculator, radios, torches, cameras	0.1 kg/day

7.6.3 Waste Management during Decommissioning Phase

Prior to project abandonment or decommissioning, inventory of past practices shall be conducted with the aim of eliminating and avoiding liabilities. Consideration shall be given to re-using equipment from abandoned site. All contaminated areas shall be adequately remediated prior to abandonment. All materials shall be evacuated from site and the wastes disposed accordingly.

7.6.4 Waste Management Organization

7.6.4.1 Roles and Responsibilities

This waste management plan is binding on all staff and contractors involved on the proposed project with respect to the following:

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

7.6.4.2 Waste Management Focal Point

- Participate in the review of master plan, procedures and standards with company's waste management team.
- Develop plan for the project and adopt/implementation plan after reviewing with company corporate waste management team.
- Participate in inspections and audits.
- Submit performance report to company's corporate waste management team.
- Participate and contribute to the review of the processes.
- Participate in stakeholders' workshop when necessary.
- Manage waste streams generated in the projects

7.6.4.3 Waste Inventorisation and Tracking

Project Management's Waste Consignment Note (WCN) shall be used for tracking and a tracking database shall be properly maintained.

7.6.4.4 Monitor and Review / Improvement Performance

The project HSE team together with environmental consultants shall participate in inspections and audits of the facilities as well as project activities. They shall drive and also participate in quarterly reviews and the annual workshops when necessary. Monitoring document will be reviewed yearly during the life of the project.

7.6.4.5 Training

Cross River State Waste Management Agency and/or private accredited environmental consultants shall be contracted for training on basic Waste Management System (WMS) standards, tools and approach. The project HSE team shall coordinate the training programmes and monitor performance to identify further training needs.

7.6.4.6 Contractor's Role

The Cross River State Waste Management Agency shall develop her waste management procedure/ plan or review it in line with the proposed project plan. The agency shall also monitor and implement the plan for compliance.

7.6.4.7 Awareness

General waste management awareness shall be raised among personnel through short presentations, site inductions, toolbox talks and the use of posters, as applicable. All waste contractors shall be made aware of the project waste management procedure and guidelines through contract specification.

7.6.5 General Waste Management Procedures

This highlights the key principles of the 4-Rs in waste management. They include; reduce, recycle, recovery treatment and responsible disposal. These principles shall be incorporated into the design and management of project's associated activities. Where elimination of waste is not possible, minimization alternatives shall be explored.

7.6.5.1 Waste Identification and Characterization

Project generated wastes shall be managed in an environmentally friendly manner. Once waste streams are identified, the properties of the waste stream shall be analyzed for proper classification of the waste type. Hazardous waste includes oxidizing, highly flammable, corrosive, toxic to humans, radioactive, harmful to the environment (eco-toxic). Non-hazardous wastes are further categorized into: industrial, domestic and office. Classification of waste also simplifies qualification and inventory data management as well as enhances ease of transportation and choice of treatment process.

Table 7.5: Waste Categories and Definitions

Category	Definition
Hazardous waste	A hazardous waste is any gaseous, liquid or solid waste, which due to its quantity, physical, chemical or infectious characteristics have the potential to harm human health or the environment when improperly handled, stored, transported, treated or disposed.
Non – Hazardous	A non-hazardous waste is any gaseous, liquid or solid waste, which does not have the potential to harm human health or the environment.
Domestic Waste	This category includes kitchen waste from offices, operational and residential locations, and waste arising from estate management activities including garden wastes.
Office Waste	These are wastes generated from office services.

a) Waste collection

Waste segregated at source and well contained in appropriate waste receptacle shall be manually handled or trucked to designated collection points before it is taken to appropriate disposal facilities.

b) Waste Segregation

This is the physical separation of different waste streams and is a pre-requisite for implementing minimization options. Waste segregation shall be done at source through the provision of colour and/or text coded bins. Only containers in good condition and with properly fitting lids shall be used for waste containment. Plastic bin liners shall also be used for temporary containment to ensure hygienic waste handling.

Table 7.6: Colour Codes for Generated Wastes

Type of waste	Colour code
Food /vegetable waste	Green
Glass waste	Blue
Plastic waste	Brown
General (non-useable)	Black
Medical waste (combustible)	Yellow
Toner /developer	White

Table 7.7: Colour codes for Hazardous and Non-hazardous Medical Wastes

Type of waste	Colour code
Hazardous medical waste	
Clinical combustibles	Yellow or yellow tagged bags
Sharps	Grey
Non sharp/non-combustible	Black or black tagged bags
Foul or infected linen	Red or pink bags
Recyclable linen	White or white tagged bag
Non- hazardous	
Paper	Clear or clear tagged bag

Wastes shall be segregated according to the company's waste segregation scheme at all times. All wastes shall be stored in specific storage areas which have appropriate containment. Labelled containers for different waste streams shall be appropriately located at strategic and easily accessible areas within the different project locations. Clear texts and pictorial signs urging the use of wastes bins shall also be placed at strategic locations within the project site. All evacuated waste shall be accompanied by completed waste consignment note (WCN) from source to the final disposal site in order to ensure proper waste tracking.

c) Waste Minimization

Waste minimization may be achieved through one of a combination of two or more of the following strategies.

i) **Source Reduction –** This refer to the generation of minimal waste through more efficient practices such as:
   - Material elimination; this involves the reduction eliminating over stock unused materials. This can be achieved through buy-back arrangement/policy.
   - Material substitution; which involves effective use of an alternative or substitute material to eliminate or significantly reduce waste.
   - Process modification; this involve the evaluation of material process which generate waste to determine if alternative processes were both technically and financially feasible.
   - Improved housekeeping; waste reduction can be achieved through careful storage and maintenance of materials for easy identification.

ii) **Re-use –** This refer to the use of waste material or product in its original form e.g. containers and packaging materials.

iii) **Recycling/recovery –** This is the destruction, detoxification and/or extraction of energy or materials from wastes.

d) Waste Treatment

Waste treatment is the destruction, detoxification and/or neutralization of residues through processes such as:

- Biological methods: tank based degradation, composting.
- Thermal methods: incineration, thermal desorption.
- Chemical methods: neutralization.
- Physical methods: filtration, centrifugation and stabilization.

Waste requiring treatment shall be treated before disposal. Such wastes include effluents from the facilities and sewage. Treatment methods to be used for each waste stream (where applicable) are presented in the waste management charts below.

e) Waste Disposal

Waste disposal is the deposition of wastes on land or in water using methods appropriate for a given waste stream. Disposal methods depending on the waste stream, recommended by the Federal Ministry of Environment (FMEnv) include:

- Landfilling; this is a site used for disposal of solid waste in which wastes are buried between layers of dirt so as to fill in or reclaim low-lying ground.
- Surface discharge; this is the management of release of materials into water or land.
- Land spreading or land farming; this is the treatment of near surface soil contamination for hydrocarbons and pesticides.

- Encapsulation/Stabilization; this disposal method involves the fixing of waste into materials that could be useful in construction activities.
- Solidification; this is when waste is solidified from one state to another stage in their production. This is the final or near-final step.
- Incineration; this is the burning of waste materials in a closed chamber at high temperature.
- Re-injection; this is the injection of waste material into a suitable formation.

7.6.5.2 Implementation Strategies

It is the responsibility of the project health and safety management team to ensure that the above procedures are implemented in a manner that is Specific, Measurable, Attainable, Realistic and Time based (SMART).

- Waste management issues shall be reviewed quarterly after audits.
- Project management team shall include waste management issues in routine HSE inspections and findings from such inspections shall be tracked for closure.
- The Project management team and the Cross River State Waste Management Agency shall jointly carry out waste management audit/inspections of facilities. Occasionally project HSE team as well as environmental consultant shall be involved in the project audits. Findings from the audits and inspections shall be properly documented and followed up.
- Cross River State Waste Management Agency shall be responsible for the management of waste from their activities in line with Project management team/Cross River State Government policies.
- Waste management performance monitoring shall be reported to the project management.
- Waste management shall be included in the agenda of the project management review meetings as part of management commitment when the need arises.
- The project team shall in conjunction with company HSE team carry out regular awareness campaigns on waste management issues across the project.

Table 7.8: Wastes Identification, Handling and Disposal

WASTE TYPE / WASTE NAME	Handling			Minimization/Disposal Method /Facility
DOMESTIC	**Colour Code of Bin**	**Storage**	**Transportation**	
Food/Kitchen Wastes	Green	in bins or neatly packaged in a well labelled polythene	In bins or neatly packaged in a well labelled polythene inside a covered truck	Disposed at government approved dumpsite
Garden Waste	Green	designated storage site in the facility	In covered vehicles with fully completed Waste Consignment Note (WCN)	Disposed at government approved dumpsite
Garbage	Green	Can be sorted to recover recycle items	In covered truck with fully completed WCN	Disposed at government approved dumpsite
Plastic	Brown	Collect, segregate & store temporary in company's waste dump	In bins or neatly packaged in a well labelled polythene inside a covered truck	Be Sold to third party for recycling
OFFICE				
Toner Cartridge	White	Good housekeeping procedure	Collected with the waste bag closed and transported with appropriate label for recycling	Reuse or moved to government approved dumpsite by Cross River State Waste Management Agency or sale to other end users.
Paper	Clear	Store under waste shed	Transport to waste dump by Cross River State Environmental Protection Agency	Recycle/disposed at government approved dumpsite
INDUSTRIAL				
Glass	Blue	Collect, segregate & store temporary in company's waste dump	Transport in closed waste bag with appropriate label by waste contractor	Recovery & Recycling; Send to glass manufacturing company

WASTE TYPE / WASTE NAME	Handling			Minimization/Disposal Method /Facility
Scrap Metal	Grey	Store in designated areas in the facility	Transport in vehicle/trucks fit for the type of metal to be moved	Re-use, Recycle or sale to other end users.
Cans and Tins	Grey	N/A	It shall be collected and disposed by Cross River State Environmental Protection Agency	Disposed at government approved dumpsite
Computer Scraps & Consumables	Orange	Arrange neatly in a cool dry place	In covered truck with fully completed WCN	Sale to other end users
Oil/Fuel Filters	Blue	Drain oil, cut open to remove diaphragm and crush metal case	In trucks to the scrap metal yard	Re-use, Recycle or sale to other end users
Cables	Grey	Neatly kept in the waste depot	In covered truck disposal site	Re-use; Can be sold to vendor for re-cycle and reuse
Clinical Waste	Yellow	Neatly place in black polythene before putting in the red bin	Transport in sealed bags to incinerator	Incinerated at very high temperature
Fluorescent/tube bulbs	Blue	Arrange neatly to avoid breaking	In covered trucks with fully completed WCN	Recycle; Sell to vendors to recycle mercury
Computer Scraps & Consumables	Orange	Arrange neatly in a cool dry place	In covered truck with fully completed WCN	Sale to other end users
Sewage	N/A	Septic/sewage tank or sewer	Transported via sewage pipes to sewage tanks/sewers	Degraded by biological processes

WASTE TYPE / WASTE NAME	Handling			Minimization/Disposal Method /Facility
Spent Batteries	Orange	Arrange neatly without breakage in a cool dry place	In covered trucks with dully completed WCN	Recycle/Recovery; Sell spent batteries to recycling companies

7.7 Road Safety & Traffic Management Plan

The plan encompasses the addresses of community safety related impacts that may arise from the increased vehicular traffic due to movement in and out of the airport during the operation phase as well as equipments/machineries particularly during construction phase. The plan will be regularly reviewed and as vehicle movement requirements are identified in detail.

7.7.1 During Construction Phase

The following mitigation measures will be implemented during this phase:

- Project vehicular movement will be restricted to defined access routes.
- Proper signages will be displayed at important traffic junctions along the vehicular access routes to be used by construction phase traffic. The signage will serve to prevent any diversion from designated routes and ensure proper speed limits are maintained near residential areas.
- Any road diversions and closures will be informed in advance to the project vehicles accessing the above route. Usage of horns by project vehicles will be restricted near sensitive receptors viz. schools, settlements etc.
- Traffic flows will be timed wherever practicable during period of increased commuter movement in the day.
- Temporary parking facilities shall be provided within the work areas and the construction sites to avoid road congestion.
- Vehicular movement to be controlled near sensitive locations viz. schools, colleges, hospitals identified along designated vehicular transportation routes.
- Routine maintenance of project vehicles will be ensured to prevent any abnormal emissions and high noise generation.
- Adequate training on traffic and road safety operations will be imparted to the drivers of project vehicles. Road safety awareness programs will be organized in coordination with local authorities to sensitize target groups viz. school children, commuters on traffic safety rules and signages.

7.7.2 During Operational Phase

Vehicular movement impacts during operation can be effectively addressed through implementation of mitigation measures as discussed during the construction phase.

7.8 House Keeping

Better housekeeping can improve the working conditions. The following measures shall be imbibed:

- Regular cleaning

- Avoiding accumulation and dumping of wastes and damaged equipments and items anywhere inside the plant affecting aesthetics and increasing risk of fire and other hazards.
- Keeping ventilation systems of premises in good working condition to avoid ingress of dust inside the pressurized room.
- Keeping air conditioning plants in good running conditions for control/instrumentation rooms.
- Regular watering of untarred/unpaved roads by spraying water during construction and maintenance to avoid dust emission from vehicle movement.
- Maintaining hygienic conditions in areas like canteens, near drinking water sources and toilets.
- Developing a positive outlook in the employees for improving the project facility.

7.9 Safety & Emergency Plan

Safety of both men and material during construction and operation stages are of concern. Keeping in view the safety requirements during construction and operation and maintenance phases, a safety policy will be formulated for the proposed airport project. Separate safety rules shall be prepared for each type of occupation/processes involved in the project in consultation with manufacturer/supplier of equipments and materials. Also, regular safety inspections shall be ensured of all buildings, equipments, and operations.

7.9.1 Safety Organization

Cross River State Government shall put up a safety department for the proposed Obudu Cargo and Passenger Airport project and this will be headed by an HSE Manager, having qualified and experienced supporting staff. The responsibilities of Safety Department will include identification of the hazardous conditions and unsafe acts of workers and advise on corrective action, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He/She shall also be responsible for ensuring compliance of Safety Rules/Statutory provisions.

7.9.2 Safety Awareness among Workers/Employees

Training programmes in safety and accident prevention shall be organized at all levels of employees with a view to familiarize them with the general safety rules, safety procedures in various operational activities and to update their knowledge in safety and accident prevention, industrial hygiene and emergency equipments. These training programmes shall be conducted periodically in a planned manner to refresh their knowledge.

7.9.3 First Aid Training

First aid training programmes shall also be conducted for all employees with the help of qualified medical and para-medical staff. This programme may be conducted in batches. The programme shall include basic first-aid techniques and will be repeated periodically to refresh knowledge.

7.9.4 Muster Point

In an emergency, it will certainly be necessary to evacuate visitors and personnel from affected areas. The evacuation will be effected on getting necessary message on evacuation; visitors and employees would be directed to a predetermined safe place called muster point. The chosen location shall be the point, where all visitors and staff would assemble in the case of emergency before evacuation.

7.9.5 Declaration of Emergency

An emergency may arise due to major outbreak of fire. In case of major outbreak of fire the state of emergency has to be declared by the HSE Manager by sounding emergency siren. A siren audible to a distance of 5km range will be available for this purpose.

7.9.6 Emergency Management Training

The key personnel (HSE Manager and His/Her team) shall regularly undergo special courses on disaster management. All concerned senior and junior staff will periodically undergo courses on the use of personal protective equipment and response to emergency.

7.9.7 Mock Drills

The procedures as laid down in this plan are imperative, and shall be occasionally tested via periodic mock drills. To avoid any lethality, the emergency response time shall be clocked below 2 minutes during the mock drill.

- 1st step: Test the effectiveness of communication system.
- 2nd step: Test the speed of mobilization of emergency teams.
- 3rd step: Test the effectiveness of search, rescue and treatment of casualties.
- 4th step: Test emergency isolation and shut down and remedial measures taken on the system.
- 5th step: Conduct a full rehearsal of all the actions to be taken during an emergency.

The disaster management plan shall be periodically revised based on experiences gained from the mock drills.

7.9.8 Other Safety Measures

Considering that fire explosion is a likely hazard in projects of this nature, the airport facility is being provided with systems to guard against such hazards. Salient among these are:

- A proper layout to prevent and minimize the effects of any hazardous situation.
- Provision of operating systems to conduct the process through well-established safe operating procedures.
- Control system, which has trip provisions to prevent hazard conditions escalating.
- Provision of a fire protection system to control fire.
- Provision of flame-proof lighting system in the fire prone areas.

7.9.9 Safety Review Check List

A checklist is one of the very useful tools for hazard identification. A checklist will be prepared and used as a final check that nothing has been neglected.

7.10 Fire Fighting & Protection System

7.10.1 Safety policy and Regulations

Keeping in view of the safety requirement during construction, operation and maintenance phase, the proposed Obudu Cargo and Passenger Airport project management will formulate safety policy with the following regulations:

- Take steps to ensure that all known safety factors are taken into account in the design, construction, and maintenance of machinery/equipments and the entire building complex.
- Ensure that adequate safety instructions are given to all employees and passengers.
- Provide wherever necessary safety appliances and to ensure their proper use.
- Ensure proper implementation of fire prevention and appropriate fire-fighting service together with training facilities for personnel involved in this service.
- Prepare separate safety rules for both staff, passenger and visitors.
- Ensure regular safety inspection at suitable intervals of equipments, and other operational areas.

7.10.2 Fire Protection System

Cross River State Government shall install adequate number of well mounted type of portable fire extinguishers at strategic areas which includes the terminal building, control tower, cargo warehouse, car park, etc. these portable fire extinguishers shall basically contain carbon dioxide in dry powdery form. There shall also be a fire station as part of the project.

7.11 Environmental Monitoring Programme (EMP)

Regular monitoring of critical environmental parameters is of immense importance to assess the status of environment during the project operation. The monitored data can serve as an indicator for any change in environmental quality due to operation of the proposed project with respect to baseline environmental conditions, so that suitable mitigatory steps could be taken in time to safeguard the environment.

Monitoring indicators have been developed for each of the activity considering the mitigation measures proposed. Indicators have been developed for ascertaining the environmental quality and the performance of the EMP implementation through Environmental Quality Indicators (EQI's) and Environmental Performance Indicators (EPI's) respectively which focus not only on quantifying or indexing activity-environment interactions that may potentially impact the environment but at the same time also help in comparing different components of environmental quality against previously established baseline values. Monitoring results would be documented, analyzed and reported by contracted accredited environmental consultant in conjunction with the HSE Manager. Monitoring requirements (including monitoring frequency) have been presented in the table below.

Table 7.9: Proposed monitoring requirements for the proposed project (Environmental Performance Monitoring)

EPI No.	Environmental Performance Indicator (EPI)	Monitoring Parameter	Location	Period & Frequency
A.	**Construction phase**			
A1.	Air emissions from vehicles and machineries	• CO, HC, SOx, NOx, VOC based on emission factors • % of vehicles possessing valid Personal Use of Company Car (PUCC) Certificates	• Exhausts	Monthly during construction phase
A2	Dust generated from vehicle movement	• Visual observation of dust generation • Noise pressure level in dB(A)	• Site & approach road	Monthly during construction phase
A3	Noise emissions from vehicular movement	• Compliance with FMEnv noise limits • Check for valid certificates of Type Approval and also valid certificates of conformity of production for equipments particularly generating sets	• Near noise sources (5m)	Monthly during construction phase
A4	Sourcing of water	• Volume of water sourced and consumed	• Sourcing and usage areas	Daily during construction phase
A5	Fugitive emissions from handling and storage of raw materials	• Visual observation	• Material stockpiles	Daily during construction phase
A6	Community and health safety	• Complaints registered by local communities • No. of Accidents	• Grievance records • Safety records	Monthly during construction phase
A7	Occupational health and safety	• Health surveillance of workers • Sanitation status of labour camps and canteen	• Medical records • Labour camp maintenance records	Monthly during construction phase

EPI No.	Environmental Performance Indicator (EPI)	Monitoring Parameter	Location	Period & Frequency
		• Potable nature of drinking water viz. coliform, pH, TSS, Residual chlorine • Usage of proper PPEs • Safety performance indicators viz. LTIs. Near misses, fatalities etc	• Drinking water storage tanks • Construction site	Daily during construction phase
A8	Disposal of sewage	• Visual observation of leaks, overflows etc • Odour	• Septic tank and soak pits	Daily during construction phase
A9	Surface run-off discharge	• Visual observation of water logging due to drainage disruption • FMEnv Inland Water Discharge Parameters	• Areas abutting construction site • Discharge point	Monthly during construction phase
A10	Domestic waste generation, storage, handling and disposal	• Quantity of waste generated and recycled • Visual observation of waste segregation and storage conditions viz. usage of labelled and covered bins, insect repellents etc. • Awareness level of onsite workers	• Waste generating areas viz. canteen, labour camps etc • Workers involved in waste handling and storage	Weekly during construction phase
A11	Hazardous chemicals and waste storage, handling and disposal	• Visual observation of chemical storage conditions viz. presence of spill kits, drip trays, fire extinguisher, display of Material Safety Data Sheet (MSDS) etc. • Quantity of waste oil and other hazardous waste generated and recycled to registered recyclers • Awareness level of onsite workers	• Hazardous waste storage areas • Workers involved in waste handling and storage	Weekly during construction phase

EPI No.	Environmental Performance Indicator (EPI)	Monitoring Parameter	Location	Period & Frequency
B.	**Operational Phase**			
B1	Air emissions from aircraft operational activities and vehicular movements	• CO, HC, SOx, NOx, VOC based on emission factors • % of vehicles possessing valid Personal Use of Company Car (PUCC) Certificates	• Maintenance Records	Daily during operational phase
B2	Noise generated from aircraft operation and vehicular movement	• Noise pressure level in dB(A) • Maintenance parameter check with respect to aircraft noise	• Near noise sources (5m) • Noise generating aircrafts and vehicles	Weekly during operational phase
B3	Water sourcing and consumption	• Volume of water sourced and consumed	• Water usage areas	Daily during operational phase
B4	Community health and safety	• Complaints registered by the local communities • No. of. Accidents	• Grievance Records • Safety Records	Monthly during operational phase
B5	Occupational health and safety	• Health surveillance of workers and passengers • Sanitation status of onsite terminal building building, control tower and cargo warehouse • Potable nature of drinking water viz. coliform, pH, TSS, Residual chlorine • Usage of proper PPEs • Safety performance indicators viz. Learning Tools Interoperability (LTIs). Near misses, fatalités etc	• Medical records • Office building maintenance records • Drinking water storage tank • Operational sites	Daily during operational phase

Table 7.10: Proposed monitoring requirements for the proposed project (Environmental Quality Monitoring)

EQI No	Environmental Quality Indicator (EQI)	Monitoring Parameter	Location	Period & Frequency
A	**Construction Phase**			
A1	Ambient noise quality	Measurement of Noise Pressure Level in dB	Nearest receptor viz. villages, schools, ecological habitat	Monthly during construction phase
A2	Surface water quality	Parameters as per FMEnv limits	Drainage channel	Quarterly during construction phase
A3	Ground water quality	Depth of ground water table		Quarterly during construction phase
B	**Operational Phase**			
B1	Ambient noise quality	Measurement of Noise Pressure Level in dB	Nearest receptor viz. villages, schools, ecological habitat	Monthly during operational phase

7.12 Budgetary Provisions for EMP Implementation

Adequate budgetary provision has been made by Cross River State Government for the execution of this environmental management plan. The estimated cost of Environmental Protection measures for this project has been estimated as 0.1% of the gross project cost.

Table 7.11: Proposed environmental monitoring programme (both during construction and operation Phases)

Area of Monitoring	Number of Sampling Stations	Frequency of Sampling	Parameters to be Analysed
Meteorology	1 location	Continuous/ Daily	Wind speed and direction, Max. and Min. Temperature, Humidity, Solar Insolation, Atm. Pressure, Rainfall
Noise	25 locations	Monthly and reported quarterly to the FMEnv	Ambient Equivalent continuous Sound Pressure Levels (Leq) at day and Night time.
Water Quality	Ground water (2 locations)	Monthly and reported quarterly to the FMEnv	pH, Temp, Cond, TSS, TDS, BOD, O&G Heavy metals
Soil	25 locations	Monthly and reported quarterly to the FMEnv	Physico-chemical properties, Nutrients

7.13 Social Management Plan

7.13.1 Community Development Plan

Investors (whether private or government) is expected to play a role in the development of an area in which it does business. In most cases, it is difficult to operate and do business without the cooperation of the local communities and other stakeholders. To build a good rapport with the local communities, Cross River State Government shall engage the local communities along with administrative machinery to develop an ongoing process of positively enhancing the socio-economy of the communities.

The various areas where involvement shall be made are discussed below:

Health Care Service: The proposed project shall be equipped with a clinic which shall equally provide healthcare service to the immediate host communities.

Infrastructural Amenities Support: On account of the proposed project infrastrutures such as roads, street lights, drainnages, water supply shall be put in place which the host communities will benefit from.

Technical and Vocational Training: Technical and vocational training shall also be made available for indigenous youth to aid skill acquisition, empowerment and capacity building.

7.14 Community Liaison Plan

The community liaison plan concentrates on communication with the project affected communities. Cross River State Government shall disclose the project details to make the communities aware of the important features of the project. A Project Information Booklet would be prepared and distributed in the project affected communities. This booklet shall preferably be presented in vernacular language. The booklet in addition to containing the salient features of the project shall have a map depicting the boundaries of the airport and its ancillary facilities. The important landmarks e.g. settlement, schools and roads, etc. shall also be demarcated so that it becomes easy for the people to relate to the ground conditions. To ensure wide circulation of the Project Information Booklet, it will be made available at all the schools, centres, markets and other public facilities in the project host and neighboring communities.

7.15 Monitoring and Reporting

Environmental and social key performance indicators will be developed in accordance to the FMEnv guidelines and the International Finance Corporation (IFC)/World Bank Group's performance Standards. This will be monitored at regular intervals to identify changes in conditions, new issues, mitigation, successes and opportunities for improvement in consultation and disclosure. The monitoring results will be reported as required, and will be available to the public. Stakeholder perceptions will also be monitored by Cross River State Government Community Relations Team Representatives.

Furthermore, Cross River State Government shall also take up robust CSR programme geared towards community welfare and support activities for socio-economic development of the nearby areas, to build a good rapport with the local communities by engaging the local community along with the administrative machinery to develop an ongoing process of development of the communities/villages surrounding the airport.

CHAPTER EIGHT
REMEDIATION PLANS AFTER DE-COMMISSIONING/ CLOSURE/ABANDONEMENT

8.1 Introduction
Decommissioning refers to the process by which the operations of a project is terminated. It is an administrative and technical process which includes clean-up of project materials and progressive demolition of the plant. The costs of decommissioning are spread over the lifetime of a facility and saved in a decommissioning fund. After a facility has been completely decommissioned, it is released from regulatory control and the project proponent is no longer responsible for environmental safety. Decommissioning may proceed all the way to "greenfield" status.

Cross River State Government as part of its decommissioning plan for the proposed project shall properly treat all effluents and solid wastes. Excavated areas shall be backfilled and graded. Furthermore, all solid waste excluding scraps shall be disposed in an environmentally sound manner while scraps shall be recycled as much as possible. The State Government shall also restore the site as much as possible and all surfaces shall be stabilized and protected to control landslides/subsidence, erosion, water pollution and human hazards.

The overall project planning shall include land reclamation operations including sufficient budget allocation. The environmental baseline data which has been collected prior to the project implementation will be valuable in the re-establishment of natural or agricultural ecosystem on the site once project is decommissioned. Prior to commencing removal of items of equipment, Cross River State Government shall ensure that the equipments has been approved for decommissioning by reviewing the Equipment Decommissioning Note.

8.2 Procedures for Decommissioning after Ceasing Operation
The project consists of numerous recyclable materials, including glass, semi-conductor material, steel, wood, aluminium, copper, and plastics. When the project reaches the end of its operational life, the component parts will be dismantled and recycled. The Project components will be dismantled and removed using minimal impact conventional construction equipment and recycled or disposed of safely.

8.2.1 General Decommissioning Process
Effectively, the decommissioning of the proposed Obudu Cargo and Passenger Airport is itemised below:

- Aircrafts; large and small shall be removed/relocated.
- Electrical and mechanical equipments/devices/materials shall be removed and recycled off-site by an approved recycler.

- Terminal building and control tower shall either be demolished or retained and converted to other uses.
- Concrete pavements/foundations shall be removed and recycled off-site by a concrete recycler.
- Fencing shall be removed and will be recycled off-site by an approved recycler.
- Runway and other roads constructed for the project will remain onsite should the landowner(s) choose to retain them, or be removed and the gravel repurposed either on- or off-site.
- The project site may be converted to other uses in accordance with applicable land use regulations in effect at that time of decommissioning there are no permanent changes to the site and it can be restored to its original condition including re-vegetation. Any soil removed for construction purposes will be relocated on the site or used for landscaping after construction is complete.

8.2.2 Rehabilitation Process

The land that will be rehabilitated shall be the land where the project components and associated infrastructure stands. Before rehabilitation begins dismantling and demolition of all structures built on the land would have been carried out. Once demolition is complete rehabilitation of affected site shall be undertaken to its original state or close to original state. Site rehabilitation shall include the following:

- Filling of all depression including trenches that could have been done for the project;
- Levelling and appropriate landscaping of the entire site;
- Removal of all debris and scrap from site;
- Carrying soil tests and analysis from various site locations were different structures and activities were being undertaken to ensure that any site soil contamination is handled appropriately and required soil amendments and treatments are done to ensure the result soil in that site supports the required vegetation that will later be planted. Soil amendments that may be done may include physical removal of affected soils and replacement with desired soil or phytoremediation;
- Planting of appropriate species of trees, shrubs and grasses to undertaken taking consideration of local ecological requirements;

8.3 Procedures for Decommissioning during Construction (Abandonment of Project)

In case of abandonment of project during construction, the same decommissioning procedures as for Decommissioning after Ceasing Operation will be undertaken and the same decommissioning and restoration program will be honoured, in as far as construction proceeded before abandonment. The facility will be dismantled, materials removed and recycled, the soil that was removed will be graded and the site returned to its preconstruction state.

8.4 Closure Outcomes/Completion Criteria

The expected closure outcomes for all site components are that: community and future generations are left with no residual liability for site rehabilitation and maintenance; public health and safety is not endangered; landscape function and vegetation is resilient, self-sustaining and comparable to the surrounding areas; and no increase in contamination level above baseline condition. The completion criteria for these are:

- Government acceptance of project completion report which demonstrates achievement of all completion criteria.
- Audit shows if any remaining project infrastructure is left in a safe and secure manner, and discourages public access.
- Landscape and vegetation report undertaken and reported to show function is resilient, self-sustaining and comparable to the surrounding environment.
- Site contamination survey (conducted to relevant Nigerian standards) demonstrates no elevated level of selected contaminant.

Table 8.1: Closure outcomes and completion criteria (Template)

Area	Cross River State Government Action/ Expected Outcome	Completion Criteria
Site infrastructure		
Airport terminal building	All infrastructures shall be removed unless required for end land use or requested and agreed between Cross River State Government and relevant regulatory agencies	Audit of domain against final closure plan to confirm the airport terminal building or related infrastructure does not remain on site
Electrical, mechanical, wooden and plumbing equipments	All equipments (electrical, mechanical, wooden and plumbing etc.) shall be removed	Audit of area against final closure plan to confirm no equipment/infrastructure remain on site
Cargo storage warehouse	All infrastructures shall be removed	Audit of domain against final closure plan to confirm no cargo storage warehouse infrastructure remain on site
Runway and other roads	All infrastructures shall be removed unless required for end land use or requested and agreed between Cross River State Government and relevant regulatory agencies	Audit of domain against final closure plan to confirm no runway or other road infrastructure remain on site

Septic tank	Decommissioning and backfilling	Audit of domain against final closure plan to confirm full compliance

8.5 Potential Residual Risks – Post Project Closure

When the project site is abandoned, decommissioned and subsequently closed, the air quality will improve together with relative reduction in the noise level associated with project operations (aircraft flight operations, vehicular movement etc.). There will also be reduced project related traffic in the area. However, the associated negative effects include reduced employment opportunity and reduced spending in the local community. A summary of the residual risks of all impacts associated with the closure and rehabilitation of the project are tabulated below.

Table 8.2: Residual risk for each domain

Area	Impact	Likelihood	Consequence	Residual Risk
General				
All site components (Terminal building, cargo warehouse and control tower)	The community and future generation are left with residual liability for site rehabilitation or maintenance	Unlikely	Moderate	Moderate
	Public health and safety is not ensured.	Rare	Major	High
	Landscape function and vegetation is not resilient, self-sustaining and comparable to the surrounding areas.	Unlikely	Moderate	Moderate
	Long term contamination of land.	Unlikely	Minor	Low

Area	Impact	Likelihood	Consequence	Residual Risk
	The community is unaware of project closure concept and timing.	Rare	Major	High
	Infrastructure is not removed	Rare		
Water supply/ponds				
Surface water management structure	Surface water management structures remaining in place are not physically stable and safe to fauna and humans.	Unlikely	Moderate	Moderate
Overburden stockpile				
Overburden stockpile	Excavated construction soil stockpile not physically or chemically stable.	Unlikely	Major	High
	Self-sustaining vegetation is not established over excavated construction soil storage areas.	Unlikely	Major	High
	Decrease in visual amenity of landform compared to baseline.	Likely	Insignificant	Moderate

Area	Impact	Likelihood	Consequence	Residual Risk
Runway and other associated road infrastructure				
Runway and other roads	Landscape function and vegetation is not resilient self-sustaining and comparable to the surrounding areas	Rare	Minor	low

8.6 Post Closure Monitoring

An environmental monitoring program after the closure of the site shall be performed to determine whether (or not) the objectives of closure are being met. Aspects to be monitored include:

- Air quality
- Flora and fauna: species composition, condition and abundance
- Surface water quantity and quality (if any)
- Soil quality
- Surface water quality and stream sediment quality
- Public safety is compromised as a result of passenger and cargo airport project legacy.

8.7 Schedule

The orderly and efficient rehabilitation of the project area shall be in phases as may be determined by Cross River State Government. The progress of closure will be done carrying both the Federal Ministry of Environment (FMEnv), Federal Ministry of Aviation (FMA), Nigerian Civil Aviation Authority (NCAA), Cross River State Ministry of Transport, and Cross River State Ministry of Environment.

8.8 Labour Demobilization

For labour demobilization, the following shall be implemented;

- Consult with labour at least one year before the commencement of decommissioning.
- Embark on a re-training process to enable labour acquire other skills.
- Project workers shall either be adequately paid off or shall be relocated to other areas for employment.
- Appropriate pension schemes shall be put in place for project workers for their upkeep when project is closed or de-commissioned.

8.9 Handling of the Host Community

Closure of the project will have significant impact on the local community. This is likely to include:

- Reduced purchasing power of the local people as a dependable source of income would have ceased to exist;
- A number of locally sourced employees will be laid off;
- Closure and/or relocation of businesses and services that were drawing clientele from the project; and
- Termination of certain services from the project operators to the community.

In order to plan for the possible impacts, the company shall put the following measures in place well in advance of closure time:-

- Transfer management of community services to the hands of locals at list six months in advance;
- Organise local people into responsible groups and train them on ways to manage community projects transferred to them; and
- Maintain certain aspects of the project that can attract revenue to the locality.

CHAPTER NINE
CONCLUSION AND RECOMMEDATIONS

9.1 Conclusions

Cross River State Government employed the services of Geo Environmental Resources Limited (GERL), a reputable indigenous environmental management firm with highly qualified and vast consultants in the various field of the earth and environmental management, to carry out the Environmental and Social Impact Assessment (ESIA) of its proposed Obudu Cargo and Passenger Airport project in Obudu LGA, Cross River State in line with regulatory requirements and guidelines of the government of Nigeria under the full representation of the Federal Ministry of Environment (FMEnv) and Cross River State Ministry of Environment. This report presents the assessment of the environmental and socio economic components of the proposed project.

The assessment here has thoroughly and carefully examined the potential positive and negative impacts of the proposed Obudu Cargo and Passenger Airport project. The perceived beneficial impacts of the project will outweigh the adverse effects but nevertheless mitigation measures were developed for the adverse impacts based on best industrial practices. In addition, the measures developed are aimed at ensuring that the impact on land use, vegetation, air, socio economics and health are mostly localized and can be controlled and remediated to a level reasonably practicable. The impacts identified are typical of airport projects and can be contained while applying the recommended mitigation measures to the identified impacts.

Based on the findings of the ESIA study the following conclusions can be made:

- The aviation activities of the proposed Obudu Cargo and Passenger Airport shall have its threat to human lives & the general environment of the host communities reduced if operated within the recommended industry best practices.
- With the proposed Mitigation Measures in Chapter Six, the airport project associated potential impacts will be reduced on the general environment which is in line with the outcry from governments of most nations in the world for global environmental sustainability.
- The results from the assessment of the baseline ambient air, soil and water quality as well as noise level of the immediate environment of the proposed project conforms to the regulatory standard limits for healthy living condition.
- The proposed project has more beneficial impacts on the host community, Cross River State and the Nation at large than negative effects.

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APPENDIX ONE

SOCIO ECONOMIC SURVEY QUESTIONNAIRE

Date:

COMPANY NAME: --

PROJECT TITLE --

PROJECT LOCATION: --

SOCIO-ECONOMIC DATA QUESTIONNAIRE FOR ENVIRONMENTAL IMPACT ASSESSMENT

The questionnaire is intended to collect social, economic and health data of people living around the project site as required by the EIA Act No. 86, of 1992 as well as the EIA Guidelines and other relevant requirements. Therefore, as a member of the community within the defined boundary, we need you to complete the questionnaire honestly and truthfully, to enable us evaluate the impact of the project on the socio-economic and health of the community. The information you provide will not be used for any other purpose apart from what is stated here, except compelled by a law court.

IDENTITY OF THE RESPONDENT		
Questionnaire number: |___|___|		
State: __________	LGA: __________	Village: __________
Family Name:	First Name:	
Phone #:	No Phone ☐	
Email address	No email ☐	
Is the respondent the Head of House? Yes ☐ No ☐		
If not, what is his/her status: Spouse ☐ Child ☐ Sibling ☐ Others ☐ Specify: __________		

SECTION A: DEMOGRAPHIC DATA

1. Gender: Male ☐ Female ☐		
2. Age: ________ year old		
3. Marital status: 1. Single ☐ 2. Married ☐ 3. Widowed ☐ 4. Divorced/Separated ☐ 5. Don't Know (DNK) ☐	**If married:** 1. Polygamous ☐ 2. Monogamous ☐ 3. Don't Know (DNK) ☐	
4. State of Origin: ________	**5. Ethnic group:** ________	**6. Religion:** ________
7. Education: i) Highest education level attained: No education ☐ Primary ☐ Secondary ☐ Tertiary ☐ University ☐ NFE* ☐ DNK ☐		
ii) Non formal education attained: Quar'anic/Islamiyya Sch. ☐ Adult Education ☐ Vocation ☐ Others ☐ If other, specify: ________		

NFE*: non-formal education, DNK= don't know

8. OCCUPATION		
(a) Nature of Occupation:	**(b) If self-employed, what do you do?**	**(c) If an employee, what else do you do?**
Private Sector Employee ☐	Farmer ☐	Farmer ☐
Public Sector Employee ☐	Pastoralist ☐	Pastoralist ☐
Self-employed ☐	Fisherman ☐	Fisherman ☐
Full Time House Wife ☐	Trader ☐	Trader ☐
Student ☐	Business man ☐	Business man ☐
Other ☐	Taxis/Bus Driver ☐	Taxis/Bus Driver ☐
	Okada/Keke ☐	Okada/Keke ☐
	Carpenter ☐	Carpenter ☐
	Builder ☐	Builder ☐
	Mechanic ☐	Mechanic ☐
	Plumber ☐	Plumber ☐
	Electrician ☐	Electrician ☐
	Others (please specify) ☐	Others (please specify) ☐

9. House Hold Size: Total No. __________, Female ________, Male ________

(**NOTE:** Definition of members of household: People sleeping and eating in the house for at least the last 6months. Do not count visitors, boarding children BUT children of the household away for school, visiting others, etc.)

10. Household Incomes: State amount of incomes received from these activities during the past 12 months where no income received, leave it blank

SOURCE OF INCOME	AMOUNT (₦)
Agriculture	
Livestock	
Fishing form river or fish pond	
Hunting	
Wood (collection)	
Charcoal (production)	
Business	

SOURCE OF INCOME	AMOUNT (₦)
Pension	
Money transfer (family)	
Renting (land, house, etc.)	
Salary (official)	
Casual jobs (okada, electrician, etc.)	
Trading	
Other sources (specify)	

11. Household Facilities: Does your household have any of the following facilities?

Power generator	Yes ☐ No ☐	Bicycle	Yes ☐ No ☐
Gas or kerosene stove	Yes ☐ No ☐	Plough	Yes ☐ No ☐
Refrigerator	Yes ☐ No ☐	Cart	Yes ☐ No ☐
Television	Yes ☐ No ☐	Cable TV (subscription)	Yes ☐ No ☐
Radio/cassette/music system	Yes ☐ No ☐	Air conditioner	Yes ☐ No ☐
Car/Truck	Yes ☐ No ☐	Fan	Yes ☐ No ☐
Motor cycle	Yes ☐ No ☐	Others (specify) __________	

12. What is the housing pattern prevalent in the community:

Roof	Walls	Floor
1. Corrugated iron sheets ☐	1. Plain mud ☐	1. Earth/sand/dirt/straw ☐
2. Thatch ☐	2. Mud ☐	2. Smoothed mud ☐
3. Asbestos ☐	3. Mud bricks ☐	3. Smooth cement ☐
4. Concrete/cement ☐	4. Wood ☐	4. Wood/planks ☐
5. Wood and mud ☐	5. Grass ☐	5. Ceramic tiles ☐
6. Bamboo/reed ☐	6. Compacted ☐	6. *Other, specify:* ________
7. Plastic canvas ☐	7. Burnt bricks ☐	
8. Bricks ☐	8. Concrete ☐	
9. *Others, specify:* ________	9. *Other, specify:* ________	

13. Nature of accommodation: 1) Live with parents/ spouse ☐ , **2)** Owned (Inherited) ☐, **3)** Owned (Bought) ☐, **4)** Rented ☐, **5)** Borrowed ☐, **6)** Rent Shared ☐, **7)** Squatting ☐, **8)** Others form of tenure ☐.

14. ENERGY CONSUMPTION (used for cooking and lighting, etc.)			
	What is the household's source of energy for…? (tick all that applies)		
Cooking	1. Main electricity ☐ 2. Solar ☐ 3. Gas (biogas) ☐ 4. Bottled gas ☐ 5. Paraffin/kerosene ☐ 6. Charcoal ☐ 7. Firewood (biomass) ☐	**Lighting**	1. Main electricity ☐ 2. Solar ☐ 3. Gas (biogas) ☐ 4. Hurricane lamp ☐ 5. Pressure lamp ☐ 6. Wick lamp ☐ 7. Candles ☐
	8. Crop residues ☐ 9. Livestock dung ☐ 10. *Others, specify:* ________		8. Firewood (biomass) ☐ 9. *Others, specify:* ________

15. DRINKING WATER

What is the household's source of drinking water during...? (tick all that applies)			
Dry season	1. Piped water ☐ 2. Rainwater catchment ☐ 3. Protected spring ☐ 4. Unprotected spring ☐ 5. Water vendor (mai ruwa) ☐ 6. Tanker truck ☐ 7. Bottled water ☐ 8. Surface water (lake/dam/river/stream) ☐ 9. Borehole (commercial) ☐ 10. Borehole (private) ☐ 11. *Other, specify:* ______	Wet season	1. Piped water ☐ 2. Rainwater catchment ☐ 3. Protected spring ☐ 4. Unprotected spring ☐ 5. Water vendor (mai ruwa) ☐ 6. Tanker truck ☐ 7. Bottled water ☐ 8. Surface water (lake/dam/river/stream) ☐ 9. Borehole (commercial) ☐ 10. Borehole (private) ☐ 11. *Other, specify:* ______
What is the distance between the MAIN source of water and house?			
Dry season	______ Km	Wet season	______ Km

16. Household Food Consumption

1. How many meals, does the household normally have per day?......./Day (between 1 and 3)
2. Do you need to buy food to satisfy your household needs, or you have enough from your farm? Yes ☐ No ☐

SECTION B: HEALTH AND VULNERABILITY

1. Are you handicapped or chronically sick? Yes ☐ No ☐ if yes, provide details on his/her sickness or handicap: ______
2. Are there any other members of the household handicapped or chronically sick? Yes ☐ No ☐ if yes, provide details on their sickness or handicap: ______
3. Where there any deaths in the household in the last year? Yes ☐ No ☐ if yes, provide details on cause(s) of deaths: ______
4. Which of the following is available in your community? (tick all that are available)
   a. Teaching Hospital ☐
   b. Federal Medical Center ☐
   c. General Hospital ☐
   d. Clinic/Maternity ☐
   e. Primary Health Care ☐
   f. Pharmaceutical Chemist ☐
   g. Patent Medicine Store ☐
   h. Traditional Doctor/Herbs ☐
   i. Others (specify) ☐
5. What constitutes your main diet? (tick all that are applicable)
   a. Carbohydrate source (garri, rice, yam, etc) ☐
   b. Protein source (beans, meat, fish, egg, etc) ☐
   c. Vitamins (fruits, vegetables, etc) ☐
   d. Fatty and oil source (margarine, palm fruit, etc) ☐

6. Substance use (Alcohol and drugs):

Do you engage in the following habits			If yes, how many times daily
Take alcohol	Yes ☐	No ☐	
Drugs (without prescription)	Yes ☐	No ☐	
Smoke cigarette	Yes ☐	No ☐	
Others (specify)	Yes ☐	No ☐	

7. Do you have qualified Doctors, Nurses and other health personnel? ____________________

8. How are very serious medical cases handled? ____________________

9. Name the prevalent diseases in the area; ____________________

____

10. Peculiar disease (if any)

____

____

SECTION C: SOCIAL INFRASTRUCTURE/ECONOMIC INFRASTRUCTURE

1. What is the nature of the access road in this area?____________________

____

2. What type of transportation do you have? ____________________

3. Do you have market? Yes ☐ No ☐ , If yes; Mention their names and the days of function?

____

____

____

4. Do you have Bank(s)? Yes ☐ No ☐ , If yes, mention their names

____

____

____

5. What recreation facilities do you have in your community? Describe them as brief as you can.

____

____

6. Economic/industrial facilities around the area;____________________

____

7. Are there private/public institutions in the area/community? If yes name them;

____

____

____

7. How is solid waste disposed of? Thick the box(es) applicable and for more options, write on others.

Burning; ☐ dumping; ☐ throwing in running/stagnant water ☐ , Others: ____________________

8. How is human waste disposed of? Pail systems; ☐ Pit toilet; ☐ Defecation into water channels ☐

Any other (specify): __________

9. Do you have primary schools? __________ If yes, mention their names

10. Do you have secondary schools? __________ If yes, mention their names

11. Do you have higher institutions? __________ If yes, mention their names

11. What is the proportion of the people in your community who attended different levels of educational institution? (If you were to select 100 school students/pupils)

Primary school; __________

Secondary school; __________

Higher institutions; __________

12. What is the proximity of the educational institution to your community? __________

SECTION D: CULTURE AND RELIGION

1. What religious organizations are present in your community? State their proportions:

Christian: ________ Moslems: ________ Traditional Religion: ________

Others: __________

2. Do you have shrines and Deities in your community? Yes ☐ No ☐ If yes, mention their names and where they are located and what time are they worshiped?

Monthly ☐ Quarterly ☐ Yearly ☐ Any specific time of worship Day/Month

2. Do you have any areas (forests, rivers, etc.) being regarded as sacred? Yes ☐ No ☐ If yes, mention their names and locations

____
____
____

3. Do you have any historical or archeological site/monuments in your community? Yes ☐ No ☐ If yes, mention their names and locations

____
____

4. Mention the kind of festival being celebrated in your community and at what time of the year?

____
____
____

5. What are the Dos and Don'ts in the community?

____
____
____

6. List the major ethnic groups in the area/community;

i ________ ii ________ iii ________ iv ________ v ________

SECTION F: SOCIAL ENVIRONMENT

1. Briefly describe the structure of authority in your community (List in order of importance)

____
____
____

2. What type of land tenure system do you have in your community?

____
____

3. List the common community based social groups and organization found in the community and their Functions;

____
____
____

4. What do you think are the reasons for poverty in this community?

____

5. What would you say is the proportion of jobless people in this community? (If you were to select from among 100 persons) ________________________________

SECTION G: ENVIRONMENTAL PROBLEMS

1. List the main environmental problems in this community (e.g. deforestation, erosion, oil, spillage, gas, flaring etc.) and give perceived causes for the different problems.

S/No	Environmental Problems	Causes
1		
2		
3		
4		
5		

2. How seriously do these problems affect your income generating activities?

   Has little effect; ☐ Has serious effect; ☐ Has forced us to stop some activities ☐

   (Please provide further information on any serious effect)

   ____

   ____

   ____

3. Has the government or any other organization embarked on the activity to help reduce environmental problems in your community? Yes ☐ No ☐

4. If yes, what is the type of development programme; which organization; and what have been the impact?

   ____

   ____

   ____

SECTION H: CONCERNS ABOUT THE IMPACTS OF THE PROJECT

CONCERNS ABOUT THE IMPACTS OF ESTABLISHING THE PROJECT

Do you have concerns about establishing the PROJECT in your community?	Yes ☐ No ☐
If YES, what are they? (you can attach more sheets if more information exist about your response)	

(I). How do you think this project will benefit this community during the construction stage?

Item	Very Minimal	Minimal	Great	Don't Know
Job opportunity				
Improved social life				
Increase income				
Improvement of living standard				

(II). How do you think the project will benefit this community during the operational phase?

Item	Very Minimal	Minimal	Great	Don't Know
Job opportunity				
Improved social life				
Increase income				
Improved better communication				
Occupational Change				
Improvement of living standard				

(III). How do you think the project will adversely affect this community during the construction phase?

Item	Very Minimal	Minimal	Great	Don't Know
Job opportunities				
Destruction of/encroachment on land				
Loss of farmland				
Ground water contamination				
Surface water contamination				
Occupational Change				
Noise level				
Loss of wildlife species				

(IV). How do you think the project will adversely affect this community during the operational phase?

Item	Very Minimal	Minimal	Great	Don't Know
Pollution of drinking water				
Land pollution				
Land vibration				
Ground water contamination				
Surface water contamination				
Occupational Change				
Noise level				
Loss of wildlife species				

Thank You for your cooperation

APPENDIX TWO

APPLICATION FOR THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF CROSS RIVER STATE GOVERNMENT'S OBUDU CARGO AND PASSENGER AIRPORT, OBUDU LGA

GEO ENVIRONMENTAL RESOURCES LIMITED

"ENVIRONMENTAL SERVICES WATER RESOURCES, GEOPHYSICAL/GEOTECHNICAL ENGINEERING, ELECTRICAL, BIO-TECHNICS, WASTE DISPOSAL, CIVIL WORKS, SUPPLIERS AND GENERAL CONSULTANCY"

E-mail: info@geoenvresources.com
geoenvresources@gmail.com

ADDRESS:
Suite SB 81, 2nd Floor, New Banex (VOM) Plaza,
Aminu Kano Crescent, Wuse 11,
Abuja - Nigeria.
Tel: 09-2204061

Our Ref:........ Your Ref:........ Date:........

OFFICE OF THE HON. MINISTER
21 MAY 2019
Sign..........
FED. MIN. OF ENVIRONMENT ABUJA

DIRECTOR ENVIRONMENTAL ASSESSMENT DEPARTMENT
21 MAY 2019

May 21, 2019 COPY
GEOENV/ABJ/2019-2076
The Honourable Minister,
Federal Ministry of Environment,
Mabushi, FCT - Abuja.

Sir,

APPLICATION FOR THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF CROSS RIVER STATE GOVERNMENT'S OBUDU CARGO AND PASSENGER AIRPORT, OBUDU LOCAL GOVERNMENT AREA, CROSS RIVER STATE

The above subject matter refers.

We write to apply for the Environmental and Social Impact Assessment (ESIA) of the above named project in line with the EIA Act 86 of 1992 (CAP E12, LFN, 2004).

Kindly find attached evidence of payment via Remita (with RRR: **2903-0145-1897**), the sum of **Fifty Thousand Naira (₦50,000.00)** only, in favour of the Federal Ministry of Environment (FMEnv), as Application Fee. Also attached are a copy of the completed application form and Terms of Reference (ToR) for the ESIA of the project.

Please accept the assurances of our highest regards.

Very truly yours,
For: **Geo Environmental Resources Limited**

(Engr. Abu Abdulganiyu)
MD/CEO

GEO ENVIRONMENTAL RESOURCES LIMITED
RC 708123

(Incorporated in Nigeria RC 708123) 08051569942, 08038835136, 08092849994
Directors: Engr. Abu Abdulganiyu (Nigerian), Abu Joy Ejura (Nigerian), Abu Anthonia Claire (Nigerian)
"...the sustainability of the environment is our watchword"

APPENDIX THREE

FMENV LETTER APPROVING THE SITE VERIFICATION EXERCISE AND CONDUCT OF SCOPING WORKSHOP

FEDERAL MINISTRY OF ENVIRONMENT

Environment House
Independence Way South, Central Business District, Abuja - FCT.
Email:ea@ead.gov.ng, www.ead.gov.ng

ENVIRONMENTAL ASSESSMENT DEPARTMENT

FMEnv/EA/EIA/5109/Vol.1/
7th June, 2019

Cross River State Government,
Governor's Office,
Leopard Town,
Cross River State.

RE: APPLICATION/REGISTRATION FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) PERMIT FOR THE OBUDU CARGO AND PASSENGER AIRPORT AT OBUDU L.G.A, CROSS RIVER STATE.

Please refer to your letter dated 21st May, 2019 on the above subject.

2. I am directed to acknowledge the receipt of the evidence of payment of the sum of Fifty Thousand (N50, 000.00) Naira only with Remita Retrieval Reference (RRR) Number 2903-0145-1897 dated 20th May, 2019 being the EIA registration fee for the proposed project.

3. I am further directed to inform you that the Terms of Reference (ToR) submitted is not adequate for the EIA study. Consequently you are please requested to submit a revised Terms of Reference (ToR) which would include the following among others:

(a) Air space management system, Airport design, Length of the Runway, etc.
(b) Detailed Sampling Frame.
(c) Critical Environmental receptors to be impacted.
(d) Communities/livelihoods to be affected by the proposed project.

4. The next stage of the process is the site verification exercise which is to be carried out by the officials of the Ministry in collaboration with other relevant regulators in the state.

5. Consequently, You are to pay the sum of Five Hundred and Forty Thousand (N540, 000.00) Naira only into the Ministry's Treasury Single Account (TSA) to cover the exercise. You are also requested to kindly provide necessary logistics to ensure a hitch free exercise.

6. You may contact **M. B. Ajai** on **08023228544** to confirm the receipt of this letter and for any further information on the exercise.

7. Thank you for your cooperation.

Abbas O. Sulelman
For: Honourable Minister.

APPENDIX FOUR

ATTENDANCE OF THE SCOPING WORKSHOP AT PROJECT AFFECTED COMMUNITIES (ATIEKPE, IGWO, IKWOMIKWU AND OKAMBI)

GEO ENVIRONMENTAL RESOURCES LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

OBUDU LGA, CROSS RIVER STATE, NIGERIA. (~~SITE VERIFICATION~~) SCOPING WORKSHOP

ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGER AIRPORT

PROJECT LOCATION: OBUDU LGA CROSS RIVER STATE

DATE: 06-07-2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
1	Ude Therisa U	08113337874				
2	Ubiam James	09028204171				
3	Ibiam Victoria	08113337874				
4	Lydia Ugaba	07052462424				
(5)	Raymond Ugaba	08161295420				12:00
6	Ushie Daniel	08059915604				
7	Friday Atah	08073450921				
8	Anas Bishung	08024403565				
9	Josephine Bishung	08024403565				
10	Francis Bishung	08148275220				
11	Ushaka Joseph U	09019394178				
12	John Agro	08074583131				
13	John Bishung Agim	08024403565				
14	John Atah	08073450921				
15	Agim Justine	09066714710				
16	Jeremiah Afindor	09014534943				
17	SP Gabriel Amanu	07035539526				
18	Patrick B. Adie	08132215708				
19	Imbuke Clement	09125853220				
20	Ugbong Pauline	07022694469				
21	Sunday					
22	Sunday Nzama	09053172058				
23	Mary L. Ushie	08057815459				
24	Richard Abunimye	08083138795				
25	Sunday Agro-A.	07014743645				
26	Ushie Emmanuel	08128365570				

GEO ENVIRONMENTAL RESOURCES LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

SCOPING WORKSHOP

OBUDU LGA, CROSS RIVER STATE, NIGERIA. (~~SITE VERIFICATION~~)

ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGER AIRPORT

PROJECT LOCATION: OBUDU LGA, CROSS RIVER STATE

DATE: 06-07-2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
1	ADIE, CHARLES ADIE		07036760053			
2	UYANG EVARISTUS		08084211742			
3	IKWEN JAMES		07084389383			
4	UTSU CLEMENT LIKO		07067589915			
5	Joseph Udeye					
6	chief Emma Ugbong		08029054716			
7	H.H UTSU FIDELIS LAWUSA		08169192277			
8	HRH. Cornelius Isom		08088883106			
9	HH Evaristus Uyang		08084211742			
✓	HH James Ikwen		07084389383			
11	HRH UGBE ISAAC A		09060619054			
12	KENNEDY ULEM		07087559902			
13	UKEZI N. AGOGO		08087665819			
14	ABOH FIDELIS		07011243588			
15	Andeshi Felix N.		07087397977			
16	Emma Akwandaye		07082983819			
17	Imbufe Gabriel		09076056272			
18	Cyprian A. Ukakem.		07031376086			
19	Anagiose emmanuel		08021030049			
20	Aboh Patrick Adie.		07080546777			
21	Fredrick Andoma					
22	Akpanke peter Akomaye		08124612212			
23	Ikagba Pius .A.		07086060847			
24	behashie Emmanuel		09074308953			
25	ATSU PETER ASHIBEL		08084960140			
26	UKABA JOSEPH UNIMINA		07062667361			

GEO ENVIRONMENTAL RESOURCES LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

OBUDU LGA, CROSS RIVER STATE, NIGERIA. (~~SITE VERIFICATION~~ SCOPING WORKSHOP)

ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGER AIRPORT

PROJECT LOCATION: OBUDU LGA, CROSS RIVER STATE

DATE: 06-07-2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
1	IGBAL MICHAEL		09020644672		[illegible]	
2	Peter Ugbe Udie		07067408441		[illegible]	
3	Afoing Horace		08128718537		[illegible]	
4	Fredrick Ukwondi		08128718537		[illegible]	
5	David Ashitebe		-			
6	UGBE GRACE		07069791040		[illegible]	
7	UGBE Elizabeth		- - -		[illegible]	
8	Akebaye Joseph		- - -		F.I. Akobe	
9	Ateing Comfort		09065182415		[illegible]	
10	UGBE Elizabeth		09063658202		[illegible]	
11	ALICE UGBE		08103667288		[illegible]	
12	FELICIA ADIE		09010323681		[illegible]	
13	Afoing Patricia				[illegible]	
14	UGBE VINCENT U.		08066365187	vincentugbe@gmail.com	[illegible]	
15	Adie Pius		09036180462		[illegible]	
16	Ukwodi Agnes					
17	Hon. Benjamin Ukwondi		07019611372		[illegible]	
18	Hyacinth Adah		08033614395		[illegible]	
19	Richard Ugye		08071432242		[illegible]	
20	LIWHUNDE MIKE		07055627233		[illegible]	
21	AGIO GODWIN		07080518636		[illegible]	
22	Sylvester J. Akpowho		08033858559		[illegible]	
23	David B. Adie		09068849229		[illegible]	
24	Lidudiwhe Emmanuel		08026276273		[illegible]	
25	Denis Akenzon		08083232483			
26	Adie JOSEPH Adie		09022173534		[illegible]	

GEO ENVIRONMENTAL RESOURCES LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

OBUDU LGA, CROSS RIVER STATE, NIGERIA. (~~SITE VERIFICATION~~) SCOPING WORKSHOP

ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGER AIRPORT

PROJECT LOCATION: OBUDU LGA, CROSS RIVER STATE

DATE: 06 - 07 - 2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
1	ALEKA SUNDAY		08163272806			
	AGBA CHRISTOPHER					
	ATINDOR CICELIA		07060654830			
	BENEDICT ABUHE		09012786951			
	STEVEN ATINDOR		09015746830			
	ADUNG FERDINAND		08163501454			
	UBIE GODWIN I		09028204171			
	IKAM BENEDICT A.		08128716517			
	Agnes Awusha		=	=		
	AKOMAYE KENNETH		08135916704			
	AKWA TOK		08088331974			
	Clement AJAH		08127734107			
	Gregory Bekeh		09088244851			
	CLETUS IYAM		08087132183			
	Jeremiah ATINDOR		09014C4943			
	Ikam Joseph		07049889072			
	Justine Agim		09016717164710			
	Comfort Ulem A.	IGWO	08119052740			
	Innocent Ashitebe		08078562164			
	Boniface Ashitebe		08124103955			
	ASHITEBE Blessing		08072231192			
	Ashitebe Timothy		08074976700			
	KYRIAN ANDE		08158049184			
	Emma Usie Agio		09029559915			
	Timothy Bishung		07067501726			
	Catherine Bishung		08129093778			
	Martina Goddy Bishung		08057931346			
	Rita Ato					
	Sunday Aweye		08125150560			
	Ushie Agnes					

GEO ENVIRONMENTAL RESOURCES LIMITED

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OBUDU LGA, CROSS RIVER STATE, NIGERIA. (~~SITE VERIFICATION~~) SCOPING WORKSHOP

ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGER AIRPORT

PROJECT LOCATION: OBUDU LGA, CROSS RIVER STATE

DATE: 06-07-2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
	Lydia Akwandaye		07064633570			
	Comfort Akwandaye		09022948924			
	Azah Akwandaye		07080706791			
	ANYATING JOHN		08137323346			
	ANDOR, PETER, NELLY		09028263709			
	Ulem Comfort		08086991895			
✓	Idiku Celestine A.					
✓	Jerome Bishop		0712154835			
	Gabriel Atrange	Atiekpe	–			
	Andrew Adung	Atiekpe	–			
	[illegible] Itare	✓	08039328973			
	FEL CAESA	–	07019652823			
	Mary Adung		08129566618			
	UGBE LOIS A.		07065015516	=		—
	UGBE Joseph		07081016895	=		
	UGBE Goodness	— —	07063609054	=		
	UGBE MARGARET,		08160541911	—		
	Cecilia Ugomanbiang		08072410276			
	Victoria Ukwomeh		07019611377			
	AWUSHA Emmanuel		07083572073			
	Ikam Benedict A.		08128716517	=		
	AKOMAYE FRANCIS N		08078400617			
	AKPANKE JOSEPH		09018561922	=		
	ALEKA SUNDAY		08163272806			
	Agim Eugene		✓ ✓	=		
	JOHN ANDOR					

GEO ENVIRONMENTAL RESOURCES LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

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ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGE AIRPORT

PROJECT LOCATION: OBUDU LGA CROSS RIVER STATE

DATE: 06-07-2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
1	AKPANKE, CHRISTOPHER A.		08038682807		[illegible]	6-7-2019
2	Ukey Emmanuel		08036779767		[illegible]	6/7/2019
3	Paul J Ufsu		—		[illegible]	6/7/2019
4	Goddy I. Ikor	Atiekpe	—		G. I. K	6/7/2019.
5	Patrick Akiang	Atiekpe	08127909618		[illegible]	6/7/2019
6	Akiang Elizabeth	Atiekpe	08127909618		[illegible]	6/7/2019
7	Akomaye Cornelius	Atiekpe	08071242408		[illegible]	6/7/2019
8	Akomaye J. Akashie	Atiekpe	08058206831		[illegible]	6/7/2019
9	Ayayia, Simon Ayayia	Atiekpo	08020769161		[illegible]	✓
10	Akeke, Michael Umu	-do-	08125152931		[illegible]	✓
11	Liwhu Adapkwu	-do-			[illegible]	✓
12	Godwin Umagwu	Atekpe	08106172440		[illegible]	✓
13	Cecilia Akuonwonge	Atekpe	08162713838		[illegible]	✓
14	Bepeh Emmaculata A.	Atiekpe	07016672499		[illegible]	6/7/2019
15	Helen Akiang	Atiekpe	08148667645		[illegible]	6/7/2019
16	Uniuke Godwin	Atiekpe	0809389376		[illegible]	[illegible]
17	Ishado Felix U.	Atiekpe	07011345233		[illegible]	6/7/2019
18	Augustine Akem	Atiekpe	08154603567		[illegible]	6/7/2019
19	Atendi Gideon A.	Atiekpe	08088745083		[illegible]	6/7/2019
20	Sunday Atendoru.	"	07060657830		[illegible]	"
21	[illegible] A C I	"	09073280938		[illegible]	
22	Akomaye Sylvanus	Atiekpe	07033145028	—	[illegible]	6/7/19
23	Ben Jake	Atiekpe	08086307066		[illegible]	6/7/2019
24	Agida T. U.	"	08092263098		[illegible]	6-7-2019
25	Akomaye Udey	Atiekpe	07064633570		[illegible]	
	Mary J Akang		08147234377		[illegible]	

GEO ENVIRONMENTAL RESOURCES LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

OBUDU LGA, CROSS RIVER STATE, NIGERIA. (~~SITE VERIFICATION~~ SCOPING WORKSHOP)

ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGER AIRPORT

PROJECT LOCATION: OBUDU LGA CROSS RIVER STATE

DATE: 06-07-2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
1	Ligie Don Chris		08027231055			
2	Adeh Gabriel		08102967205			
3	Victor Aleh		07083273628			
4	Kingsley Adimpeye		07083273628			
5	Jacob Ugbe		07088455734			
6	Adie Augustine A.		09079662970			
(7)	AKOMAYE SUNDAY	OBUDU	08086380696	SUNNYAKOMA@gi.ng		11.8 AM
(8)	Godwin ABASHIE		07015855285			
	LIKO Paul .I.		07017720108			
10	Ugbuka Emmanuel		09013318326			
	Ingwu Emmanuel Ingwu		08109132285			
12	MOSES IKAP		07067908~~[illegible]~~1104			
13	ABRAHAM BEPEH		09024948357			
14	AKWA TOK	~~[illegible]~~ 08088331974				
15	Emmanuel Akiang		09051170502			
16	BISHUNG PATRICK	OBudu	08089273363			
17	BISHUNG PETER		07030463835			
18	chris Ukie		09077062616			
19	Ikogba Linus U.		09034618123			
20	Peter Aberike	OBUDU	07087177839	~~Peterbishung at gmail~~		
21	BISHUNG PETER	OBUDU	08134469759			
	AKWANDAYE JOHN	BUDU	09017409711			
22	Iduku Vincent A.		08088273245			
23	IJAM JOSEPH	OBUDU	09070423696			
24	IFOEMOH AKWETH	OBUDU	09017409711			
25	DENIS BETIANG	OBUDU	09070423696			

GEO ENVIRONMENTAL RESOURCES LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

OBUDU LGA, CROSS RIVER STATE, NIGERIA. ~~(SITE VERIFICATION)~~ SCOPING WORKSHOP

ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGER AIRPORT

PROJECT LOCATION: OBUDU LGA CROSS RIVER STATE

DATE: 06-07-2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
1	Anthony Adah Ukembe	Atrekpe	08111928469		[signature]	
2	Ogboreka, Prince	Okambi	08036588958		[signature]	
3	Daniel Adike	Okambi	07068655668		[signature]	
4	Bishung Godwin	Atiekpe	08058886932		[signature]	11.09
5	Richard Abunimye	Atiekpe	07057333035		[signature]	11.10
6	Helen Abunimye	✓	08121808729		[signature]	11.11
7	Anumpuye Kingsley	Iewo	07083253702		[signature]	11:12
8	Adah Fidelis A.	Atrekpe	07014445850		[signature]	11:14
9	Agaba Christiana	Ikwomikwo	08103720888		[signature]	11:16
10	Agaba Theresa	✓	07052462424		[signature]	11:16
11	Agaba David	✓	08161295420		[signature]	11:17
12	Ugemmabiang cecilia	✓	08126683753		[signature]	11:18
13	Victoria Ukalondi	✓	08072410276		[signature]	11:18
14	Isaac Ushie	✓	08084070748		[signature]	11:20
15	Ushaka Paul Abonye	Okambi	07088730787		[signature]	11:21
16	Agaba John	Ikwomikwo	07052461424		[signature]	11:22
17	Ashiepe Donald	Atiekpe	08091476044		[signature]	✓
18	Akomaye Thomas	✓	08154182931		[signature]	✓
19	Ashiepel Akomaye	✓	—		[signature]	✓
20	Akomaye Cornelius	✓	08071242408		[signature]	✓
21	Ashaka Akomaye	✓	08124717350			
22	Sir Inde Godwin	Okambi	08051325685		[signature]	11.24am
23	Ukwondi Gloria A	Ikwumikwu	08087146248		[signature]	11.25am
24	Ugbe Anthony A.	Ikwumikwu	0808742112		[signature]	11:30am
25	Udie Christopher Ikor	Atiekpe	08074137369			
26	Augustine Udie	✓				

GEO ENVIRONMENTAL RESOURCES LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

OBUDU LGA, CROSS RIVER STATE, NIGERIA. SCOPING WORKSHOP ~~(SITE VERIFICATION)~~

ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGER AIRPORT

PROJECT LOCATION: OBUDU LGA CROSS RIVER STATE

DATE: 08-07-2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
1	ERIC ADAH		07012399644			
2	BISHUNG JEROME					
~~3~~	~~AP~~		08058586932			
3	Akomaye Lucy U.		07019869760			
4	Stephen ugbong		08065582262			
5	David Igenye					
6	Ugbeleba Sam					
7	Ugar Akinshere		09016387441			
8	Abah Aboh					
9	Pius Atiandshie		07087686240			
10	Gabriel Andorbe					
11	Adie Ashuwle					
12	FRIDAY BAHASHE		07089296643			
13	Andortam John		08065024977			
14	AZU David A.		09098345514			
15	Moses Ushukwashi		08125319310			
16	Michael Andor		08087132283			
17	Cletus Iyam					
18	Bushang Asinn					
19	Dake Atsi		08124455540			
20	ATSI BENEDICT		08124279994			
21	Emmanuel Ashitebe		08030553169		EMMANUEL	
22	Augustine Itilinwe		08158309076			
23	Luke Ashitebe		08028878244		LUKE	
24	BENEDICT ASHITEBE		08081537183		BENEDICT	

GEO ENVIRONMENTAL RESOURCES LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

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ATTENDANCE SHEET

PROJECT TITLE: OBUDU CARGO AND PASSENGER AIRPORT

PROJECT LOCATION: OBUDU LGA CROSS RIVER STATE

DATE: 06-07-2019

S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
27	Udie thomas Ikor	Atiekpe	08074137376			
28	Bishung Lawrence	Atiekpe	07059723215			
29	Emmanuel U. Ayagia	Igwo	08136198157			
30	Ogar, Gabriel U.	Igulo	08[illegible]2931279			
31	Francisca A	Mkem				
32	Justice Udoyo A.	Atikpe	0870559[illegible]			
33	Ushie dangel A.	Atikpe	0708647[illegible]			
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34	Akeh Umekeh	Atiekpe	07015301454			
35	Akhungwu Ikor	Atiekpe	09019973700			
36	Adie Ithong	Atiekpe	0901[illegible]56978			
37	Ugbe Godwin A	Ikwomikwu	08083172010			
38	ATIAMBE William	ATIEKPE	09072306621			
39	Jeremiah ATINDOR		09014541945			
40	Victoria Ikwen		07034110233			
41	Bishung Paul A		08152574409	Paulbishungashiwel@gmai		
42	Margaret Bishung		08052928716			
43	Emmanuel Bishung		08131007011			
44	Veronica Bishung		08148275220			
45	Sylvanus Bishung		08148275120			
46	ALICE IKOR	ATIEKPE				
47	Emmanuel Angiating		08052755302			
48	Benard Abuemaye		07050604[illegible]9			
49	Micheal Anyodor		09035422386			
50	ATSI Kyzen		09098341530			
51	ROSE UMEKO		07015301454			

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE CROSS RIVER STATE GOVERNMENT PROPOSED OBUDU CARGO AND PASSENGER AIRPORT,

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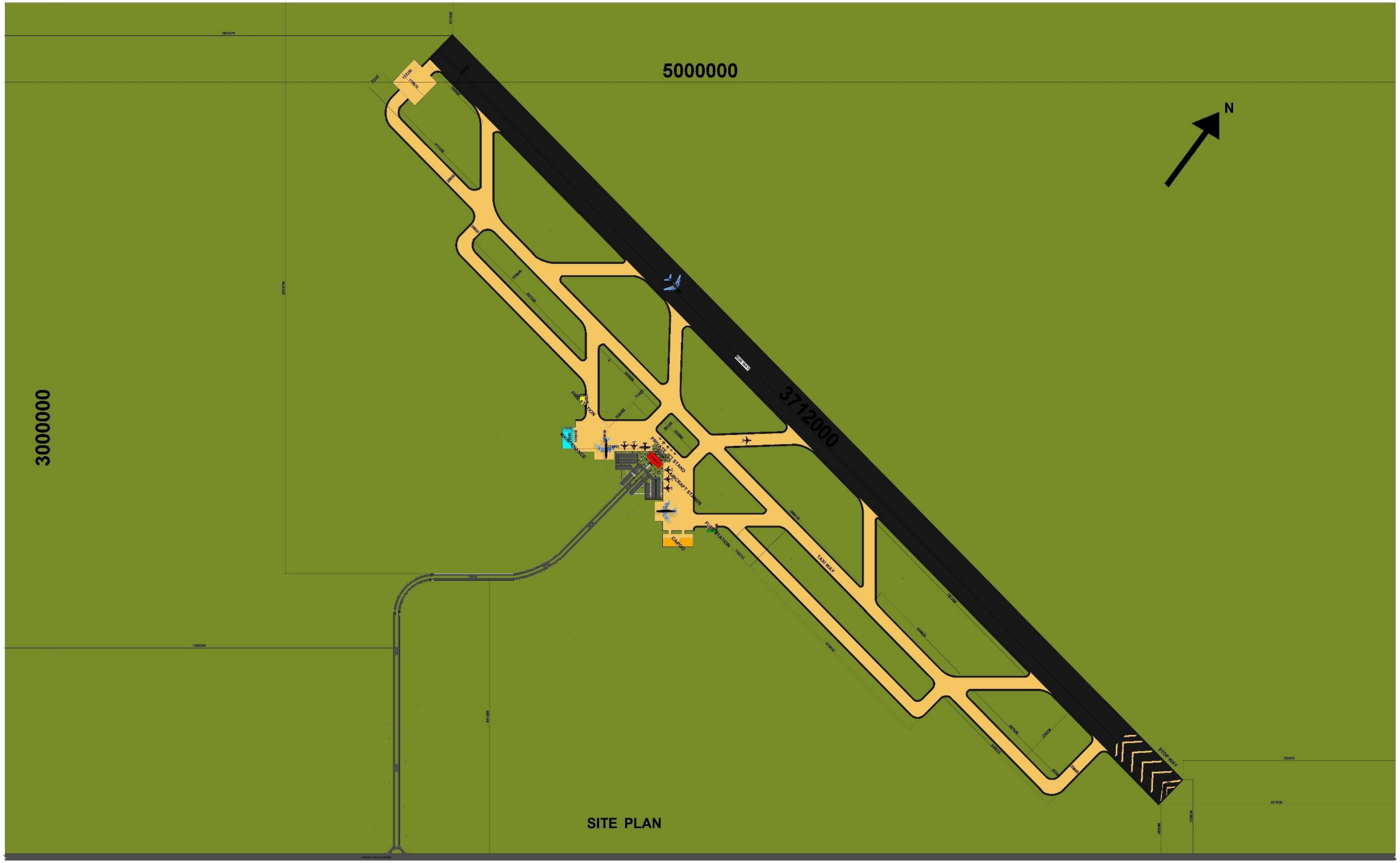
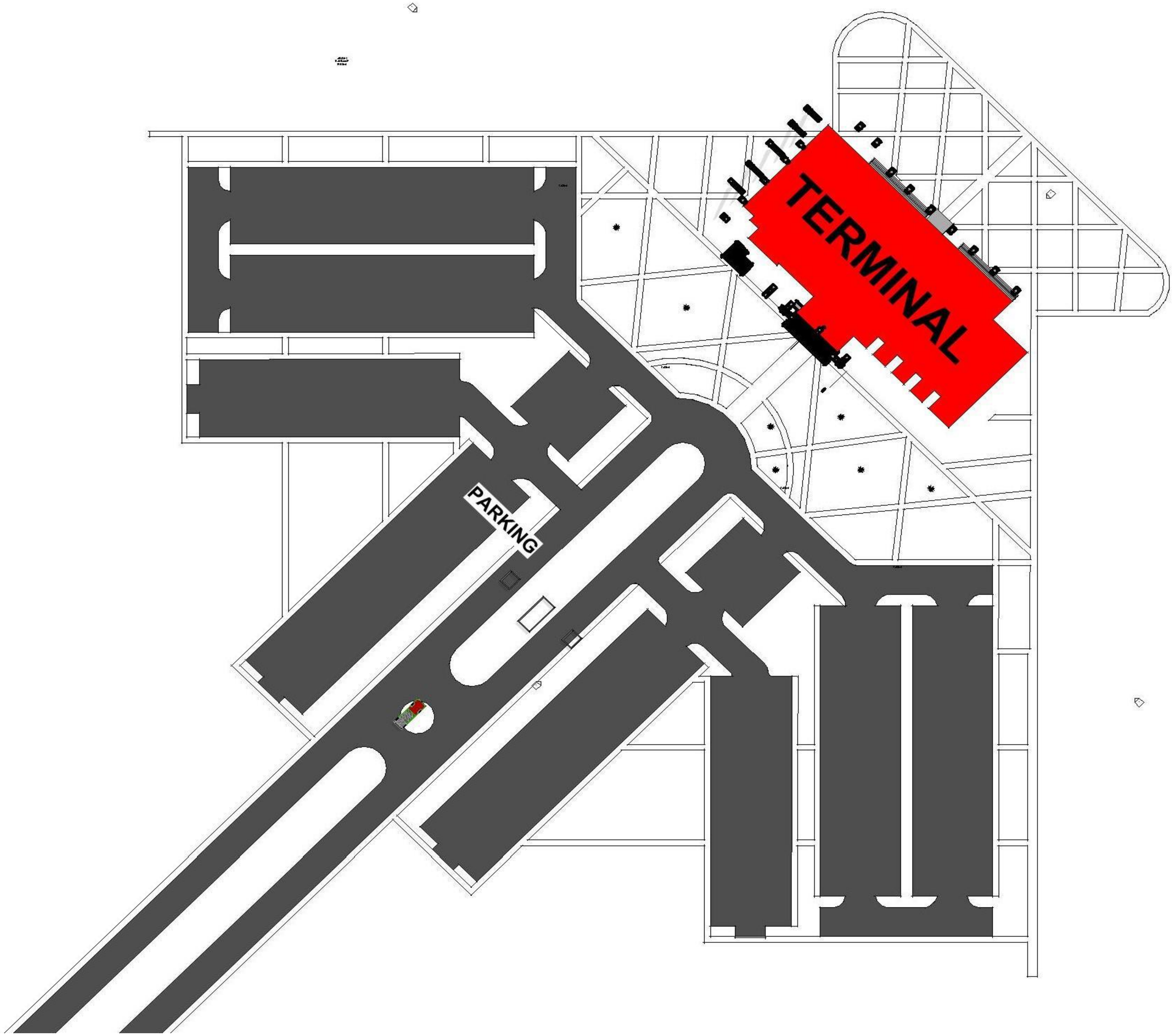
DATE: 06-07-2019

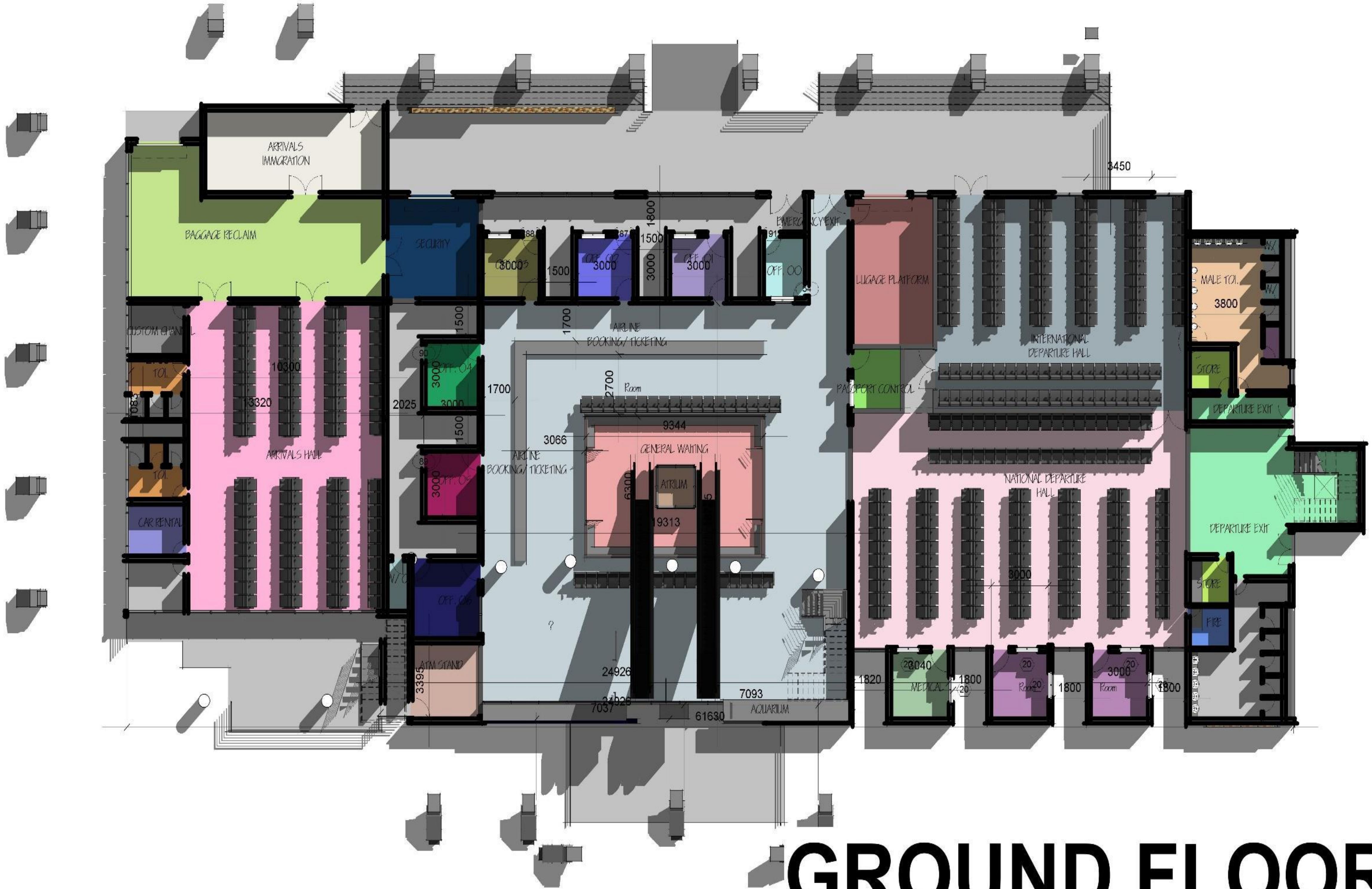
S/N	NAME	ORGANISATION	TELEPHONE	E-MAIL	SIGNATURE	TIME
1	UKEH FELICIA U.		08082067772		[signature]	
2	UGIAN MARCELLINUS				[signature]	
3	Richard Ugian		07080005915		[signature]	
4	Amuble Clement		07037886195		[signature]	
5	AKPANKE VICTORIA A		08086832323		[signature]	
6	UGBE RICHARD A.		08123073977		[signature]	
7	UKPEM PHILOMINA		08123383465		[signature]	
8	UKPEM MATHIAS		08086807076		[signature]	
9	ASHAMU GABRIEL		07086358036		[signature]	
10	Akpanke David		08128319488		[signature]	
11	Ugbe Francis U.		08124452042		[signature]	
12	Egbong Joachim	Team Honour	07030951552		[signature]	11.00am
13	Ushinde Emma				[signature]	
14	UNAKE DENIS		08030738311		[signature]	11 : am
15	Akem Moses A		09029127545		[signature]	11 : am
16	IKWEN, PETER IKWEN		09016273056		[signature]	11 : am
17	PATRIC AKPANKE		07089296171		[signature]	11. am
18	Timothy Adie		08084563440		[signature]	
19	Emmanuel Bisnuong				[signature]	
20	ALUKU CORNELIUS		08028420227		[signature]	
21	Ishang Mathew				[signature]	
22	Ibn Cotta Ikuru					
23	Ubaba Damian		08020646562		[signature]	
24	UBLIBLI, ERIC	AKOMAYIE	08083773319		[signature]	
25	Akem Peter		07013170939		[signature]	
26	Bea Adah		07054785081		[signature]	

APPENDIX FIVE

DESIGN OF THE PROPOSED OBUDU CARGO AND PASSENGER AIRPORT


5000000
N
3000000
3712000
SITE PLAN

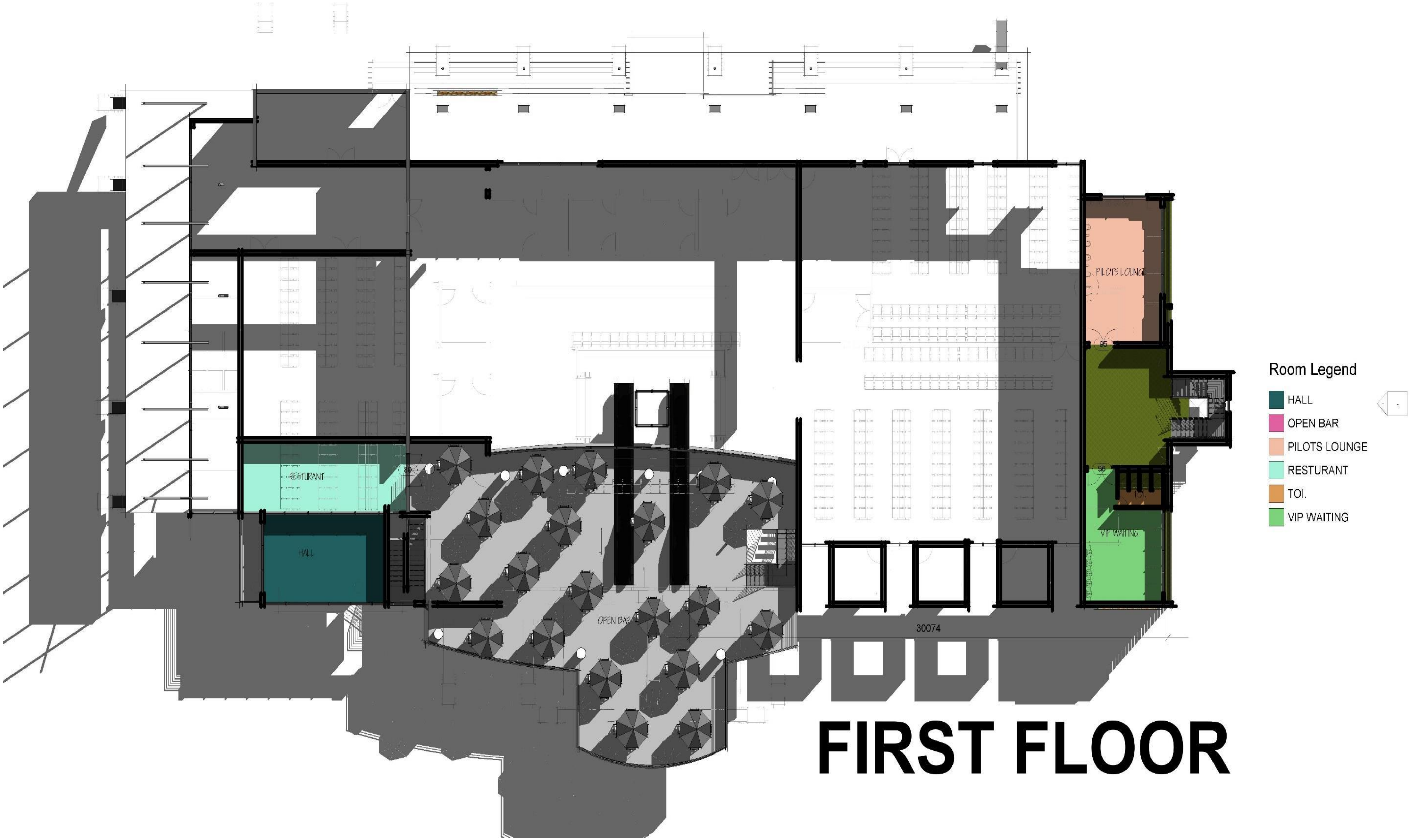

TERMINAL
PARKING



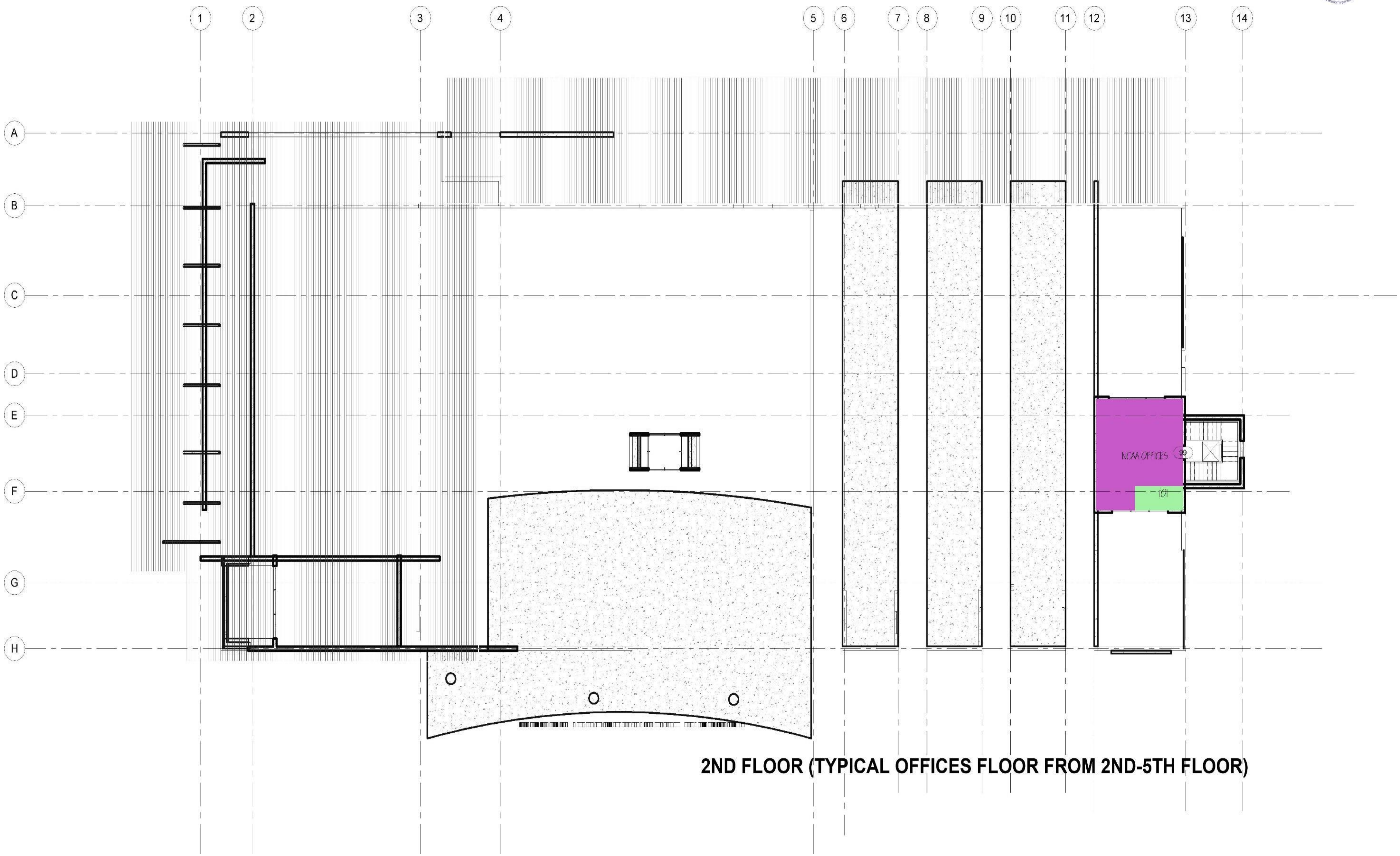
Room Legend

- AIRLINE BOOKING/TICKETING
- AQUARIUM
- ARRIVALS HALL
- ARRIVALS IMMGRATION
- ATM STAND
- ATRIUM
- BAGGAGE RECLAIM
- CAR RENTAL
- CUSTOM CHANNEL
- DEPARTURE EXIT
- EMERGENCY EXIT
- FIRE
- GENERAL WAITING
- INTERNATIONAL DEPARTURE HALL
- LUGAGE PLATFORM
- MALE TOI.
- MEDICAL
- NATIONAL DEPARTURE HALL
- OFF. 00
- OFF. 01
- OFF. 02
- OFF. 03
- OFF. 04
- OFF. 05
- OFF. 06
- PASSPORT CONTROL
- Room
- SECURITY
- STORE
- TOI.
- W/C

GROUND FLOOR

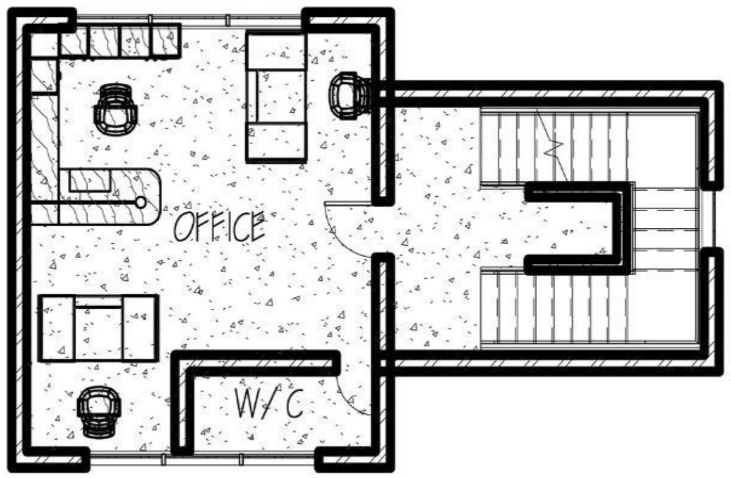

PILOTS LOUNGE
RESTURANT
HALL
OPEN BAR
VIP WAITING
30074
Room Legend
HALL
OPEN BAR
PILOTS LOUNGE
RESTURANT
TOI.
VIP WAITING

FIRST FLOOR

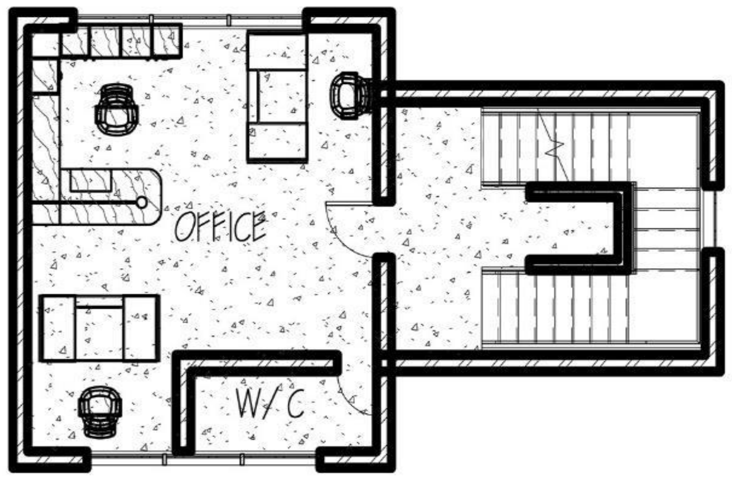


2ND FLOOR (TYPICAL OFFICES FLOOR FROM 2ND-5TH FLOOR)

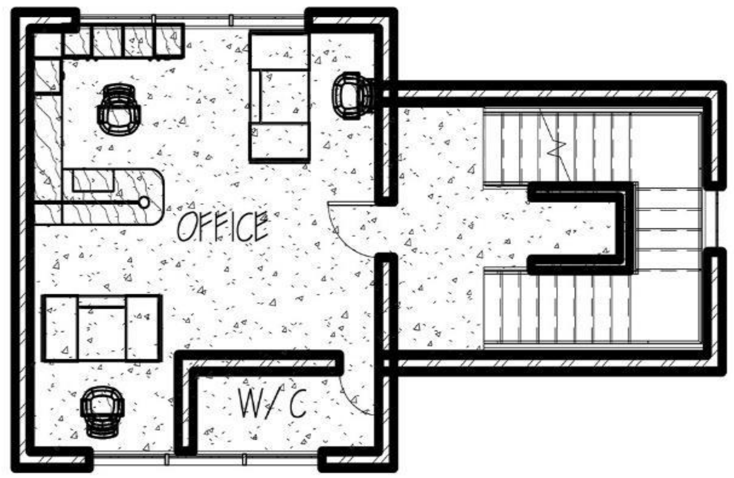
CONTROL TOWER PLAN



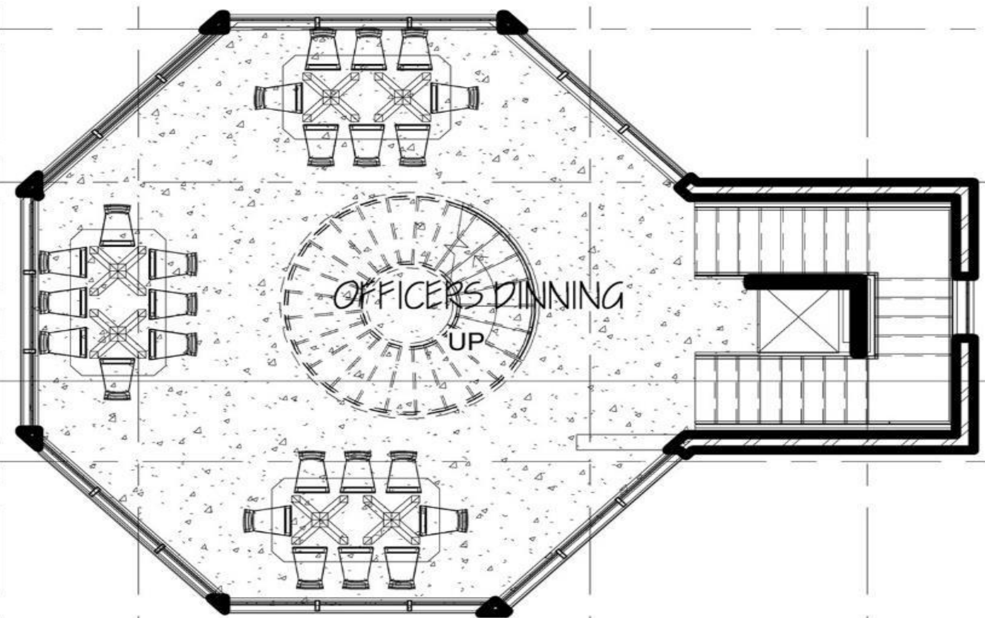
3RD FLOOR



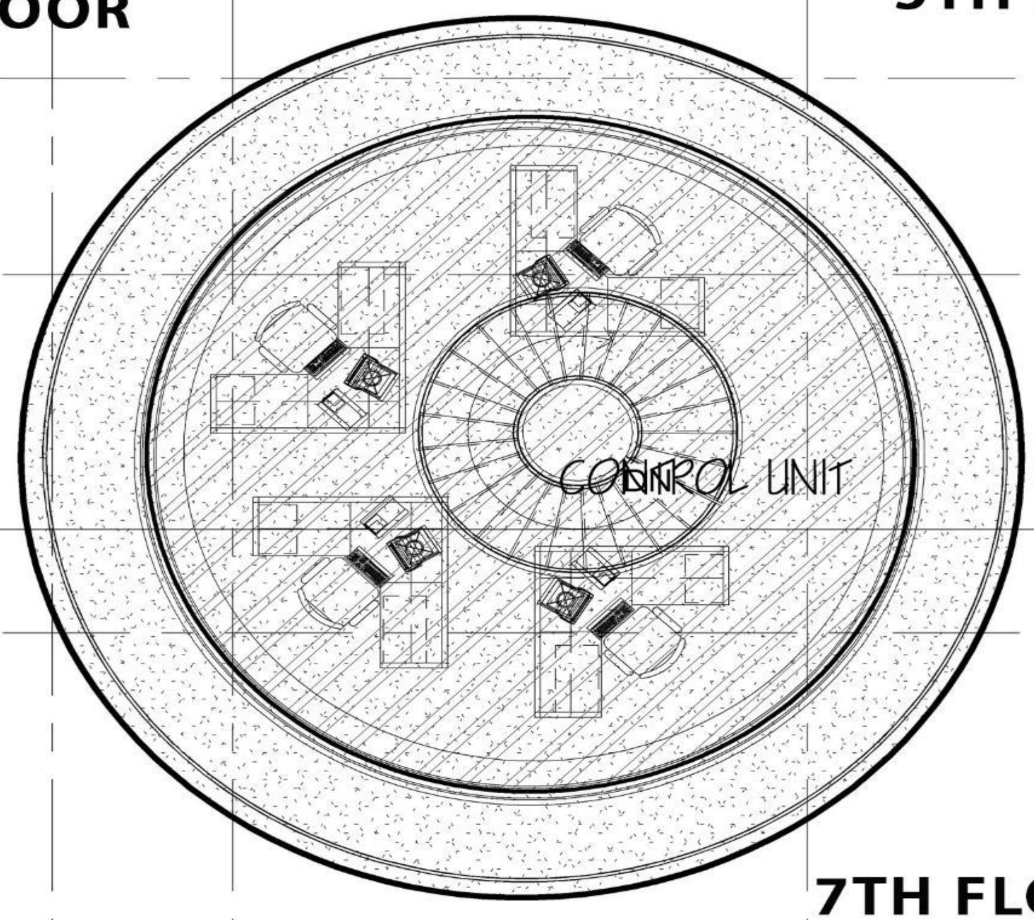
4TH FLOOR



5TH FLOOR

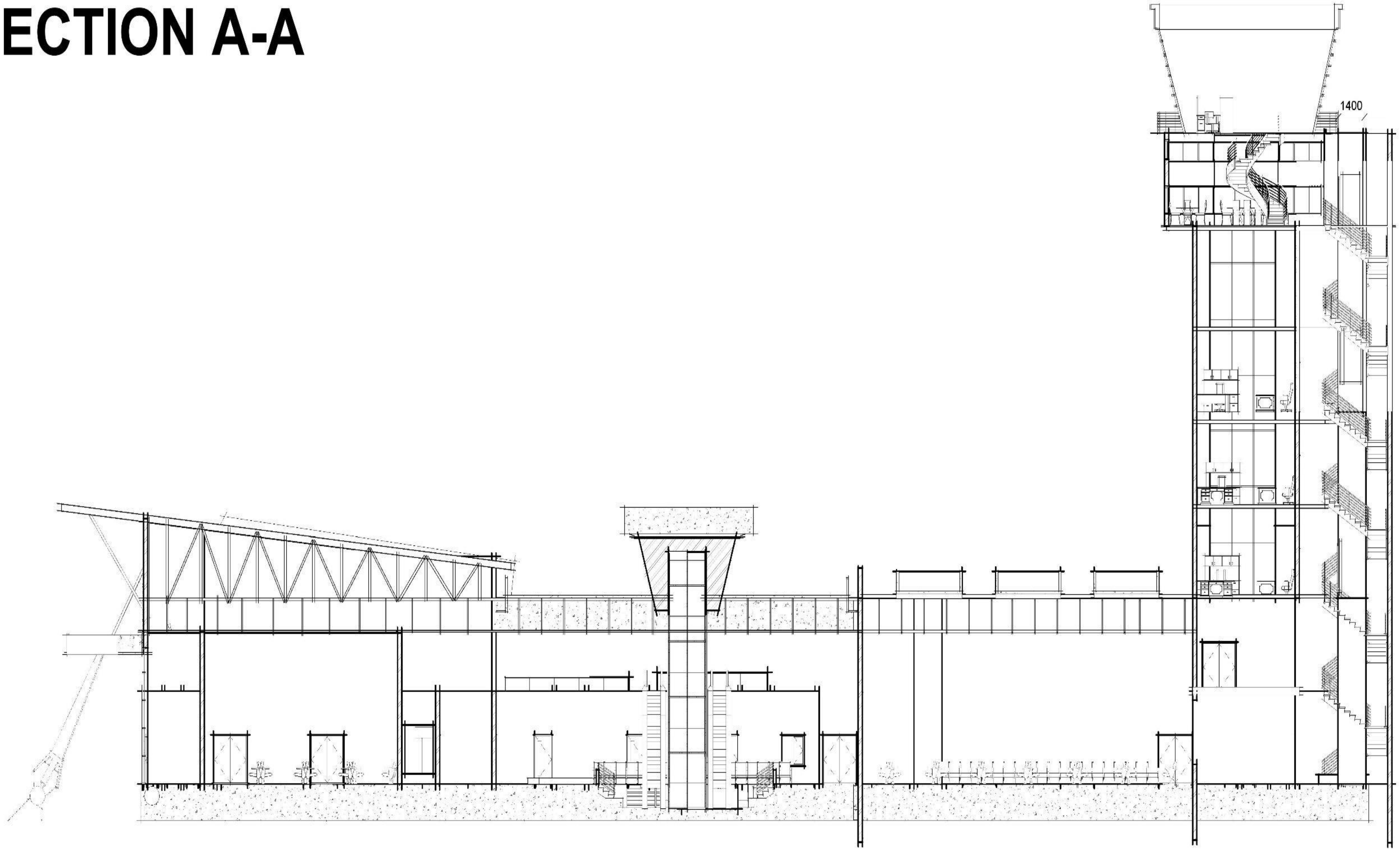


6TH FLOOR

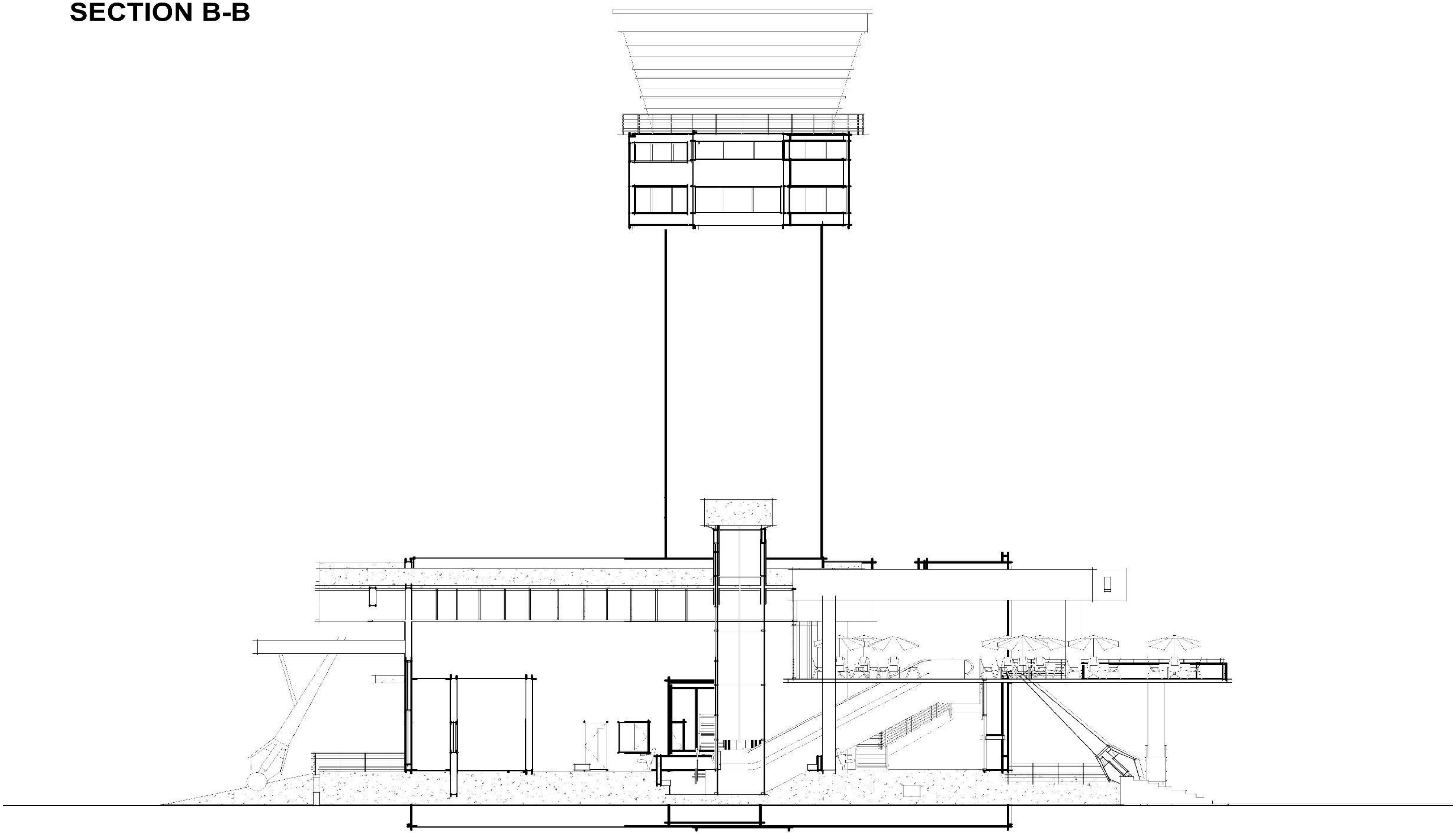


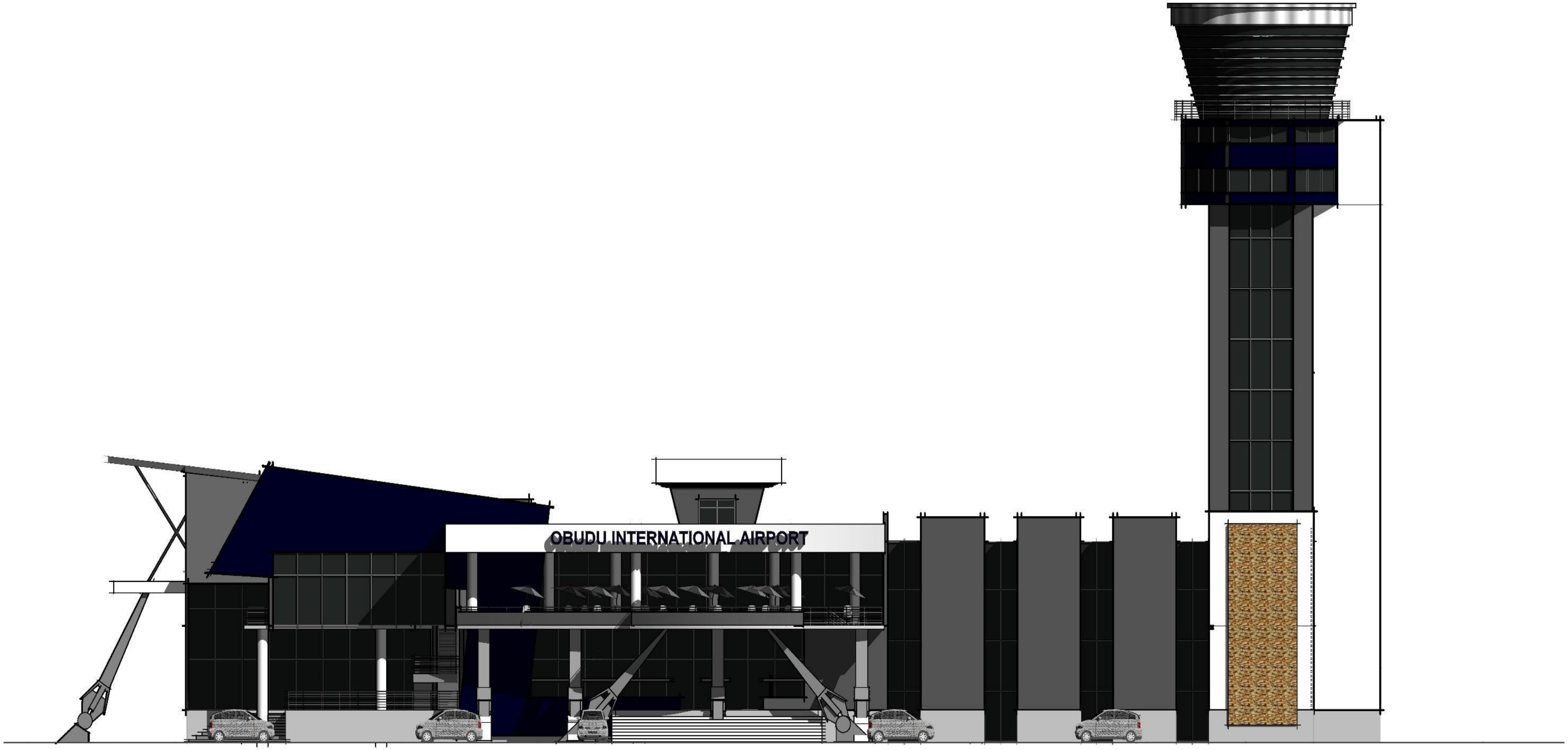
7TH FLOOR

SECTION A-A



SECTION B-B





SOUTH ELEVATION

WEST ELEVATION

NORTH ELEVATION