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ABBREVIATIONS AND ACRONYMS

General Abbreviation and Acronyms

AAS	Atomic Absorption Spectrophotometer
AC	Alternating Current
ADSMEV	Adamawa State Ministry of Environment
AIDS	Acquired Immune Deficiency Syndrome
APHA	American Public Health Association
ASTM	American Society for Testing and Material
Ba	Barium
BCU	Bay Control Unit
BOD	Biochemical Oxygen Demand
BS	British Standard
Ca	Calcium
Cd	Cadmium
Cfu	Colony forming units
Cl^{-}	Chloride ion
CO	Carbon Monoxide
CO_2	Carbon IV Oxide
COD	Chemical Oxygen Demand
Cond.	Conductivity
Cr	Chromium
Cu	Copper
dB	Decibel
DC	Double Circuit
DEP	Design and Engineering Practice
DO	Dissolved Oxygen
DS	Dissolved Solid
EAECL	Environmental Assessment & Evaluation Company
EBS	Environmental Baseline Studies
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EMP	Environmental Management Plan
EMF	Electromagnetic Force
Fe	Iron
FDAL	Federal Department of Agricultural Land Resources
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FMEnv.	Federal Ministry of Environment
FOW	Fibre Optical Wire
GHG	Green House Gas

GPS	Global Positioning System
GIS	Geographical Information System
HIL	Hydropower Investment Limited
HUB	Hydrocarbon Utilizing Bacteria
HUF	Hydrocarbon Utilizing Fungi
Hg	Mercury
HIV	Human Immunodeficiency Virus
HSE	Health Safety and Environment
ISO	International Standard Organization
JHA	Job Hazard Analysis
K	Potassium
Kg	Kilogram
kV	Kilovolts
LGA	Local Government Area
m	meter
mA	Milliampere
MESL	Main Stream Energy Solution Limited
Meq	Milli equivalent
Mg	Magnesium
Mg	Milligram
mm	Millimeter
MVA	Millivolt per ampere
N	Nitrogen
NH_4	Ammonia
Na	Sodium
ND	Not detected
NO_3^-	Trioxonitrate v ion
Ni	Nickel
NO_2	Nitrogen iv Oxide
NSEPA	Niger State Environmental Protection Agency
NSME	Niger State Ministry of Environment
NSMLH	Niger State Ministry of Land and Housing
NTU	Nephelometric Turbidity Unit
PAPs	Project Affected Persons
PPE	Personal Protective Equipment
Pb	Lead
PO_4^{3-}	Phosphate ion
pH	Hydrogen ion concentration
PPE	Personal Protective Equipment
ppm	parts per million
PTL	Power Transmission Line

PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
R	Risk factor / Reversible
RAPID	Research and Public Information Dissemination
RCV	Rated Control Voltage
ROT	Rehabilitate Operate and Transfer
ROW	Right of way
SO_4^{2-}	Tetra oxoSulphateiv ion
SO_2	Sulphuriv Oxide
SPM	Suspended Particulate Matter
SS	Suspended Solids
t	Time
TDS	Total Dissolved Solid
THB	Total Heterotrophic Bacteria
THC	Total hydrocarbon content
THF	Total Heterotrophic Fungi
TCN	Transmission Company of Nigeria
TL	Transmission Line
TLROW	Transmission Line Right of Way
USEPA	United State Environmental Protection Agency
TDS	Total Dissolved Solids
TH	Total Hardness
TOC	Total Organic Carbon
TS	Total solid
TSS	Total Suspended Solid
WHO	World Health Organization

Abbreviation and Units of Measurements

%	Percentage
g/m^3	Microgrammes per metre cube
Cfu/ml	Colony forming unit per milliliter
Cfu/g	Colony forming per unit grams
cm	centimeter
Db(A)	Decibel Accoustics
g	Grammes
mg/l	Milligramme per litre
Hz	Hertz
Km	Kilometre
KPa	kilopascal
KV	kilovolts
M	Metre

M^2	Metre
M^3	Metre cube
Mg/kg	Milligram per kilogram
Mw	Megawatts
NTU	Nephelometric Turbidity Units
^0C	Degree Celcius
^0F	Degree Fahreinheit
Ppm	Parts per million
Psi	Pound per square inch
S	Second

List of EIA Preparers

s/n	NAME	FIELD	RESPONSIBILITY
1	Amadi Uchenna Ansalem	Environmental Management/Impact Prediction	Team Leader/ProjectCoordinator
2	Mr. Akharame Idonije	Water Chemistry/Microbiology	Project Manager
3	Dr. Oguotoke Olusegun	Quality Assurance Control/HSE	Team Member
4	Dr. Martins Eze	Socio-Economics/Health Impact Assessment	Team Member
5	Mr. Okoro H.E	Flora and Fauna Study/Geology	Team Member
6	Mr. Bright Ekenmah	Soil Science	Team Member
7	Dr. Adediran Adetayo	Air Quality/ Meteorology	Team Member
8	Prof Donatus Adie	Hydrology/Hydrogeology	Team Mmber
9	Engr. Innocent Nwachukwu	Project Description, Alternatives Analysis	Team Member
10	Mr. Oluseni Gbenga	GIS Support/ Land Use	Team Member
11	Sundays Musa	Field Assistant	Team Member
12	Vera Onwochei	ICT/Office Logistics	Team Member
13	Okhomina George	Field Assistant	Team Member

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EXECUTIVE SUMMARY

INTRODUCTION:

This document presents the Environmental Impact Assessment (EIA) of the proposed Amfani Industrial park and Smart City Project. With a view to achieving diversification of the economy from oil, and absorbing the growing workforce by creating productive jobs and also promote exportation through effective industrialization process leveraging on special economic projects, the Federal Government of Nigeria(FGN) is currently developing world class Special Economic Zones (SEZs). The concept of industrial park is being promoted globally to fast-track industrialization, socio-economic development of designated areas and jobs/wealth creation. Hydropolis Investment Limited (HIL) has keyed into the foregoing concept of the FGN and intends to embark on a project known as the Amfani Industrial Park and Smart City Project.

It is in view of the above, that Hydropolis Investment Ltd (HIL) engaged the services of Messr: Environmental Assessment and Evaluation Company Limited (EAECL)to carry out an Environmental Impact Assessment (EIA) study for the project before its actual commencement.

PROJECT LOCATION

The proposed project would be located at Longitude 4°5'45'' to 4°38'30'' and Latitude 9°59'15'' to 9°54'30'' in Amfani area of Magama Local Government Area (LGA) of Niger State, Nigeria. Land area earmarked for this development is approximately 1000 hectares and situated by the Kainji Lake which is the source of water for the Kainji Dam and the major basis for citing the project in this location.

LEGAL AND ADMINISTRATIVE FRAMEWORK

The legal and regulatory framework for carrying out EIA of the proposed Amfani Industrial Park and Smart City project are contained in relevant Nigerian statutes and international environmental conventions to which Nigeria is signatory. These include;

- The regulations, Guidelines, standards, codes and recommended practice of the Federal Ministry of Environment, (FMEnv).
- Other National Legislation
- Niger State Legislation
- Relevant Nigeria Laws and Regulation on Waterways, Works, Industrial activities, etc.

- Applicable International Guidelines, Treaties and Conventions.

PROJECT JUSTIFICATION

Need for the Project

Among other factors, this project is specifically engendered by structural reforms of the Nigerian economy and the production spheres that are affected by ever stronger competitive struggle within the constantly changing global market space and the impacts of the global crisis. It is worthy of note that the previous production and industrial structure of economies could not stand; hence this new concept of industrial park development.

The development of this industrial park can be viewed as an integrated solution to development and economic growth. Industrial park has proven to be an instrumental tool in ensuring social and economic development in the world. The development of the Amfani Industrial Park will lead to a significant reduction in the need for travel by thousands of people who depend on the surrounding towns like New Bussa, Mokwa, Ibbi, Zugurma, Wara, Auna and as far as Jebba for one basic need or the other. Therefore, in this regard, the importance of the Amfani Industrial park cannot be overemphasized.

In a large and populous state such as Niger State with several satellite rural settlements, widely spread across the state, more commercial and social hubs are required to be developed at areas suitable for both business and social development in order to allow for effective development cutting across the state. Therefore, in the overall consideration the need for construction of an Industrial park at Anfani Village in Magama LGA in Niger State is to meet the demand for sustainable development within and across Niger State and provide opportunities for collaboration amongst business operators for public good enhancement.

PROJECT DESCRIPTION

The Amfani Industrial Park and Smart City project when fully completed will be made up of the following components:-

- A smart city with residential apartments of different sizes with uninterrupted power and internet services.
- High-tech industrial park for low to high technology production.
- Commercial area, business district and financial hub

- World Class Medical Services
- Smart Primary/Secondary Schools.
- Hydropolis University
- Hydropolis Airport
- Recereational area for leisure and sports consisting of Water Park, Amusement Park, Sport Arena, Water Sport and Cruising.
- Hospitality Industry of different grade of world class hotels. Golf Course, International Conference/Convention Facilities.

The project will provide a range of services for potential tenants and offer a variety of investment and co-operation options to both tenants and investors alike. Numerous structures and facilities as highlighted above have been plannedfor this development. These will further include access roads, airport, slipway, alternative power source, water supply, fire-fighting station, etc. However, the Airport is planned for the next phase of this project. The design principles for the Master Plan are as follows:

- The core commercial and residential developments are located in close proximitytotheindustrialareasinthenorth.CoreCommercialAreasare located centrally with only limited commercial development along the waterfront.
- The Industrial Park is located to the north of the development and is linked with the golf course through a strong commercial axis activated by retail and mixed use developmentnodes.
- Existingriversandwet/drygulliesarepreservedandintegratedwithin an urban greennetwork.
- CityCentresareestablishedalongthemaingreennetwork,andonthe lakeshoreline.
- Green networks respect the topography. Minimum intervention inclose proximity to the water reduce environmental and visual impacts on the naturalassets.
- Radial urbanstructure;
- Segregated residential areas that are developed around thegreen network create different “cluster” neighbourhoods.
- Primary roads provide a direct link from the city located on the south to the industrial area in thenorth.
- Industrial and urban vehicular flows are segregated. Lorry routesare segregated from light motor vehicles.
- Tourism areas are distributed in close proximity to thewaterfront

- The design approachhas beeninformed by the followingdesigninformantsthat haveshapedthekey direction of theMasterPlan;
- The design informantshave been identifiedthroughthe findings of thedata analysisstudyconductedand the appraisalof the physicalfeatures of thesite.Thefollowing factors informed the design of the master plan;
- Wind Direction: Prevalent winds are from the south west and the south-east. The north of the site has therefore been identified as the optimum location for the industrial areas, so as to avoid any potential negative impacts of air pollution.
- Lake water levels: The water levels in the lake rise to approximately 142.5 meters and the recommended minimum site elevation is 144m. The 144meters contour has been taken as the maximum extent of waterfront development, minimizing the need to expensive cut and fill and equally minimizing site grading costs.
- Site Contours: the site contours slope gently from the west to the east, and the master plan road networks will need to take this into consideration.
- Golf: The peninsula to the south of the site has been identified as the optimum location for the Golf Course.

Waste Generation and management

Expected waste categories to be generated during the different phases of the project shall include felled trees and other vegetal matter from project site clearing, domestic rubbish/trash, scrap metals, non-plastic combustible and packaging materials, plastic packaging materials, drum and containers, chemical waste hazardous substances and chemicals, waste oil, medical wastes, cement slurries and mix, kitchen waste (organic). The strategies for waste management and treatment have been outlined under the Environmental Management Plan (EMP) in chapter 7 of this report.

Decommissioning, Rehabilitation and Restoration

This involves the following steps or processes;

- Dismantling of the buildings/ structures and installations.
- Dismantling of building/structure foundations
- Removal of all material from project site.
- Restoration of land to its original situation as much as possible

DESCRIPTION OF THE EXISTING ENVIRONMENT

The baseline information on the bio-physicochemical and socio-economic environment of the proposed project area were based on information from literature as well as findings of a two season field sampling studies, laboratory analyses and a detailed socioeconomic.

Climate and Meteorology

Niger State experiences distinct dry and wet seasons with annual rainfall varying from 1,100mm in the Northern part of the State to 1,600 mm in the southern parts. The maximum temperature is recorded between March and June, while the minimum is usually between December and January. The rainy season lasts for about 150 days in the Northern parts and about 120 days in the Southern parts of the State. Generally, the climate soil and hydrology of the State permit the cultivation of most of Nigeria's staple crops and still allows sufficient opportunities for grazing, fresh water fishing and forestry development with high temperature and humidity follows a tropical pattern with the raining season starting about April and ending in September, followed by dry season. The climate of the project area is tropics (i.e. semi-hot equatorial). It is controlled by latitudinal locations, prevailing (seasonal) winds and nearness to the Atlantic Ocean. There are two dominant air masses, namely:

- The dry north easterly winds otherwise referred to as the Tropical Continental air mass (cT) blows from across the Sahara, north of the West African region, and
- The wet south westerly winds otherwise referred to as Tropical Maritime air mass (mT) blows from across the Atlantic Ocean in the south.

Separating the two air masses is an Inter Tropical Convergence Zone (ITCZ), often referred to as Inter-Tropical Discontinuity (ITD) or Inter-tropical Front (ITF). The front oscillates with the apparent location of the sun towards the north and south of the equator thereby accounting for the dominant seasons of the area. Marginal alterations are also recorded due to other landform characteristics, especially the dominant ocean currents, configuration of surrounding shoreline and the generally flat topography of the region.

Ambient Air Quality and Noise Level

The air quality/noise level result shows that the concentration of key contaminants (SOx, NOx, CO, N_2S, VOC_S and SPM Temp and Noise level) fall below the Federal Ministry of Environment's regulatory limits for both the dry and wet seasons. Except for NO_2 on just a sample point during the dry season.

Geology/Hydrogeology/Drainage

The project area is made of the Cretaceous sediments of the down faulted and failed rift that is the Benue Trough which occur in a series of sedimentary basins that extend north east of the confluence of the Niger and Benue Rivers, bounded by the Basement Complex strata to the north and south of the Benue River. The Lower Benue Basin consists of shales, silts and siltyshales with subordinate sandstones and limestone's intruded by dolerite dykes.

The Upper Benue Basin consists of a thick succession of continental sandstones overlain by marine and estuarine deposits. The basal formation is the Bima Sandstone. The Bida Basin runs North West from the confluence of Niger and Benue rivers from the Anambra Basin in the southeast and to the northwest towards the Sokoto Basin. The basin contains Cretaceous age mainly continental sandstones, siltstones, claystones and conglomerates. The Middle Niger Basin at the confluence of the Niger and Benue rivers contains 500 to 1000m of increasingly marine sediments. Quaternary to Recent age alluvial deposits occur along the main river valleys. These deposits range from thin discontinuous sands to thick alluvial deposits up to 15 km wide and 15 to 30 m thick along the Niger and Benue rivers. The alluvial deposits include gravel, coarse and fine sand, silt and clay. Thin deposits of unconsolidated and mixed sands and gravels occur along the courses of ephemeral Fadamas in northern Nigeria.

Water Quality studies

Water quality studies of an aquatic system are essential in understanding the chemical nature of water bodies, their productivity and the pollution status of the aquatic system.

Surface/Ground water characteristics

In the course of this study, samples of surface water were collected from the Kainjilake and a stream within the project site.

PH

pH values were all in the slightly acidic for both surface and ground water, the range across the study area during both the rainy and dry seasons, with mean values ranging between 5.22 and 7.45 in the rainy season and 5.14 and 7.80 in the dry season for surface water while it ranges between 6.84 and 7.14 for dry season and 5.40 and 7.20 during the rainy season for ground water.

Conductivity

Specific conductivity values observed were relatively high in the project area. Specific conductivity values ranged from 43.60 to 172.10 micro Siemens per centimetre (mS/cm) in the rainy season and 48.00 to 180.24 mS/cm in the dry season while for groundwater the values ranges from 620.00 to 670.00 mS/cm in the dry season and 516.00 and 625 mS/cm in the rainy season. The lower values for the rainy season are not surprising since these would be expected due to a lowering in values through dilution by freshwater sources and rainfall.

Total Dissolved Solids

TDS for surface water ranged between 20.00mg/l and 92.70mg/l during the wet season and 22.09 mg/l and 87.96mg/l during the dry season, while for groundwater the value ranges between 240.46mg/l and 291.25mg/l during the wet season and 297.60 mg/l and 321.67mg/l during the dry season.

Salinity

Average surface water salinity ranged between 0.001 and 0.55 parts per thousand (ppt) for the wet season and 0.01 and 0.61ppt for the dry season, for ground water salinity ranged between 0.23 and 0.42 parts per thousand (ppt) for the wet season and 0.19 and 0.48ppt for the dry season.

Dissolved Oxygen

DO was generally high across the study area. The mean values for surface water ranging from 6.0 to 7.0 mg/l in the rainy season and 6.00 to 6.70 mg/l in the dry season, while the mean value for ground water ranges from 6.2 to 6.80mg/l in the rainy season and 6.20 to 6.70 mg/l in the dry season. This indicates that the study area is very productive since none of the values dropped below 3.80 mg/l. During both seasons these values are indicative of a sunny and nutrient rich environment. During the rainy season an extensive increase of organic material is to be expected from this source in this near shore location thus explaining the rather large difference in DO levels between the two seasons.

Nitrate

Nitrate of surface water ranger between 1.11 to 7.99mg/l in the rainy season and 1.24 to 115.14mg/l for the dry season, the ground water range between 0.41 and 2.97mg/l for rainy season and 0.12 and 1.0 mg/l during the dry season. Nitrate is the most oxidized form of nitrogen compounds commonly present in streams. The highest concentration of nitrate in the water sampled was 115.14mg/l which is above the FMEnv threshold of 20mg/l, every other measurement is within the threshold.

Metals and Heavy Metals

Generally, there are low concentrations of heavy metal in the project area, among which are chromium, manganese, nickel, iron few point where zinc and cadmium are detected while vanadium, mercury and lead are not detected at the project site.

Surface Water Microbiology

Microbial analysis of the water sampled showed the presence of Total Heterotrophic Bacteria Count, Total Heterotrophic Fungi and Hydrocarbon Utilizing Fungi in the analyzed sample indicating faecal contamination of surface water in the study area. Fungi and Enterobacter were all found to be present in this sample. This may be attributed to human actions including grazing, washing and defecating near the Streams.

Sediment characteristics

The sediments samples were taken from the stream within the project site and the Kainji Lake bordering the project site. All parameter measures fell within FMEnv limits.

Soil Studies

Generally, the average pH value of soil samples from the study area was 6.9 which is within the FMEnv limit of 6-9.

Soil Nutrients (Nitrate Nitrite, Phosphate and Sulphate)

Although, the general concentrations of anions in soil samples from the study area were high except for the sulphate, however they were found to be within the acceptable range for good agricultural performance.

Exchangeable Cations (Magnesium (Mg^{2+}), Calcium (Ca^{2+}), Potassium (K^+) and Sodium (Na^{2+})

For dry season the average Magnesium concentration was 0.588mg/kg which is below the FMEnv limit 50mg/kg. Calcium in the soil samples has an average concentration of 1.04mg/kg which is below the FMEnv limit of 150mg/kg. potassium has an average data of 0.54mg/kg and sodium has an average data of 0.67mg/kg. For wet season the average Magnesium concentration was 0.56mg/kg which is below the FMEnv limit 50mg/kg, Calcium in the soil samples has an average concentration of 1.01mg/kg which is below the FMEnv limit of 150mg/kg, potassium has an average data of 0.51mg/kg and sodium has an average data of 0.59mg/kg.

Heavy Metals

The following heavy metals were analyzed in soil samples from the project site: Manganese (Mn), Iron (Fe), Vanadium, Nickel (Ni), Cadmium, Chromium, Lead (Pb), Zinc (Zn) and Mercury. While mercury is not detected, vanadium and cadmium were not detected on some sampling points.

Iron (Fe): The average concentration of iron measured from the analysis of soil samples collected from the study area for dry season is 131.51mg/kg and wet season is130.57mg/kg which is above the FMEnv limit of <1mg/kg and there is no significant difference between the top and subsoil.

Manganese (Mn): The average concentration of manganese in the soils of the study area during the dry season was 2.71mg/kg and the wet season was 2.41mg/kg. The concentration levels are well above the FMEnv recommended threshold of 0.20 mg/kg in all soil samples. Elevated levels may not be unrelated to the nature of minerals in the soil, use of agrochemicals and other anthropogenic activities in the study area.

Lead (Pb): The average lead concentration in soil samples from the study area for the dry season is 1.61mg/kg and the wet season is 1.54mg/kg. The values of Pb recorded at the study area were above the FMEnv limit of <1mg/kg prescribed for fairly unpolluted soils. This shows evidence of human activities.

Nickel (Ni): The average concentration of Nickel in soil samples for the dry season was 9.29 mg/kg and wet season was 3.07mg/kg. The Nickel concentration values obtained for all the soil samples were above the limit of <1mg/kg prescribed for unpolluted soil samples by the FMEnv.

Zinc (Zn): The average concentrations of Zinc obtained in the soil samples from the study area for the dry season was 11.92mg/kg and the wet season was 12.30mg/kg. The values of Zn recorded at the study area were above the limit of <1mg/kg prescribed for unpolluted soil by the FMEnv. The slightly elevated levels of heavy metals in the soil of the project area may not be unrelated to the nature and availability of solid minerals underneath the soil as well as anthropogenic activities including the use of hydrocarbon products and agro-chemicals which may have contaminated the soils in the area.

Vegetation/Forestry Studies

The vegetation is characterized with interspersions of thickets, grassland tree savannah, and fringing woodland or gallery forests along the valleys. The dominant woody species in the Amfani communities include Elaeisguinesis, (cashew)Anacardiumoccidentales, *Terminalialaxiflora*, *Albiziazygia*, *Ficus exasperate*, *Ficussyncomorous*, *Khayasenegalesis*, *Tarmarindusindica* (tsamiya), *Parkiabiglobosa* (Doruwa), *Vitellariapradoxa* “Kadanya” (Shear butter),*Vitexdoniana* (dinya), *Annonasengalensis* , *Mangiferaindica*, Citrus senensis, *Azadirachtaindica* (Dongoyaro) etc. also grasses and isolated trees. Trees of economic value, including locust bean, shea-butter, mango and citrus were identified.

Aquatic Macrophytes

The Kainji lake inhabits a good percentage of aquatic macrophytes; predominatly water lettuce (*Pistia stratiotes*), water lily (*Nymphaea spp*), swamp potato (*Ipomoea aquatica*).

LAND USE

The land use pattern identified within the project study area, include but not limited to the following;

- Agricultural land use
- Residential land use
- Commercial land use
- Religious land use
- Educational land use

Wildlife Studies

The wildlife identified within the study area in which the proposed Amfani industrial park and smart city project will be located include the following as stated in the table below.

List of Common Vertebrate Animals Identified in the Study Area

Class	Scientific Name	Common Name
AVES (Bird)	Milvusmigrans	Black kite
	Nectariniaspp	Yellowish nesting sunbird
	Pycnonotusbarbatus	Common garden bulbul
	Gulteraedourdi	Guinea fowl
	Urotriochisspp	Hawk
	Corvusalbus	Pied Crow
	Euplectesprogne	Long-tailed widow bird
	Plesionstigaracusullatus	Village weaver bird
	Coturnixspp	Quails
	Bubulcus ibis	Cattle egret

REPTILIA	Veranusniloticus	Forest monitor
	Agama agama	Rainbow Lizard
	Trachylepisspp	Grey Skink
	Kinixyserosa	Hinged land tortoise
	Dendroaspisviridis	Green mamba
	Najamelanoeuca	Black cobra
	Python reginis	Royal python
AMPHIBIANS	Buforegularis	African toad
	Ranaspp	Frog
MAMMALIA	Glaucomycyterusspp	Forest Bat
	Rattusspp	Bush rat
	Cricetaomysgambianus	Gambian giant rat
	Thryonomysswinderianus	Greater cane rat(Grass

		cutter)
	Xeruscrythropus	Ground squirrel
	Neotragusbatesi	Dwarf antelopes
	Autherurusafricanus	Porcupine
	Nandimabunotata	Two spotted palm covet
	Genettapoevnsis	Forest genet

Fisheries

Fishing activities are prominent with the project area as it is a source of livelihood to many fishermen and a great variety of species are caught on daily basis e.g*Clarias anguillaris,* Brycinus Nurse(Alestidea), Snake Head Fish, *Red Belly Tilapia, etc.*

Planktons

The numbers and forms of planktonic animals (zooplankton) and planktonic plants (phytoplankton) are used as indices of polluted water and also as very useful indices of primary productivity of water.

A total of 24 taxa of phytoplankton belonging to four divisions namely Chlorophyta (green algae), Bacillariophyta (diatoms), Euglenophyta (euglenids) and Cyanophyta (blue-green algae) were recorded in the samples. The green algae dominated the phytoplankton community with 15 species. It also constituted 66% and 58% of the total phytoplankton population. The blue-green algae, euglenids and diatoms following in that order constituted the rest of the phytoplankton. The distribution of algae population was relatively even across the lake and there was no significant difference (P = 0.8572) amongst them. There was also no significant spatial variation in the number of taxa which range between 5 and 14 on the lake.

Zooplankton

Seventeen species of zooplankton were encountered in the plankton. The relative abundance and spatial distribution of the species are seen over the lake. The most frequently encountered and more diverse were the Crustaceans. The crustaceans consisting of 6 species each of copepods and cladocerans dominated the plankton in number of species and population during both the dry and wet seasons. Other zooplankton encountered included 3 species of rotifera, 2 protozoans and 1 ostracod. The population was generally more during the dry season than the wet season.

Benthic Communities

Community structure and distribution of macro-benthos in Kainjilake was evaluated and it revealed that annelids were the dominant benthos species recorded across sampling stations during both seasons under study with the occurrence of two mollusc species during the dry season.

SOCIO-ECONOMICS AND HEALTH IMPACT ASSESSMENT

The study was conducted in 7 communities in Magama LGA of Niger State. The communities include; TudunFaila, TunganGari, GadanZare, Yunawa, Amfani , TungaAlhaji and Gungawa villages. Apart from Amfani and Gungawa communities, the rest of the communities are located within the same area called Sabongari.. The study covered the socio-cultural resources of these communities, demographic issues including population and growth, age and sex distribution, and adult literacy. Health facilities and their patronage, disease prevalence and disease vectors, water and sanitation, and nutrition were also studied. Additionally, the study discusses the perceptions, concerns and expectations of members and residents of these communities.

Demographics

The population estimates for Niger State following the 2006 national census, as published by the National Population Commission (NPC), is 3,950,249 while that of Magama LGA is 181,653.

Altogether, 250 individual respondents were interviewed from communities in the study area; in addition, there were four (4) Focus Group Discussion (FGD) sessions (1 for in each of the study group).

Demography of Respondents

Males constituted the bulk (76.4%) of the respondents, while females constituted 23.6%. The gender distribution is a reflection of the patriarchal nature of the study communities, which makes the males more likely to be identified as the heads of their households. It also reflects the socio-religious system which makes females less visible in interaction with strangers. Majority (93.2%) of the individual respondents were married, while 3.8% were single, and 3% divorced or widowed.

Respondents interviewed during the survey were within ages 10–75years. 27.6% were below 30 years, 27.2% were within 31–40 years, 20.8% were between 41 and 50 years, 13.2% were between 51 and 60 years, and 5.6% were above 60 years. Majority (92.7%) of the respondents were Muslims

Household Composition, Structure and Size

The typical household unit in the study area has a head and several members. In many cases the head is the father and members include his wife, children and wards. The wards are often children of relations and, in some cases, friends. From questionnaire responses, the mean household sizes obtained were 6.4 for the surveyed communities.

Education

Educational level is one of the key determinants for measuring standard of living. About one-thirds (35.8%) of the respondents did not have any formal education, 49.2% had only primary level/Quoranic education; 10.6% had secondary level education, and only 4.4% had tertiary/post-secondary education. This indicates a relatively high level of illiteracy in the study communities.

Livelihood Activities

Livelihood activities across the surveyed communities are similar. The identified activities are mainly primary production activities like farming, animal rearing, hunting, fishing and timber works.

Commerce and provision of services like petty trading, artisanship practices and employment in the civil/public services were also identified. The largest proportions of household members in all the communities are engaged in farming.

Settlement Pattern and Housing Conditions

All the communities have the characteristics of both linear and nuclear settlements. The linear characteristics derive from the concentration of houses along the main streets and lanes in the settlements. Their nuclear characteristics derive from the clustering of houses. Houses are built in clusters which in some cases may identify family lineages and kindred groups. Spacing between houses is not definite and could range from three or four metres to about ten metres.

The houses are quite diverse in their design and construction materials. About 98% of houses in the study area lack modern designs and they are built without utilities like kitchen, toilet and bath, in-house. A majority of the houses in the communities are family bungalows and tenement (rooming) houses

Language, Marriage and Family

The major languages of communication in all the communities are the Hausa and English. English is spoken in both its formal and pidgin forms. The project affected communities are all multilingual as there many ethnic groups therein, however, Hausa language is considered as the indigenous language in all the surveyed communities.

The marriage institution is accepted and revered in all the communities. Marriages are contracted between adult males and adult females, though there are few cases of juvenile marriages, there are no accounts of either same sex. Monogamy and polygamy are practiced but local sources say that polygamy is on the decline.

Governance and hierarchical structure

There are well-recognized leadership structures that oversee the political administration of the study area. Two (2) levels of political organization exist in the study area; the formal government and traditional administration. At the formal government level, the 4 communities are under Magama LGA of Niger State. The leadership organization is such that the executive, legislative and judiciary functions of the modern government are well integrated. Traditionally, the communities are distinct but similar traditional administrative structures. The structure comprises the Mai Angwan and traditional council members.

Roles of Women and Youth in Community Development

The women and youth groups play important roles in the communities, and serve to bring their members together as well as intervene in their welfare. During the survey it was noted that culturally women could not, lead the communities, head the key organs of traditional administration, seat or participate with the men in taking community decisions. This cultural inhibition is a clear indication of gender inequality in the communities.

The youth on the other hand, have become a strong force in the communities. Their roles basically include ensuring internal and external security, enforcing law and order and development planning. Youth leadership, especially the President and Secretary are regularly invited to community meetings with the traditional councils, where decisions about development and security are taken.

Security

Interactions and observation in the study area revealed that there is relative security of lives and properties in the area. This security is largely attributed to the homogeneity of the area and the presence and activities of the vigilante group also known as civilian JTF and the Nigeria armed personnel. This vigilante group plays a vital role in the provision of security to their various communities patrolling the community day and night as a way of checkmating crime. The vigilante group is manned by mostly youths, retired military and para-military men of the community.

Infrastructure

In educational facilities, the surveyed communities have four (4) UBE Primary schools and 2 Government Secondary Schools. These schools are characterized by poor infrastructure except for the one in SabonGari built and donated by the project proponent. In terms of electricity, the project area is not linked to the national grid of any Electricity Distribution Company. Urgent steps are needed to connect these communities to the national grid. Those involved in various economic enterprises possess electricity-generating sets to ameliorate the effect of the unavailable power supply in the area.

General Hospitals located in the Local Government headquarter and 2 primary health care facilities in SabonGari and Amfani communities that serve as centre for primary and secondary medicare activities with few qualified nurses and no doctor. About marketing infrastructure, the study area has small makeshift market with no market infrastructures. The study area needs assistance in the construction of modern markets.

Major mobile communication service providers (MTN, Airtel, Etisalat and Glo) are functional in the study area though the services are characterized by poor network signals.

Health Survey and Disease Prevalence

Records from Primary Health Centresin SabonGari and Amfani communities, series of in-depth interviews and focus group discussions (FGD) reveal the following as the most frequent illness in the study area; Cholera, Typhoid, Malaria etc. There are Health Care centres in all the communities and numerous Primary Health Centres in the study area though with little or no qualified nurses. Interactions revealed sources of treatment for the various ailments to be traditional with the aid of herb, modern-predicated on visit to health centre and self-medication or spiritual.

Summary of Public Consultations and the Opinions Expressed

The proponent considers consultation as a major feature of its operations; the thrust of the consultation programme for the proposed project is to promote mutually beneficial relationships with all the stakeholders through close contacts and regular consultations and also with the aim of notifying the stakeholders of the nature, scale and timing of the proposed project, thereby eliminating any fears or apprehension.

Communities' Concerns

- Environmental damage: Most communities fear that construction activities will destroy the vegetation, cause turbidity in the rivers and affect the water that is used by households for drinking and other purposes.

- Loss of livelihoods: PACs also fear families in the communities will lose their farmlands, fish ponds, grazing area, economic trees and, therefore, lose their livelihood activities.
- Social problems: Introduction and increase in vices like drug use and prostitution, teenage pregnancy, school dropout, and insecurity during project construction.
- Health problems: Increase in the occurrence of STDs and HIV/AIDs.
- Payment of compensation: All compensation paid to families be revisited before commencement of the project.

Community Expectations

Expectations of the communities consist mainly of human capital development and development of infrastructural facilities.

Potential and Associated Impacts

Identification of Impacts and Activities Interactions

Details of the Industrial Park construction, operations and decommissioning activities that could engender environmental impacts are as follows:

- Site preparation (Bush clearing/creation of access road and camping)
- Mobilization of construction elements
- Recruitment and community engagement
- Onsite fabrication (metal works, etc.)
- Building/other structures foundation.
- Building/other structures erection activities
- Waste management
- Fuel/hazardous material handling
- Painting and coating
- Fire/explosion (unplanned activity)
- Incident/Accidents (Unplanned activity e.g. building/other installation collapse)
- Commissioning
- Facilities operation/maintenance
- Facilities element replacement
- Decommissioning-Abandonment/Restoration

MITIGATIONS

Mitigation details for the industrial park construction, operations and decommissioning activities by HIL and EPC contractor that shall help ameliorate environmental impacts are as follows:

- Early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed

- Project will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities and implement resettlement action plan for project affected persons.
- All vehicles and boats are certified road / water worthy prior to being mobilized for work activities.
- Creating requirements for contractors to hire local labour and ensure skill acquisition and development.
- Project will develop a health plan to address potential health issues
- Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora and fauna management.
- Machinery, vehicles and instruments that emit high levels of noise should be used on a phased basis to reduce the overall impact.
- Develop project specific waste management plan and ensure proper implementation.
- Develop standard work procedures where work hazards are identified and addressed.
- Enforce good environmental demobilization procedures (e.g. cleaning sites and restoring to original status).
- Floating farms, jetties, walkways and other platforms to be installed or constructed in the Kaiji Lake shall be installed following the best engineering/technological standard and practices that will guarantee minimal disturbances to the lake's hydrological regimes.

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

EMP is an important management tool which sets out conditions and targets to be met during project implementation. It is developed to ensure that the mitigation measures, monitoring requirements and any environmental compliance review shall actually be carried out in subsequent stages of the project.

The overall objective of (performance) monitoring shall be to identify any unanticipated changes to the biophysical, health and social environment brought about by the Industrial Park Project Baseline information against which development and post development impacts and mitigation measures can be measured and compared has been established.

CONCLUSION

The proposed Amfani Industrial Park and Smart City Project is capable of achieving its goal of growing Nigeria economy in an environmentally sustainable manner if the recommendations made in this report are implemented methodically with due diligence.

An Environmental Management Plan (EMP) covering the biophysical and socio-economic aspects of the project was developed in order to ensure that mitigation measures would be established and maintained throughout the life cycle of the project and consultation with the host communities is expected to be a continuous process. Mitigation measures were based on best available technology, safety, health and environmental considerations.

EXECUTIVE SUMMARY

INTRODUCTION:

This document presents the Environmental Impact Assessment (EIA) of the proposed Amfani Industrial park and Smart City Project. With a view to achieving diversification of the economy from oil, and absorbing the growing workforce by creating productive jobs and also promote exportation through effective industrialization process leveraging on special economic projects, the Federal Government of Nigeria(FGN) is currently developing world class Special Economic Zones (SEZs). The concept of industrial park is being promoted globally to fast-track industrialization, socio-economic development of designated areas and jobs/wealth creation. Hydropolis Investment Limited (HIL) has keyed into the foregoing concept of the FGN and intends to embark on a project known as the Amfani Industrial Park and Smart City Project.

It is in view of the above, that Hydropolis Investment Ltd (HIL) engaged the services of Messr: Environmental Assessment and Evaluation Company Limited (EAECL) to carry out an Environmental Impact Assessment (EIA) study for the project before its actual commencement.

PROJECT LOCATION

The proposed project would be located at Longitude 4°5'45'' to 4°38'30'' and Latitude 9°59'15'' to 9°54'30'' in Amfani area of Magama Local Government Area (LGA) of Niger State, Nigeria. Land area earmarked for this development is approximately 1000 hectares and situated by the Kainji Lake which is the source of water for the Kainji Dam and the major basis for citing the project in this location.

LEGAL AND ADMINISTRATIVE FRAMEWORK

The legal and regulatory framework for carrying out EIA of the proposed Amfani Industrial Park and Smart City project are contained in relevant Nigerian statutes and international environmental conventions to which Nigeria is signatory. These include;

- The regulations, Guidelines, standards, codes and recommended practice of the Federal Ministry of Environment, (FMEnv).
- Other National Legislation

- Niger State Legislation
- Relevant Nigeria Laws and Regulation on Waterways, Works, Industrial activities, etc.
- Applicable International Guidelines, Treaties and Conventions.

PROJECT JUSTIFICATION

Need for the Project

Among other factors, this project is specifically engendered by structural reforms of the Nigerian economy and the production spheres that are affected by ever stronger competitive struggle within the constantly changing global market space and the impacts of the global crisis. It is worthy of note that the previous production and industrial structure of economies could not stand; hence this new concept of industrial park development.

The development of this industrial park can be viewed as an integrated solution to development and economic growth. Industrial park has proven to be an instrumental tool in ensuring social and economic development in the world. The development of the Amfani Industrial Park will lead to a significant reduction in the need for travel by thousands of people who depend on the surrounding towns like New Bussa, Mokwa, Ibbi, Zugurma, Wara, Auna and as far as Jebba for one basic need or the other. Therefore, in this regard, the importance of the Amfani Industrial park cannot be overemphasized.

In a large and populous state such as Niger State with several satellite rural settlements, widely spread across the state, more commercial and social hubs are required to be developed at areas suitable for both business and social development in order to allow for effective development cutting across the state. Therefore, in the overall consideration the need for construction of an Industrial park at Anfani Village in Magama LGA in Niger State is to meet the demand for sustainable development within and across Niger State and provide opportunities for collaboration amongst business operators for public good enhancement.

PROJECT DESCRIPTION

The Amfani Industrial Park and Smart City project when fully completed will be made up of the following components:-

- A smart city with residential apartments of different sizes with uninterrupted power and internet services.
- High-tech industrial park for low to high technology production.
- Commercial area, business district and financial hub
- World Class Medical Services
- Smart Primary/Secondary Schools.
- Hydropolis University
- Hydropolis Airport
- Recereational area for leisure and sports consisting of Water Park, Amusement Park, Sport Arena, Water Sport and Cruising.
- Hospitality Industry of different grade of world class hotels. Golf Course, International Conference/Convention Facilities.

The project will provide a range of services for potential tenants and offer a variety of investment and co-operation options to both tenants and investors alike. Numerous structures and facilities as highlighted above have been planned for this development. These will further include access roads, airport, slipway, alternative power source, water supply, fire-fighting station, etc. However, the Airport is planned for the next phase of this project. The design principles for the Master Plan are as follows:

- The core commercial and residential developments are located in close proximity to the industrial areas in the north. Core Commercial Areas are located centrally with only limited commercial development along the waterfront.

- The Industrial Park is located to the north of the development and is linked with the golf course through a strong commercial axis activated by retail and mixed use development nodes.

- Existing rivers and wet / dry gullies are preserved and integrated within an urban green network.

- City Centres are established along the main green network, and on the lake shoreline.
- Green networks respect the topography. Minimum intervention in close proximity to the water reduce environmental and visual impacts on the natural assets.
- Radial urban structure;
- Segregated residential areas that are developed around the green network create different "cluster" neighbourhoods.
- Primary roads provide a direct link from the city located on the south to the industrial area in the north.
- Industrial and urban vehicular flows are segregated. Lorry routes are segregated from light motor vehicles.
- Tourism areas are distributed in close proximity to the waterfront
- The design approach has been informed by the following design informants that have shaped the key direction of the Master Plan;
- The design informants have been identified through the findings of the data analysis study conducted and the appraisal of the physical features of the site. The following factors informed the design of the master plan;

    - Wind Direction: Prevalent winds are from the south west and the south-east. The north of the site has therefore been identified as the optimum location for the industrial areas, so as to avoid any potential negative impacts of air pollution.

    - Lake water levels: The water levels in the lake rise to approximately 142.5 meters and the recommended minimum site elevation is 144m. The 144meters contour has been taken as the maximum extent of waterfront development, minimizing the need to expensive cut and fill and equally minimizing site grading costs.

    - Site Contours: the site contours slope gently from the west to the east, and the master plan road networks will need to take this into consideration.

    - Golf: The peninsula to the south of the site has been identified as the optimum location for the Golf

Course.

Waste Generation and management

Expected waste categories to be generated during the different phases of the project shall include felled trees and other vegetal matter from project site clearing, domestic rubbish/trash, scrap metals, non-plastic combustible and packaging materials, plastic packaging materials, drum and containers, chemical waste hazardous substances and chemicals, waste oil, medical wastes, cement slurries and mix, kitchen waste (organic). The strategies for waste management and treatment have been outlined under the Environmental Management Plan (EMP) in chapter 7 of this report.

Decommissioning, Rehabilitation and Restoration

This involves the following steps or processes;

- Dismantling of the buildings/ structures and installations.
- Dismantling of building/structure foundations
- Removal of all material from project site.
- Restoration of land to its original situation as much as possible

DESCRIPTION OF THE EXISTING ENVIRONMENT

The baseline information on the bio-physicochemical and socio-economic environment of the proposed project area were based on information from literature as well as findings of a two season field sampling studies, laboratory analyses and a detailed socioeconomic.

Climate and Meteorology

Niger State experiences distinct dry and wet seasons with annual rainfall varying from 1,100mm in the Northern part of the State to 1,600 mm in the southern parts. The maximum temperature is recorded between March and June, while the minimum is usually between December and January. The rainy season lasts for about 150 days in the Northern parts and about 120 days in the Southern parts of the State. Generally, the climate soil and hydrology of the State permit the cultivation of most of Nigeria's staple crops and still allows sufficient opportunities for grazing, fresh water fishing and forestry development with high temperature and humidity follows a tropical pattern with the raining season starting about April and ending in September, followed by dry season. The climate of the project area is tropics (i.e. semi-hot equatorial). It is controlled by latitudinal locations, prevailing (seasonal) winds and nearness to the Atlantic Ocean. There are two dominant air masses, namely:

- The dry north easterly winds otherwise referred to as the Tropical Continental air mass (cT) blows from across the Sahara, north of the West African region, and
- The wet south westerly winds otherwise referred to as Tropical Maritime air mass (mT) blows from across the Atlantic Ocean in the south.

Separating the two air masses is an Inter Tropical Convergence Zone (ITCZ), often referred to as Inter-Tropical Discontinuity (ITD) or Inter-tropical Front (ITF). The front oscillates with the apparent location of the sun towards the north and south of the equator thereby accounting for the dominant seasons of the area. Marginal alterations are also recorded due to other landform characteristics, especially the dominant ocean currents, configuration of surrounding shoreline and the generally flat topography of the region.

Ambient Air Quality and Noise Level

The air quality/noise level result shows that the concentration of key contaminants (SOx, NOx, CO, N_2S, VOC_S and SPM Temp and Noise level) fall below the Federal Ministry of Environment's regulatory limits for both the dry and wet seasons. Except for NO_2 on just a sample point during the dry season.

Geology/Hydrogeology/Drainage

The project area is made of the Cretaceous sediments of the down faulted and failed rift that is the Benue Trough which occur in a series of sedimentary basins that extend north east of the confluence of the Niger and Benue Rivers, bounded by the Basement Complex strata to the north and south of the Benue River. The Lower Benue Basin consists of shales, silts and silty shales with subordinate sandstones and limestone's intruded by dolerite dykes.

The Upper Benue Basin consists of a thick succession of continental sandstones overlain by marine and estuarine deposits. The basal formation is the Bima Sandstone. The Bida Basin runs North West from the confluence of Niger and Benue rivers from the Anambra Basin in the southeast and to the northwest towards the Sokoto Basin. The basin contains Cretaceous age mainly continental sandstones, siltstones, claystones and conglomerates. The Middle Niger Basin at the confluence of the Niger and Benue rivers contains 500 to 1000m of increasingly marine sediments. Quaternary to Recent age alluvial deposits occur along the main river valleys. These deposits range from thin discontinuous sands to thick alluvial deposits up to 15 km wide and 15 to 30 m thick along the Niger and Benue rivers. The alluvial deposits include gravel, coarse and fine sand, silt and clay. Thin deposits of unconsolidated and mixed sands and gravels occur along the courses of ephemeral Fadamas in northern Nigeria.

Water Quality studies

Water quality studies of an aquatic system are essential in understanding the chemical nature of water bodies, their productivity and the pollution status of the aquatic system.

Surface/Ground water characteristics

In the course of this study, samples of surface water were collected from the Kainji lake and a stream within the project site.

PH

pH values were all in the slightly acidic for both surface and ground water, the range across the study area during both the rainy and dry seasons, with mean values ranging between 5.22 and 7.45 in the rainy season and 5.14 and 7.80 in the dry season for surface water while it ranges between 6.84 and 7.14 for dry season and 5.40 and 7.20 during the rainy season for ground water.

Conductivity

Specific conductivity values observed were relatively high in the project area. Specific conductivity values ranged from 43.60 to 172.10 micro Siemens per centimetre (mS/cm) in the rainy season and 48.00 to 180.24 mS/cm in the dry season while for groundwater the values ranges from 620.00 to 670.00 mS/cm in the dry season and 516.00 and 625 mS/cm in the rainy season. The lower values for the rainy season are not surprising since these would be expected due to a lowering in values through dilution by freshwater sources and rainfall.

Total Dissolved Solids

TDS for surface water ranged between 20.00mg/l and 92.70mg/l during the wet season and 22.09 mg/l and 87.96mg/l during the dry season, while for groundwater the value ranges between 240.46mg/l and 291.25mg/l during the wet season and 297.60 mg/l and 321.67mg/l during the dry season.

Salinity

Average surface water salinity ranged between 0.001 and 0.55 parts per thousand (ppt) for the wet season and 0.01 and 0.61ppt for the dry season, for ground water salinity ranged between 0.23 and 0.42 parts per thousand (ppt) for the wet season and 0.19 and 0.48ppt for the dry season.

Dissolved Oxygen

DO was generally high across the study area. The mean values for surface water ranging from 6.0 to 7.0 mg/l in the rainy season and 6.00 to 6.70 mg/l in the dry season, while the mean value for ground water ranges from 6.2 to 6.80mg/l in the rainy season and 6.20 to 6.70 mg/l in the dry season. This indicates that the study area is very productive since none of the values dropped below 3.80 mg/l. During both seasons these values are indicative of a sunny and nutrient rich environment. During the rainy season an extensive increase of organic material is to be expected from this source in this near shore location thus explaining the rather large difference in DO levels between the two seasons.

Nitrate

Nitrate of surface water ranger between 1.11 to 7.99mg/l in the rainy season and 1.24 to 115.14mg/l for the dry season, the ground water range between 0.41 and 2.97mg/l for rainy season and 0.12 and 1.0 mg/l during the dry season. Nitrate is the most oxidized form of nitrogen compounds commonly present in streams. The highest concentration of nitrate in the water sampled was 115.14mg/l which is above the FMEnv threshold of 20mg/l, every other measurement is within the threshold.

Metals and Heavy Metals

Generally, there are low concentrations of heavy metal in the project area, among which are chromium, manganese, nickel, iron few point where zinc and cadmium are detected while vanadium, mercury and lead are not detected at the project site.

Surface Water Microbiology

Microbial analysis of the water sampled showed the presence of Total Heterotrophic Bacteria Count, Total Heterotrophic Fungi and Hydrocarbon Utilizing Fungi in the analyzed sample indicating faecal contamination of surface water in the study area. Fungi and Enterobacter were all found to be present in this sample. This may be attributed to human actions including grazing, washing and defecating near the Streams.

Sediment characteristics

The sediments samples were taken from the stream within the project site and the Kainji Lake bordering the project site. All parameter measures fell within FMEnv limits.

Soil Studies

Generally, the average pH value of soil samples from the study area was 6.9 which is within the FMEnv limit of 6-9.

Soil Nutrients (Nitrate Nitrite, Phosphate and Sulphate)

Although, the general concentrations of anions in soil samples from the study area were high except for the sulphate, however they were found to be within the acceptable range for good agricultural performance.

Exchangeable Cations (Magnesium (Mg2+), Calcium (Ca2+), Potassium (K+) and Sodium (Na2+)

For dry season the average Magnesium concentration was 0.588mg/kg which is below the FMEnv limit 50mg/kg. Calcium in the soil samples has an average concentration of 1.04mg/kg which is below the FMEnv limit of 150mg/kg. potassium has an average data of 0.54mg/kg and sodium has an average data of 0.67mg/kg. For wet season the average Magnesium concentration was 0.56mg/kg which is below the FMEnv limit 50mg/kg, Calcium in the soil samples has an average concentration of 1.01mg/kg which is below the FMEnv limit of 150mg/kg, potassium has an average data of 0.51mg/kg and sodium has an average data of 0.59mg/kg.

Heavy Metals

The following heavy metals were analyzed in soil samples from the project site: Manganese (Mn), Iron (Fe), Vanadium, Nickel (Ni), Cadmium, Chromium, Lead (Pb), Zinc (Zn) and Mercury. While mercury is not detected, vanadium and cadmium were not detected on some sampling points.

Iron (Fe): The average concentration of iron measured from the analysis of soil samples collected from the study area for dry season is 131.51mg/kg and wet season is130.57mg/kg which is above the FMEnv limit of <1mg/kg and there is no significant difference between the top and subsoil.

Manganese (Mn): The average concentration of manganese in the soils of the study area during the dry season was 2.71mg/kg and the wet season was 2.41mg/kg. The concentration levels are well above the FMEnv recommended threshold of 0.20 mg/kg in all soil samples. Elevated levels may not be unrelated to the nature of minerals in the soil, use of agrochemicals and other anthropogenic activities in the study area.

Lead (Pb): The average lead concentration in soil samples from the study area for the dry season is 1.61mg/kg and the wet season is 1.54mg/kg. The values of Pb recorded at the study area were above the FMEnv limit of <1mg/kg prescribed for fairly unpolluted soils. This shows evidence of human activities.

Nickel (Ni): The average concentration of Nickel in soil samples for the dry season was 9.29 mg/kg and wet season was 3.07mg/kg. The Nickel concentration values obtained for all the soil samples were above the limit of <1mg/kg prescribed for unpolluted soil samples by the FMEnv.

Zinc (Zn): The average concentrations of Zinc obtained in the soil samples from the study area for the dry season was 11.92mg/kg and the wet season was 12.30mg/kg. The values of Zn recorded at the study area were above the limit of <1mg/kg prescribed for unpolluted soil by the FMEnv. The slightly elevated levels of heavy metals in the soil of the project area may not be unrelated to the nature and availability of solid minerals underneath the soil as well as anthropogenic activities including the use of hydrocarbon products and agro-chemicals which may have contaminated the soils in the area.

Vegetation/Forestry Studies

The vegetation is characterized with interspersions of thickets, grassland tree savannah, and fringing woodland or gallery forests along the valleys. The dominant woody species in the Amfani communities include Elaeis guinesis, (cashew)Anacardium occidentales, *Terminalia laxiflora*, *Albizia zygia*, *Ficus exasperate*, *Ficus syncomorous*, *Khaya senegalesis*, *Tarmarindus indica* (tsamiya), *Parkia biglobosa* (Doruwa), *Vitellaria pradoxa* "Kadanya" (Shear butter),*Vitex doniana* (dinya), *Annona sengalensis* , *Mangifera indica*, Citrus senensis, *Azadirachta indica* (Dongoyaro) etc. also grasses and isolated trees. Trees of economic value, including locust bean, shea-butter, mango and citrus were identified.

Aquatic Macrophytes

The Kainji lake inhabits a good percentage of aquatic macrophytes; predominatly water lettuce (*Pistia stratiotes*), water lily (*Nymphaea spp*), swamp potato (*Ipomoea aquatica*).

LAND USE

The land use pattern identified within the project study area, include but not limited to the following;

- Agricultural land use
- Residential land use
- Commercial land use
- Religious land use
- Educational land use

Wildlife Studies

The wildlife identified within the study area in which the proposed Amfani industrial park and smart city project will be located include the following as stated in the table below.

List of Common Vertebrate Animals Identified in the Study Area

Class	Scientific Name	Common Name
AVES (Bird)	Milvus migrans	Black kite
	Nectarinia spp	Yellowish nesting sunbird
	Pycnonotus barbatus	Common garden bulbul
	Gultera edourdi	Guinea fowl
	Urotriochis spp	Hawk
	Corvus albus	Pied Crow
	Euplectes progne	Long-tailed widow bird

	Plesionstigara cusullatus	Village weaver bird
	Coturnix spp	Quails
	Bubulcus ibis	Cattle egret

REPTILIA	Veranus niloticus	Forest monitor
	Agama agama	Rainbow Lizard
	Trachylepis spp	Grey Skink
	Kinixys erosa	Hinged land tortoise
	Dendroaspis viridis	Green mamba
	Naja melanoeuca	Black cobra
	Python reginis	Royal python
AMPHIBIANS	Bufo regularis	African toad
	Rana spp	Frog
MAMMALIA	Glaucomycyterus spp	Forest Bat
	Rattus spp	Bush rat
	Cricetaomys gambianus	Gambian giant rat
	Thryonomys swinderianus	Greater cane rat(Grass cutter)
	Xerus crythropus	Ground squirrel
	Neotragus batesi	Dwarf antelopes
	Autherurus africanus	Porcupine
	Nandima bunotata	Two spotted palm covet
	Genetta poe vnsis	Forest genet

Fisheries

Fishing activities are prominent with the project area as it is a source of livelihood to many fishermen and a great variety of species are caught on daily basis e.g *Clarias anguillaris,* Brycinus Nurse(Alestidea), Snake Head Fish, *Red Belly Tilapia, etc.*

Planktons

The numbers and forms of planktonic animals (zooplankton) and planktonic plants (phytoplankton) are used as indices of polluted water and also as very useful indices of primary productivity of water.

A total of 24 taxa of phytoplankton belonging to four divisions namely Chlorophyta (green algae), Bacillariophyta (diatoms), Euglenophyta (euglenids) and Cyanophyta (blue-green algae) were recorded in the samples. The green algae dominated the phytoplankton community with 15 species. It also constituted 66% and 58% of the total phytoplankton population. The blue-green algae, euglenids and diatoms following in that order constituted the rest of the phytoplankton. The distribution of algae population was relatively even across the lake and there was no significant difference (P = 0.8572) amongst them. There was also no significant spatial variation in the number of taxa which range between 5 and 14 on the lake.

Zooplankton

Seventeen species of zooplankton were encountered in the plankton. The relative abundance and spatial distribution of the species are seen over the lake. The most frequently encountered and more diverse were the Crustaceans. The crustaceans consisting of 6 species each of copepods and cladocerans dominated the plankton in number of species and population during both the dry and wet seasons. Other zooplankton encountered included 3 species of rotifera, 2 protozoans and 1 ostracod. The population was generally more during the dry season than the wet season.

Benthic Communities

Community structure and distribution of macro-benthos in Kainji lake was evaluated and it revealed that annelids were the dominant benthos species recorded across sampling stations during both seasons under study with the occurrence of two mollusc species during the dry season.

SOCIO-ECONOMICS AND HEALTH IMPACT ASSESSMENT

The study was conducted in 7 communities in Magama LGA of Niger State. The communities include; Tudun Faila, Tungan Gari, Gadan Zare, Yunawa, Amfani , Tunga Alhaji and Gungawa villages. Apart from Amfani and Gungawa communities, the rest of the communities are located within the same area called Sabongari.. The study covered the socio-cultural resources of these communities, demographic issues including population and growth, age and sex distribution, and adult literacy. Health facilities and their patronage, disease prevalence and disease vectors, water and sanitation, and nutrition were also studied. Additionally, the study discusses the perceptions, concerns and expectations of members and residents of these communities.

Demographics

The population estimates for Niger State following the 2006 national census, as published by the National Population Commission (NPC), is 3,950,249 while that of Magama LGA is 181,653.

Altogether, 250 individual respondents were interviewed from communities in the study area; in addition, there were four (4) Focus Group Discussion (FGD) sessions (1 for in each of the study group).

Demography of Respondents

Males constituted the bulk (76.4%) of the respondents, while females constituted 23.6%. The gender distribution is a reflection of the patriarchal nature of the study communities, which makes the males more likely to be identified as the heads of their households. It also reflects the socio-religious system which makes females less visible in interaction with strangers. Majority (93.2%) of the individual respondents were married, while 3.8% were single, and 3% divorced or widowed.

Respondents interviewed during the survey were within ages 10–75years. 27.6% were below 30 years, 27.2% were within 31–40 years, 20.8% were between 41 and 50 years, 13.2% were between 51 and 60 years, and 5.6% were above 60 years. Majority (92.7%) of the respondents were Muslims

Household Composition, Structure and Size

The typical household unit in the study area has a head and several members. In many cases the head is the father and members include his wife, children and wards. The wards are often children of relations and, in some cases, friends. From questionnaire responses, the mean household sizes obtained were 6.4 for the surveyed communities.

Education

Educational level is one of the key determinants for measuring standard of living. About one-thirds (35.8%) of the respondents did not have any formal education, 49.2% had only primary level/Quoranic education; 10.6% had secondary level education, and only 4.4% had tertiary/post-secondary education. This indicates a relatively high level of illiteracy in the study communities.

Livelihood Activities

Livelihood activities across the surveyed communities are similar. The identified activities are mainly primary production activities like farming, animal rearing, hunting, fishing and timber works.

Commerce and provision of services like petty trading, artisanship practices and employment in the civil/public services were also identified. The largest proportions of household members in all the communities are engaged in farming.

Settlement Pattern and Housing Conditions

All the communities have the characteristics of both linear and nuclear settlements. The linear characteristics derive from the concentration of houses along the main streets and lanes in the settlements. Their nuclear characteristics derive from the clustering of houses. Houses are built in clusters which in some cases may identify family lineages and kindred groups. Spacing between houses is not definite and could range from three or four metres to about ten metres.

The houses are quite diverse in their design and construction materials. About 98% of houses in the study area lack modern designs and they are built without utilities like kitchen, toilet and bath, in-house. A majority of the houses in the communities are family bungalows and tenement (rooming) houses.

Language, Marriage and Family

The major languages of communication in all the communities are the Hausa and English. English is spoken in both its formal and pidgin forms. The project affected communities are all multilingual as there many ethnic groups therein, however, Hausa language is considered as the indigenous language in all the surveyed communities.

The marriage institution is accepted and revered in all the communities. Marriages are contracted between adult males and adult females, though there are few cases of juvenile marriages, there are no accounts of either same sex. Monogamy and polygamy are practiced but local sources say that polygamy is on the decline.

Governance and hierarchical structure

There are well-recognized leadership structures that oversee the political administration of the study area. Two (2) levels of political organization exist in the study area; the formal government and traditional administration. At the formal government level, the 4 communities are under Magama LGA of Niger State. The leadership organization is such that the executive, legislative and judiciary functions of the modern government are well integrated. Traditionally, the communities are distinct but similar traditional administrative structures. The structure comprises the Mai Angwan and traditional council members.

Roles of Women and Youth in Community Development

The women and youth groups play important roles in the communities, and serve to bring their members together as well as intervene in their welfare. During the survey it was noted that culturally women could not, lead the communities, head the key organs of traditional administration, seat or participate with the men in taking community decisions. This cultural inhibition is a clear indication of gender inequality in the communities.

The youth on the other hand, have become a strong force in the communities. Their roles basically include ensuring internal and external security, enforcing law and order and development planning. Youth leadership, especially the President and Secretary are regularly invited to community meetings with the traditional councils, where decisions about development and security are taken.

Security

Interactions and observation in the study area revealed that there is relative security of lives and properties in the area. This security is largely attributed to the homogeneity of the area and the presence and activities of the vigilante group also known as civilian JTF and the Nigeria armed personnel. This vigilante group plays a vital role in the provision of security to their various communities patrolling the community day and night as a way of checkmating crime. The vigilante group is manned by mostly youths, retired military and para-military men of the community.

Infrastructure

In educational facilities, the surveyed communities have four (4) UBE Primary schools and 2 Government Secondary Schools. These schools are characterized by poor infrastructure except for the one in Sabon Gari built and donated by the project proponent. In terms of electricity, the project area is not linked to the national grid of any Electricity Distribution Company. Urgent steps are needed to connect these communities to the national grid. Those involved in various economic enterprises possess electricity-generating sets to ameliorate the effect of the unavailable power supply in the area.

General Hospitals located in the Local Government headquarter and 2 primary health care facilities in Sabon Gari and Amfani communities that serve as centre for primary and secondary medicare activities with few qualified nurses and no doctor. About marketing infrastructure, the study area has small makeshift market with no market infrastructures. The study area needs assistance in the construction of modern markets.

Major mobile communication service providers (MTN, Airtel, Etisalat and Glo) are functional in the study area though the services are characterized by poor network signals.

Health Survey and Disease Prevalence

Records from Primary Health Centres in Sabon Gari and Amfani communities, series of in-depth interviews and focus group discussions (FGD) reveal the following as the most frequent illness in the study area; Cholera, Typhoid, Malaria etc. There are Health Care centres in all the communities and numerous Primary Health Centres in the study area though with little or no qualified nurses. Interactions revealed sources of treatment for the various ailments to be traditional with the aid of herb, modern-predicated on visit to health centre and self-medication or spiritual.

Summary of Public Consultations and the Opinions Expressed

The proponent considers consultation as a major feature of its operations; the thrust of the consultation programme for the proposed project is to promote mutually beneficial relationships with all the stakeholders through close contacts and regular consultations and also with the aim of notifying the stakeholders of the nature, scale and timing of the proposed project, thereby eliminating any fears or apprehension.

Communities' Concerns

- Environmental damage: Most communities fear that construction activities will destroy the vegetation, cause turbidity in the rivers and affect the water that is used by households for drinking and other purposes.

- Loss of livelihoods: PACs also fear families in the communities will lose their farmlands, fish ponds, grazing area, economic trees and, therefore, lose their livelihood activities.
- Social problems: Introduction and increase in vices like drug use and prostitution, teenage pregnancy, school dropout, and insecurity during project construction.
- Health problems: Increase in the occurrence of STDs and HIV/AIDs.
- Payment of compensation: All compensation paid to families be revisited before commencement of the project.

Community Expectations

Expectations of the communities consist mainly of human capital development and development of infrastructural facilities.

Potential and Associated Impacts

Identification of Impacts and Activities Interactions

Details of the Industrial Park construction, operations and decommissioning activities that could engender environmental impacts are as follows:

- Site preparation (Bush clearing/creation of access road and camping)
- Mobilization of construction elements
- Recruitment and community engagement
- Onsite fabrication (metal works, etc.)
- Building/other structures foundation.
- Building/other structures erection activities
- Waste management
- Fuel/hazardous material handling
- Painting and coating
- Fire/explosion (unplanned activity)
- Incident/Accidents (Unplanned activity e.g. building/other installation collapse)
- Commissioning
- Facilities operation/maintenance
- Facilities element replacement
- Decommissioning-Abandonment/Restoration

MITIGATIONS

Mitigation details for the industrial park construction, operations and decommissioning activities by HIL and EPC contractor that shall help ameliorate environmental impacts are as follows:

- Early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed
- Project will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities and implement resettlement action plan for project affected persons.
- All vehicles and boats are certified road / water worthy prior to being mobilized for work activities.
- Creating requirements for contractors to hire local labour and ensure skill acquisition and development.
- Project will develop a health plan to address potential health issues
- Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora and fauna management.
- Machinery, vehicles and instruments that emit high levels of noise should be used on a phased basis to reduce the overall impact.
- Develop project specific waste management plan and ensure proper implementation.
- Develop standard work procedures where work hazards are identified and addressed.
- Enforce good environmental demobilization procedures (e.g. cleaning sites and restoring to original status).
- Floating farms, jetties, walkways and other platforms to be installed or constructed in the Kaiji Lake shall be installed following the best engineering/technological standard and practices that will guarantee minimal disturbances to the lake's hydrological regimes.

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

EMP is an important management tool which sets out conditions and targets to be met during project implementation. It is developed to ensure that the mitigation measures, monitoring requirements and any environmental compliance review shall actually be carried out in subsequent stages of the project.

The overall objective of (performance) monitoring shall be to identify any unanticipated changes to the biophysical, health and social environment brought about by the Industrial Park Project Baseline information against which development and post development impacts and mitigation measures can be measured and compared has been established.

CONCLUSION

The proposed Amfani Industrial Park and Smart City Project is capable of achieving its goal of growing Nigeria economy in an environmentally sustainable manner if the recommendations made in this report are implemented methodically with due diligence.

An Environmental Management Plan (EMP) covering the biophysical and socio-economic aspects of the project was developed in order to ensure that mitigation measures would be established and maintained throughout the life cycle of the project and consultation with the host communities is expected to be a continuous process. Mitigation measures were based on best available technology, safety, health and environmental considerations.

CHAPTER ONE

1.0 INTRODUCTION

1.1 GENERAL

With a view to achieving diversification of the economy from oil, and absorb the growing workforce by creating productive jobs and also promote exportation through effective industrialization process leveraging on special economic projects, the Federal Government of Nigeria(FGN) is currently developing world class Special Economic Zones (SEZs). The concept of industrial park is being promoted globally to fast-track industrialization, socio-economic development of designated areas and jobs/wealth creation. **Hydropolis Investment Limited (HIL)** has keyed into the foregoing concept of the FGN and intends to embark on a project known as the **Amfani Industrial Park and Smart City Project.**

It is in view of the above, that Hydropolis Investment Ltd (HIL) engaged the services of Messr: Environmental Assessment and Evaluation Company Limited (EAECL) - an Environmental and Technology Management consulting company duly registered and accredited by the Federal Ministry of Environment (FMEnv) to carry out a comprehensive Environmental Impact Assessment (EIA) report for the project in view before the actual commencement of the project. The industrial park and Smart City has been planned to accommodate industrial concerns in various sectors of the economy such as ICT, Hospitality (Hotels & Restaurants), Entertainment, Wholesale/Retail, Construction industries, Recreational parks to mention but a few. The Park and City is conceived as a private entity owned by Hydropolis Investment limited that will comply with national regulations with full presence of relevant governmental authorities. It is expected to provide most modern and secured infrastructural facilities that will facilitate the attraction of economic activities to the area while bearing in mind the challenges facing the state and the country at large especially in the area of security.

The Amfani Industrial Park and Smart City is conceived as a Technology Park that will provide an enabling environment for the location of technology businesses. It will be a Free Trade Zone (FTZ) and as such, offer a number of trade and commercial incentives to both start-up enterprises and blue chip multi-nationals. This development will create a series of districts or 'clusters' each with its own distinct character although developed as part of a systematic and holistic conceptual approach. It follows the global vision of using technology clusters as a reliable tool for bolstering economic development; given Nigeria's emerging prominence in the global economy

Hydropolis Investment limited took the decision to embark in the development of the Park to among other things contribute to the attainment of the following:

• Provide an alternative, world class industrial estate devoid of familiar infrastructural challenges that also offer direct access to land and water evacuation opportunities to producers of goods and services.

• Contribute in the decongestion efforts of the existing nearby Cities and Towns e.g. Federal Capital Territory, Minna, Kaduna etc. thereby easing traffic and reduction in man-hour losses.

• Provide an opportunity by which similar industries can benefit from sharing of expertise and technology.

• Stimulation of further industrial growth in the state and the Nigeria in general as well as creation of jobs opportunities.

The proposed Industrial Park and Smart City development project would involve the construction/ installation of the below mentioned components of the park. These components will be in phases and the availability of water and generation of adequate power will form the bases of the project Grid zoning of industrial and other business layouts, Hydropolis Airport and University, Hotel Resort, High Tech Industrial Park, World Class medical services, office complex:

• Service road around the park to provide easy movement opportunities;

• Material and Cargo handling facilities and units;

•Modern utility services including telecommunication, potable water, centralized waste collection and disposal; and

• State of the art security system.

The successful completion of these activities would require careful planning and management in the part of the proponent. The construction and installation of the above facilities would inevitably lead to some form of interactions between elements of the project activities and the environment, leading to either positive or negative impacts.

Statutorily, it is required in Nigeria that projects of this nature are assessed as to their environmental impact. The Environmental Impact Assessment (EIA) Act No. 86 of 1992 is particularly directed at regulating industrialization process with due regard to the environment. By this Act, for an industrial plan/development/activity of this magnitude, consideration of its environmental consequences in the form of an environmental impact assessment is mandatory prior to project execution. This EIA has been carried in compliance with national statutes. Thus, the purpose of this document is to present the findings of the EIA carried out to identify and analyze the potential environmental impacts, both negative and positive, and develop a comprehensive Environmental Management plan for the proposed park.

1.2 The Proponent

Hydropolis Limited, the proponent of the proposed project is a reputable indigenous Company registered in Nigeria as a special vehicle established by Main Stream Energy Solution Limited which has been in business in Nigeria. The company **Mainstream Energy Solution Limited (MESL)** owns and operates one of the largest Hydropower Station Located at Kainji and Jebba areas of Niger State. The development of the proposed industrial park is part of the strategic diversification plan of **Mainstream Energy Solution Limited (MESL)** into other vital economic areas. The park would be managed by Hydropolis Investment Limited (HIL) in such a manner to attract and offer unique investments and opportunities.

1.3 Project Location

The proposed project would be located at Longitude 4^{0}35'45'' to 4^{0}38'30'' and Latitude 9^{0}59'15'' to 9^{0}54'30'' in Amfani area of Magama Local Government Area (LGA) of Niger State, Nigeria. Land area earmarked for this development is approximately 1000 hectares and situated by the Kainji Lake which is the source of water for the Kainji Dam and the major basis for citing the project in this location. Map of Nigeria showing Niger state is presented in fig 1.1.

The proposed location offers easy access to the Kainji Lake and Dam thus, providing great opportunity for evacuation of generated power and Inland Water ways interaction with neighboring Towns and delivery of imported raw materials/foreign exchange.

The state which was created on 3rd of February 1976 covers a landmass of about 76,363km2. It shares boundary with Kaduna and the Federal Capital Territory FCT in the east and south respectively, Kebbi and Zamfara in the north, Kwara and Kogi in the south and Benin Republic in the east. Agriculture is the mainstay of the people with 80% of the population directly and indirectly involved. Map of Niger state showing Magama LGA is shown in fig 1.2.

Generally, the proposed Industrial park area is bounded by Nasawara Village and the Kainji Lake. The location is accessible by road from Mokwa and New Bussa and connects Sokoto State. The project expected lifespan is estimated at 29 years.

1.4 EIA Terms of Reference

Terms of Reference (ToR) for the project have been developed in line with the EIA Procedural Guidelines of 1995. The ToR contained the following:

- scope of work for the EIA including the overall data requirements on the proposed industrial park;
- environmental regulations guiding the project;
- methods and procedures for adequate ecological and socioeconomic data gathering, identification, prediction and evaluation of associated/potential impacts of the project as well as impact mitigation/control measures;
- minimum requirements of an effective Environmental and Social Management Plan (ESMP);
- Establishing basis for consultation with stakeholders and regulatory authorities.

1.5 EIA Objectives

The main purpose of this EIA is to establish a baseline of existing conditions in the project area and to assess proactively the potential impact associated impacts, including health, socio-economic and gender issues of the proposed construction and operation of the roads on the environment. It aims at ensuring sustainable development (i.e. the minimization of negative impacts) during project conception and implementation through the conduct of baseline pre-impact studies of the environment, systematic identification and evaluation of the potential impacts of proposed projects, plans, programme or legislative actions and mitigating negative impacts from the project as well as monitoring the environment during and after the project. The main specific objectives of the EIA are to:

• Establish the existing biological, physical, Socio-Economic and health conditions of the project area;

• Characterize the environment, thereby identifying the resultant hazards (including social) associated with the project;

• Identify, evaluate and predict the impacts of the project on the environment including socio-economic and health aspects with adequate interfacing and project interaction;

• Make recommendations to eliminate/mitigate/control the magnitude and significance of the impacts;

• Ensure proper consultation with the host communities around the proposed project site;

• Development of an Environmental Management Plan (EMP) that will ensure environmental sustainability throughout the project life-span.

1.6 EIA Methodology

The EIA methodology adopted for this project involved the following:

Literature Review

Desktop studies were undertaken to acquire an environmental database required for the EIA studies. The literature search included information from previous EIA studies approved by the FMEnv around the project area.

Consultation

Consultations with the relevant stakeholders is key in every EIA study. These aspects of the EIA have been carried out and are still ongoing at various levels. HIL has carried out consultation with relevant stakeholders including regulatory bodies and host communities. Stakeholders' views and opinions concerning the proposed project and its associated/ potential impacts have been integrated into the EIA process. However, consultations will continue throughout the project lifespan and issues and concerns raised by all Project Affected Persons (PAPs) will be considered. The results of all concluded consultations are included as bases for potential impact assessment and as such have been clearly documented in this EIA report.

The stakeholders consulted included:

- Federal Ministry of Environment (FMENV);
- Niger State Ministry of Environment (NSMENV)
- Niger State Ministry of Land and Housing
- Magama Local Government Area Council
- Nigeria Export Processing Zones Authority (NEPZA)and
- Host Communities; and relevant Non-Governmental Organizations (NGOs).

Field Research

Field research was undertaken so as to complement/verify or otherwise information gathered from desktop studies. Specific information on the ecological and socioeconomic conditions of the project environment was gathered during fieldwork execution. In particular, the survey covered the following environmental components:

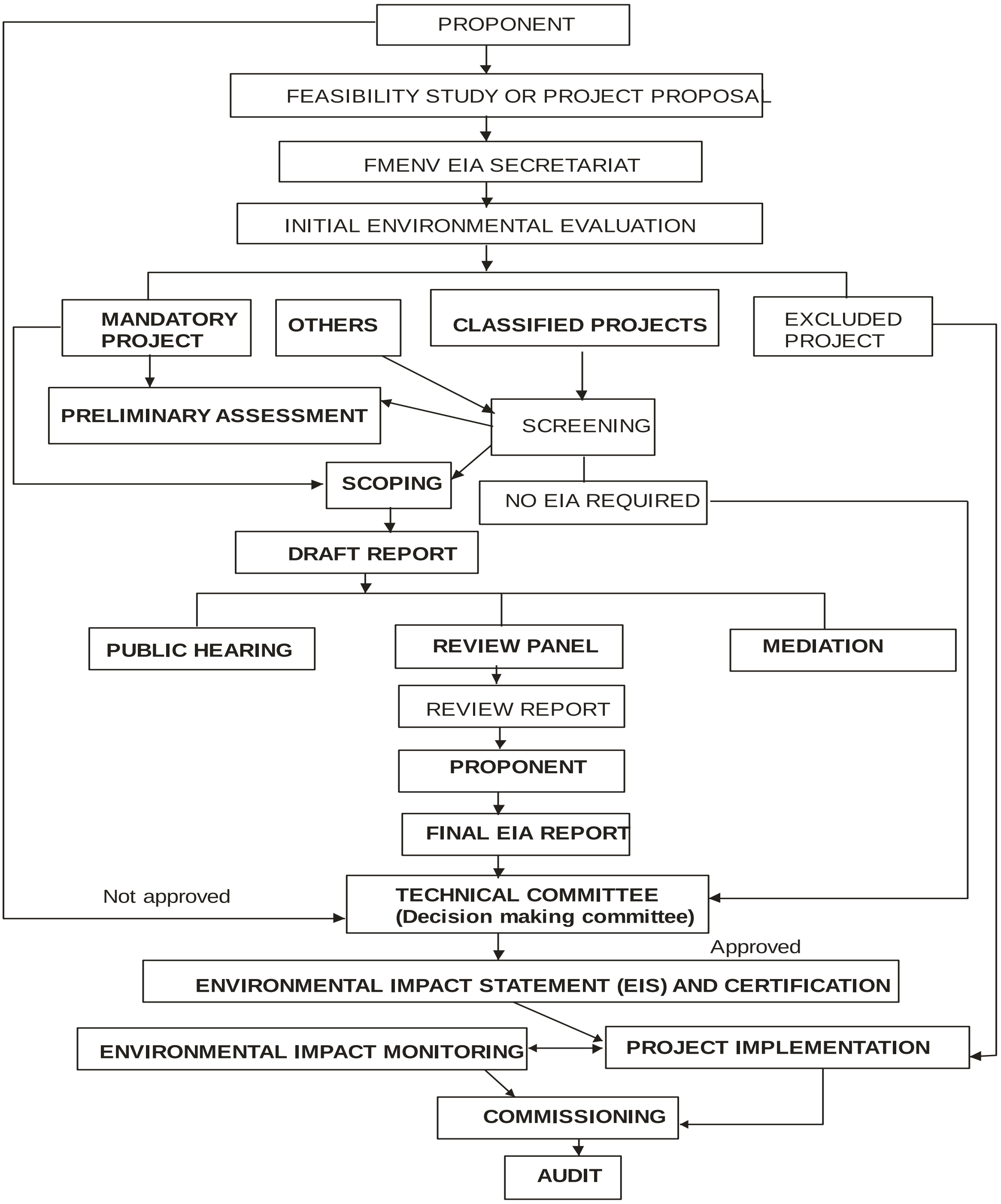
- the physical environment – water and sediment characteristics, soil characteristics, air quality, noise and potential natural hazards;
- the biological environment – water, sediment, and soil microbiology, benthos, plankton, flora and fauna (particularly rare and endangered species);
- the socio-economic and cultural environment - population, land use and patterns of land ownership and tenure, community structure, employment, distribution, public health, cultural heritage, customs, aspirations and attitudes, etc.

Potential and Associated Impact Assessment

Identification and evaluation of the associated/potential impacts of the proposed project are based on appropriate standards and acceptable environmental assessment tools such as the ISO 14001 approach and the Hazard and Effect Management Process (HEMP). The Risk Assessment Matrix (RAM) has been employed in determining risks posed by the identified potential/associated impacts of the project in order to proffer appropriate mitigation measures. In predicting impacts, the experiential/practical 'worst case scenario' approach has been applied to determine the extreme effects of project activities on environmental components, while 'consensus of opinions' has been made use of to determine the importance of affected environmental components. The impact evaluation results forms the pedestal for developing the EMP of the proposed project.

The EIA report has been compiled in accordance with the flow scheme shown in Figure 1.4.

Flow Chart of the FMENV EIA Procedure



(EIA Procedural Guidelines, 1995)

Figure 1.6: EIA Procedural Flowchart

1.6.1 The Niger State Ministry of Environment EIA Process

The EIA Process for the Ministry of Environment is outline in figure 1.7 below..

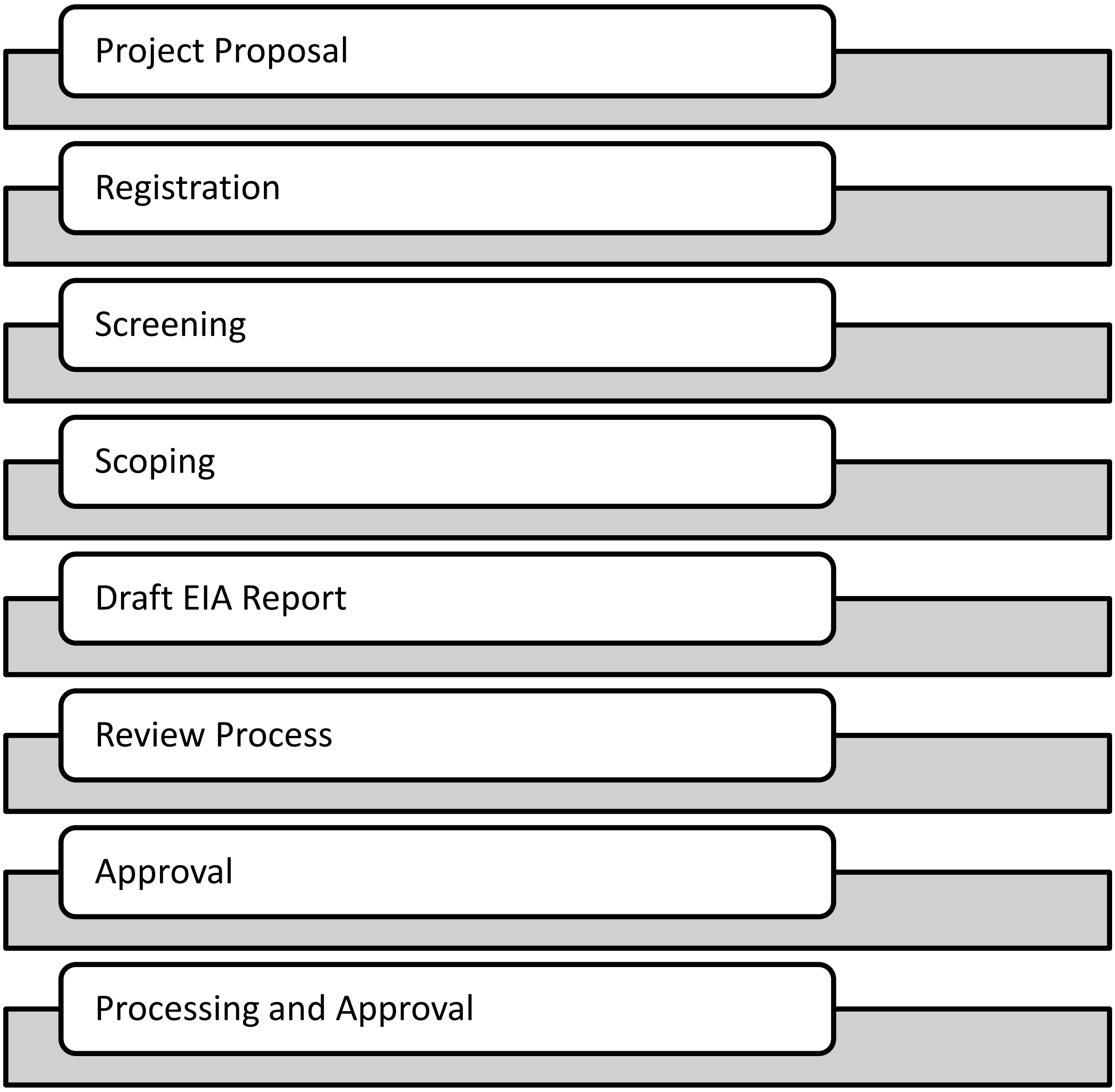


Figure 1.7: EIA Process for Niger State

1.7 Regulatory Framework

As desirable and necessary as it is, development can become an albatross (not of itself though) if there is a dearth of appropriate policies to guide it. Unguided urbanization and industrialization can lead to deforestation and desertification culminating in ruin and wreckage of the environment. In Nigeria prior to 1987 economic considerations and fundamental lack of knowledge of interdependent linkages among development processes and environmental factors, as well as human and natural resources, resulted in unmitigated assault on the environment. However, the environment and the need for its preservation took center stage after the momentous and singular event of the secret dumping of toxic waste in Koko Port, Bendel State (now Delta State) in May 1987. In its wake, international seminars and workshops were held and the consensus was for making appropriate environmental legislations.

Most projects on a large scale will trigger some policies both on national and international level. In Nigeria, the power to enforce all activities that might impact on the environment is vested in the Federal Ministry of Environment (FMEnv.) while international; agencies such as the World Bank, AfDB and other financial organizations have environmental criteria which must be obliged before the agencies invest in the project.

This section therefore seeks to identify the most pertinent policies and legislation governing the environment and social impacts in relation to the project both on national and international scale.

1.7.1 National Policy on Environment

Environmental consciousness and awareness regarding the adverse effects of development projects resulted in the articulation of a national framework for environmental protection and national resources conservation. Decree No. 58 of 1988, as amended by Decree No. 59 of 1992, established the Federal Environmental Protection Agency (FEPA) as the main government structure for environmental matters in the country. The FEPA put in place the 1989 National Policy on the Environment, revised in 1995, with sustainable development as its goal.

The National Policy on the Environment aims to achieve sustainable development in Nigeria, and in particular to:

• Secure a quality of environment adequate for good health and well-being;

• Conserve and use the environment and natural resources for the benefit of present and future generations;

• Restore, maintain and enhance the ecosystem and ecological processes essential for the functioning of the biosphere to preserve biological diversity, and the principle of optimum sustainable yield in the use of living natural resources and ecosystems;

•Raise public awareness and public understanding between the environment and development and encourage individual and community participation in environmental improvement efforts; and,

•Cooperate in good faith with other countries, international organizations and agencies to achieve optimum use of trans-boundary natural resources and the prevention or abatement of trans-boundary environmental degradation.

1.7.2 The Federal Ministry of Environment

In 1999, the Federal Ministry of Environment was created FEPA (Amended Decree No. 59 of 1992) was absorbed into the Ministry. The Ministry of Environment thus became the highest policy making body responsible for addressing environmental issues in Nigeria. The act establishing the Ministry places on it the responsibility of ensuring that all development and industry activity, operations and emissions are within the limits prescribed in the National Guidelines and Standards, and comply with relevant regulations for environmental pollution management in Nigeria as may be released by the Ministry. To fulfill this mandate, the main instruments in ensuring that environmental and social issues are mainstreamed into development projects is the Environmental Impact Assessment (EIA) Act No. 86 of 1992. With this Act, the FMENV prohibits public and private sectors from embarking on major prospects or activities without due consideration, at early stages, of environmental and social impacts. The act makes an EIA mandatory for any development project, and prescribes the procedures for conducting and reporting EIA studies.

The responsibilities of the ministry include:

•Monitoring and enforcing environmental protection measures;

•Enforcing international laws, conventions, protocols and treaties on the environment;

•Prescribing standards for and making regulations on air quality, water quality, pollution and effluent limitations, atmosphere and ozone protection, control of toxic and hazardous substances;

•Promoting cooperation with similar bodies in other countries and international agencies connected with environmental protection.

It is worthy to note that before commencement of an EIA, the FMENV issues a letter of intent on notification by the proponent, approve the terms of reference, ensure public participation, review and mediate. The possible technical activities expected for a proposed project include screening, full or partial EIA Study, Review, Decision-making, Monitoring Auditing and Decommissioning/Remediation post-closure

1.7.3 Guidelines and Standards for Environmental Pollution Control in Nigeria

This document was promulgated in March 1991 to serve as a basic instrument for monitoring and controlling industrial and urban pollution. These guidelines were initiated sequel to the promulgation of the National Environmental Policy in 1989. The guidelines and standards relate to six (6) areas of concern:

- effluent limitations;
- water quality or industrial water uses at point of intake;
- industrial emission limitations;
- noise exposure limitations;
- management of solid and hazardous wastes; and
- pollution abatement in industries

National Effluent Limitation Regulation

The National Effluent Limitation Regulation, S. I.8 of 1991 (No. 42, Vol. 78, August, 1991) makes it mandatory for industries as waste generating facilities (including research institutes, clinics, hotels etc.) to install anti-pollution and pollution abatement equipment based on Best Available Technology (BAT) for detoxification of effluent and chemical discharges. 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 specified also in the regulation.

Pollution Abatement in Industries, Industries Generating Wastes Regulation

The pollution abatement regulation, 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 FMENV; requirement of permit by industries for the storage and transportation of harmful or toxic waste; the generator'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.

Air Quality

Section 3.1 of Guidelines and Standards for Environmental Pollution Control in Nigeria issued by the Federal Environmental Protection Agency (FEPA) in 1991, stipulates emission limits of pollutants from stationary sources such as from a site, process, stack and vent. The guidelines also prescribes safe levels of common air pollutants like suspended particulate matter (SPM), oxides of carbon, nitrogen and sulphur, volatile organic compounds (VOC) and hydrogen sulphide.

Noise Level

With the objective of regulating ambient noise quality in the environment, the FEPA in chapter four of its Guidelines and Standards for Environmental Pollution Control in Nigeria, stipulates noise exposure limits for Nigeria. The standard recommends that daily noise exposure for workers should not exceed 90 dB (A) for an 8-hour working period. In addition to the FMENV limitations on noise, World Health Organization (WHO) guideline values for community noise have been used to establish critical noise limits permissible for the WIBP project.

Water and Waste Water Quality

The FEPA (now FMENV) in its Guidelines and Standards of 1991 provides for the prevention and control of water pollution and maintaining or restoring good water quality for any establishment. Specific standards are also laid down for quality of water effluents to be discharged. The body has also established groundwater protection standard. The guideline applies to owners or operators of facilities that treat, store, or dispose of dangerous waste in surface impoundments, waste piles, land treatment units, or landfills.

Management of Hazardous and Solid Wastes Regulation

S.I.15 – National Environmental Protection Management of Solid and Hazardous Wastes Regulations 1991 requires facilities to classify wastes into categories, manage them as per the prescribed guidelines and obtain prior authorization from the Federal Ministry of Environment (FMENV) for handling, treatment, storage and disposal of hazardous wastes. It also defines the requirements for groundwater protection, surface impoundment, land treatment, waste piles, landfills, incinerators, etc.

1.7.4 National Environmental and Conservation Plans and Strategies

In addition to the policies highlighted above, some plans and strategies have been put in place by the Nigerian Government to assure environmental sustainability. These strategies and actions contain elements that address the environmental and resource management.

National Conservation Strategy

This is to ensure strategic approach to address environmental and natural resources issues in order to guarantee sustainable benefits to the greatest number of people. The aim is to manage the ecosystems in such a way to yield optimum sustainable benefit to present generations while maintaining the potential to meet the needs and aspirations of future generations in such a way that essential ecological processes and life support systems are maintained. The strategy focuses on the main resources (vegetation and forage, water, marine and fisheries, wildlife and soil resources).

Nigerian National Environmental Action Plan

With the support from the World Bank, the Nigerian National Environmental Action Plan (NEAP) was developed as a meaningful framework to assist in the analysis, evaluation and discussion of the interdependence between the environment and the economy in Nigeria. It also seeks to provide an assessment of Nigeria's environmental priorities and an identification of options for mitigating the impact of environmental degradation in the country. Its implementation gave rise to the World Bank assisted Environmental Management Project in Nigeria and helped in strengthening Environmental Agencies at Federal and State levels.

This plan also helped to catalyze the study on costs/benefits of biodiversity conservation, enactment of EIA legislation and the setting up of environmental standards. The implementation of the NEAP was also supported by United Nations Development Programme (UNDP) through the Environmental Natural Resource Management Programme for Nigeria in the form of capacity building and institutional strengthening of Federal and State Environmental Protection Agencies.

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

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

Some of the responsibilities of NESREA include the following:

1. Enforce compliance with laws, guidelines, policies and standards on environmental matters;

2. Liaise with, stakeholders, within and outside Nigeria on matters of environmental standards, regulations and enforcement;

3. Enforce compliance with the provisions of international agreements, protocols, conventions and treaties on the environment including climate change, biodiversity conservation, desertification, forestry, oil and gas, chemicals, hazardous wastes, ozone depletion, marine and wild life, pollution, sanitation and such other environmental agreements as may from time to time come into force;

4. Enforce compliance with policies, standards, legislation and guidelines on the following:

i. water quality, Environmental Health and Sanitation, including pollution abatement;

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

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

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

5. Enforce through compliance monitoring, the environmental regulations and standards on noise, air, land, seas, oceans and other water bodies other than in the oil and gas sector;

6. Ensure that environmental projects funded by donor organizations and external support agencies adhere to regulations in environmental safety and protection;

7. Enforce environmental control measures through registration, licensing and permitting Systems other than in the oil and gas sector;

8. Conduct environmental audit and establish data bank on regulatory and enforcement mechanisms of environmental standards other than in the oil and gas sector;
9. Create public awareness and provide environmental education on sustainable environmental management, promote private sector compliance with environmental regulations other than in the oil and gas sector and publish general scientific or other data resulting from the performance of its functions; and

10. Carry out such activities as are necessary or expedient for the performance of its functions.

NESREA Regulations

The Federal Government through NESREA has developed Environmental Regulations which have been published in the Federal Republic of Nigeria Official Gazette and are now in force. Applicable NESREA regulations relevant to this project are briefly discussed below:

1. National Environmental (Construction Sector) Regulations, 2010. S. I. No. 19. The purpose of these Regulations is to prevent and minimize pollution from Construction, Decommissioning and Demolition Activities to the Nigerian Environment.

2. National Environmental (Coastal and Marine Area Protection) Regulations, 2010. S. I. No 18. This Regulation provides for the regulatory framework for the application of preventive, precautionary and anticipatory approaches so as to avoid degradation of the coastal and marine environment.

3. National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35. The main objective of the provisions of this Regulation is to ensure tranquility of the human environment or surrounding and their psychological wellbeing by regulating noise levels.

4. National Environmental (Soil Erosion and Flood Control) Regulations, 2010. S. I. No. 12. The overall objective of these Regulations is to check all earth-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.

5. National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2010. S. I. No. 20. The purpose of these

regulations is to restore, preserve and improve the quality of air. The standards contained herein provide for the protection of the air from pollutants from vehicular emission.

6. National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28. The purpose of this Regulation is to provide the legal framework for the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution.

7. National Environmental (Surface and Groundwater Quality Control) Regulations, 2010. S. I. No. 22. The purpose of this Regulation is to restore, enhance and preserve the physical, chemical and biological integrity of the nation's surface waters, and to maintain existing water uses.

8. National Environmental (Wetlands, River Banks and Lake Shores) Regulations, 2009. S. I. No. 26. This Regulation provides for the conservation & wise use of wetlands & their resources in Nigeria and ensure sustainable use of wetlands for ecological and tourism purposes and to protect wetland habitats for species of fauna and flora.

9. National Environmental (Permitting and Licensing System) Regulations, 2009. S. I. No. 29. The provision of this Regulation enables consistent application of environmental laws, regulations and standards in all sectors of the economy and geographical region.

10. National Environmental (Ozone Layer Protection) Regulations, 2009. S. I. No. 32. These provisions seek to prohibit the import, manufacture, sale and the use of ozone-depleting substances.

1.7.6 State Legislations: States Environmental Protection Edicts

The responsibility for environmental management in Nigeria is shared between the three tiers of government as enshrined in Chapter II Section 20 of the 1999 Constitution under the fundamental objectives and directive principles of state policy. It stipulates: "States shall protect and improve the environment and safeguard the water, air and land, forest and wild life of Nigeria". This section of the Constitution refers to Nigeria as a Sovereign State and empowered federating states to legislate on environmental issues. As a result of the law, many State governments in Nigeria have established their Ministries of Environment; in some states as a separate ministry and in others as a part of the Ministry of Water Resources or Agriculture. Almost all of the 36 States (and the Federal Capital Territory, Abuja) have in addition created a State Environmental Protection Agency (SEPAs) whose duty is to implement state environmental policies with particular attention to solid waste removal and industrial pollution control.

Furthermore, in accordance with Section 24 of the Federal Environmental Protection Agency (FEPA) Act, Chapter 131 of the Federal Republic of Nigeria, 1990, (as amended) by Decree No. 59 of 1992, the State Environmental Protection Edicts were enacted. The Edicts empower the State Ministry of Environment to establish such environmental criteria, guidelines/specifications or standards for the protection of the state's air, lands and waters as deemed necessary to protect the health and welfare of the people. The Nigerian Constitution allows States to make legislations, laws and edicts on the Environment. The ESIA Decree No. 86 of 1992 also recommends the setting up of State Environmental Protection Agencies (SEPA), to participate in regulating the consequences of project development on the environment in their area of jurisdiction. SMENVs thus have the responsibility for environmental protection at the state level within their states. The functions of the SMEnvs include:

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

ii. Co-operate with FMEnv and other relevant National Directorates/Agencies in the promotion of environmental education;

iii. Be responsible for monitoring compliance with waste management standards;

iv. Monitor the implementation of the ESIA and the Environmental Audit Report (EAR) guidelines and procedures on all developments policies and projects within the State.

In accordance with the provisions of Section 24 of Decree 58 of 1988 and Chapter 131 of the Laws of the Federation of Nigeria, the Niger State Ministry of Environment (NSMOE) and Niger State Environmental Protection Agency (NISEPA) were formed in Lagos and which are important stakeholders in the proposed project because the site of the project is within the State. Other functions of the state ministry among others include:

• advise the Governor of the State on environmental policies, priorities and on scientific and technological activities affecting the environment, within the state;

• prepare and update a State Environmental Action Plan to improve the quality of the environment;

• implement the State Environmental Action Plan;

• monitor the state of the environment and prepare an Annual State of the Environment Report for the State and transmit same to the Secretariat of the National Council on Environment in December of each year;

• liaise routinely and ensure effective harmonization with the Federal Ministry of Environment in order to achieve the National Policy on the environment;

• co-operate with FMEnv and other relevant National Directorates/ Agencies in the promotion of environmental education in the citizenry;

• be responsible for general environmental matters in the State including the negative effects of soil degradation due to flooding and erosion, mineral and oil exploitation and exploration, deforestation, physical planning including Amusement Parks, Gardens and beautification programmes, sewerage matters, water quality and water pollution control;

• In co-operation with the FMEnv to develop the institutional and human capacity for environmental pollution control;

• co-operate with Local Government Councils, statutory bodies and research agencies on matters and facilities relating to environmental protection, particularly in the management of wastes;

• establish and implement the numerous strategies of the National Policy on the Environment towards achieving sustainable development;

• mobilize the inhabitants of all areas in the State for the effective observation of environmental rules and guidelines for the promotion of healthy and safe environment;

• implement applicable existing Edicts on activities related to the environment; and

• carry out such other activities as are necessary or expedient for the full discharge of the functions of the Ministry.

1.7.7 National Legal Instrument on the Environment

Environmental Impact Assessment Act No. 86, 1992 (FMEnv). This Act provides the guidelines for activities of development projects for which EIA is mandatory in Nigeria. The Act also stipulates the minimum content of an EIA and is intended to inform and assist proponents in conducting EIA studies as well as a schedule of projects, which require mandatory EIAs. The EIA Decree No. 86 of 1992 lists drainage and irrigation as a Mandatory Study Activity, thus prescribing that an EIA is to be carried out for irrigation projects. According to these guidelines:

•Category I projects will require a full Environmental Impact Assessment (EIA).

•Category II projects may require only a partial EIA, which will focus on mitigation and Environmental planning measures, unless the project is located near an environmentally sensitive area--in which case a full EIA is required.

•Category III projects are considered to have "essentially beneficial impacts" on the environment, for which the Federal Ministry of the Environment will prepare an Environmental Impact Statement.

This project falls under category I.
Other Existing National Environmental Instruments

•National Environmental Protection Regulations (Effluent Limitation): the regulation makes it mandatory for industrial facilities to install anti-pollution equipment, make provision for effluent treatment and prescribes the maximum limit of effluent parameters allowed.

•The National Guidelines and Standards for Environmental Pollution Control in Nigeria (1991): provide regulations and guidelines for management of pollution control measures.

•National Protection (Pollution and Abatement in Industries in Facilities Producing Waste) Regulations (1991): imposes restrictions on the release of toxic substances and stipulates requirements for monitoring of pollution. It also makes it mandatory for existing industries and facilities to conduct periodic environmental audit.

•Management of Solid and Hazardous Wastes Regulations (1991): regulates the collections, treatment and disposal of solid and hazardous wastes from municipal and industrial sources.

•National Guidelines on Environmental Management Systems (1999)
•National Guidelines for Environmental Audit

•National Air Quality Standard Decree No. 59 of 1991

•National Environmental Standards and Regulations Enforcement Agency Act 2007 (NESREA Act)

•Workmen Compensation Act 1987 Occupational health and safety

•Urban and Regional Planning Decree No 88 1992

1.7.8 Federal Ministry of Industry, Trade and Investment

The ministry plays a decisive role in the diversification of the resource base of the economy by promoting trade and investment with special emphasis on increased production and export of non-oil and gas products that will lead to wealth and job creation, poverty reduction, supervise the FEC Trade Zones and ensure enhanced service deliver on a manner that will aid growth of the Nigerian economy.

•National Urban Development Policy (NUDP)
National Urban Development Policy is to promote a dynamic system of urban settlements, which fosters sustainable economic growth, promotes efficient urban and regional planning and development, as well as ensures improved standard of living and well-being of Nigerians.

1.7.9 Federal Ministry of Agriculture and Rural Development

The Federal Ministry of Agriculture and Rural Development ensures that the citizenry are provided with credible and timely information on government activities, programs and initiatives; while creating an enabling technological environment for socio-economic development of the nation.

•Water Resources Act 1993, No.101: This act promotes the optimum planning, development and use of Nigeria's water resources and other matters connected therewith. The right to the use and control of all surface and groundwater and of any watercourse affecting more than one State as described in the Schedule to this Act, together with the bed and banks thereof, are by virtue of this Act and without further assurance vested in the Government of the Federation State Environmental

1.7.10 State Policy/ Legislation

Amended Decree No. 59 of 1992, which established FEPA, also issued a federal directive to the states to establish State Environmental Protection Authorities or Agencies. The functions of State Environmental Protection Authorities include:

•Protection of air, water, land, forest and wildlife within the states;

•Preservation, conservation and restoration to pre-impact status of all ecological processes essential to the preservation of biological diversity;

•Enforcement of all environmental legislations and policies;

•Coordination and supervision of environmental assessment studies;

•Minimization of impacts of physical development on the ecosystem;

•Pollution control and environmental health in the states

•Co-operation with FMEnv and other agencies to achieve effective prevention of abatement of trans-boundary movement of waste.

1.7.11 Niger State Environmental Protection Agency (NISEPA)

Niger State Environmental Protection Agency is established by the Niger state government towards ensuring a conducive and sustainable development of the environment for present and generations to come. The Niger State Government signed an edict cited as the Niger State Environmental Protection Agency in 1996. This edict was amended on 4th of May 2011 by the Niger State House of Assembly as Niger State environmental Protection Law 2011. The executive General Manager with his team of qualified professionals based on directives from the Governor's office, prepare the Agency's programmes towards achieving a target and expected completion time as well as their cost analysis.

The Niger State Environmental Protection Agency (NISEPA) has fully legal responsibilities to manage and oversee the state of the environment and natural resources in the state. It is the agency mandate to raise the environmental awareness level and education among the people of Niger State for proper and sustainable development. Functions of Niger State Environmental Protection Agency

According to the amended edict of 4th of May 2011, the Niger state environmental protection agency should perform the following mandate;

•The environmental protection and the development of the environment of the state and in consultation to the Federal Environmental Protection Agency (FEPA).

•Protection of our environment and biodiversity conservation and sustainable development in Niger State.

•Conduct research on matters relating to environment.

•In conjunction with relevant agencies to coordinate urban and regional planning and liaise with federal, state, local government, public and private organizations.

•Collaborate with federal government through the ministry of environment in conducting public investigation on major environmental pollution.

•Monitor water, air land and natural resources quality.

•Promote environmental education and awareness.

1.7.12 Nigeria Export Processing Zones Act (CAP N107 LFN 2004)

The institutional framework that governs the establishment of ATV falls under the jurisdiction of Nigeria Export Processing Zones Authority.

"In exercise of the power conferred upon it by section 27 of the Nigeria Export Processing Zones Act, CAP N107 LFN 2004 and of all other power enabling it in that behalf, Nigeria Export Processing Zones Authority with the approval of the Honourable Minister of Trade and Investments". The objectives of these regulations will apply to the Amfani Industrial Park and Smart City

•Complement and enhance the provisions of the Nigeria Export Processing Zones Act, 2004

•Provide details of regulatory and supervisory requirements necessary to promote efficient and profitable operations in Nigeria's Free Trade Zones

•Facilitate the attainment of goals for which Free Trade Zones are established in Nigeria.

•These regulations shall take precedence over the Investment Procedures, Regulations and Operational Guidelines for free zones in Nigeria, 2004

•The Authority (Nigeria Export Processing Zone Authority) has delegated Abuja Technology Village Free Zone Company ("the Zone Manager") the responsibility to develop, manage, operate and administer the area of the zone.

1.7.13 Other Acts and Legislations

Land Use Act of 1978

The land-use Act of 1978 states that "…It is also in the public interest that the rights of all Nigerians to use and enjoy land in Nigeria and the natural fruits thereof in sufficient quality to enable them to provide for the sustenance of themselves and their families should be assured, protected and preserved'. This implies that acts that could result in the pollution of the land, air, and waters of Nigeria negates this decree, and is therefore unacceptable. Furthermore, the Land Use Act of 1978 (modified in 1990) remains the primary legal means to acquire land in the country. The Act vests all land comprised in the territory of each state of the Federation in the Governor of the state and requires that such land shall be held in trust and administered for the use and common benefit of all Nigerians in accordance with the provisions of this Act.

According to the Act, administration of land area is divided into urban land, which will be directly under the control and management of the Governor of each State; and non-urban land, which will be under the control and management of the Local Government. State Governors are given the right to grant statutory rights of occupancy to any person or any purpose; and the Local Government will have the right to grant customary rights of occupancy to any person or organization for agricultural, residential and other purposes.

Land Use in Niger State

The Land Use Act of 1978 is the principal law guiding land acquisition, resettlement, allocation and development in the Niger State. The Act provides for the Government to hold land in trust for the use and common benefit of all Nigerians, for the realization of equity, fairness and justice in the control and management of land, resettlement and compensation purposes. In addition the Niger State Act of 1976 vests the entire landmass of the state absolutely in the Government of the State. Prior to the year 2003 there were massive irregularities and double allocation of land owing to manual method of land records and allocation. However, in the year 2003 the Government of the Federation took the bold decision to embark on complete computerization of the cadastral and land registry of the FCT, which has installed development control to the master plan in the FCT. Others include;

- Water Resources Decree 1993
- Criminal Code:
- Land Planning Act (cap.303)
- The Waterworks Act 1917
- Rehabilitation, Reconstruction and Development Act, 1990
- Penal Code Act (cap.63)
- Wildlife Conservation and Management Act, Cap376
- Occupational, Health and safety Act (OSHA), 2007
- Public Health Act (Cap. 242)
- Environmental Impact Assessment Act 1996
- Environmental Vibration Pollution (Control) Regulations, 2006. etc.

Niger State Solid Waste Management Board

Kainji Lake National Park Act of 1979

Nigerian Ports Authority Act No 38 of 1999

The Nigerian Ports Authority (NPA) is a federal government agency that governs and operates the ports of Nigeria. NPA was established in 1955 by the Port Act Cap 155 Laws of the Federation of Nigeria and Lagos as a corporate body with perpetual succession. The enabling statutes have been amended several times. The successor law is the Nigerian Ports Authority Act No 38 of 1999. By Act No. 38 of 1999, Nigerian Ports Authority owns the ports and controls all public and private tasks. Under Section 7 of the NPA Act No. 38 of 1999, the functions of the Authority in summary are to:

i. Provide and operate port facilities and services;

ii. Maintain, improve and regulate the use of the ports;

iii. Ensure efficient management of port operations; and

iv. Control pollution arising from oil or any other from ships using the port limits or their approaches.

Section 8 of the Act gives the Authority very wide powers. These include power to:

i. Build and develop port docks, harbors, piers, wharves, canals, jetties, embankment and water courses;

ii. Invest the funds of the Authority;

iii. Act as consultants in relation to port and port operations in Nigeria or any part of the world;

iv. Act as carrier by land or sea, stevedore, wharfing, warehouseman or lighter man.

v. Appoint, license and manage pilots of vessels;

vi. Reclaim, excavate, enclose, raise or develop any of the lands acquired by or vested in the authority; and

vii. Win sand from the ports and their approaches for such purposes as it may deem fit.

National Inland Water Ways Authority

National Inland Water Ways Authority (NIWA) was established by Act No. 13 of 1997. The objectives of the Authority include:

• To improve and develop inland waterways for navigation;

• To provide an alternative mode of transportation for the evacuation of economic goods and persons; and

•To execute the objectives of the national transport policy as they concern inland waterways.

The statutory functions of NIWA include:

• making regulations for the inland water navigation;

• Development of infrastructural facilities for a national inland waterways; and

• ensure the development of indigenous technical and managerial skills to meet the challenges of modern inland waterways transportation.

Other functions include:

• Capital and maintenance dredging;

• Hydrological and hydrographic surveys;

• Design of ferry routes;

• remove and receive derelicts wrecks and other obstructions from inland waterways;

• approve and control all jetties, dockyard, piers within the inland waterways;

• reclaim land within the right of way;

• Construction, administration and maintenance of inland river-ports and jetties;

• provide hydraulic structures for river, bed and bank stabilization, barrages, etc;

• subject to the provisions of the Environmental Impact Assessment Act 1992, carry out environmental impact assessment of navigation and other dredging activities within the inland water and its right of way;

• undertake erection and maintenance of gauges, kilometer boards, horizontal and vertical control marks; and

• Clear water hyacinth and other aquatic weeds.

The Federal Ministry of Environment is the overall umbrella for the protection of coastal and marine environments in Nigeria. The State Governments through the State Environmental Ministries/ Protection Agencies play significant roles in the maritime states.

Sea Fisheries Act, CAP S4, LFN 2004

The Sea Fisheries Act makes it illegal to take or harm fishes within Nigerian waters by use of explosives, poisonous or noxious substances. Relevant sections include the following:

- Section 1 prohibits any unlicensed operation of motor fishing boats within Nigerian waters;
- Section 14 (2) provides authority to make for the protection and conservation of sea fishes.

Inland Fisheries Act, CAP I10, LFN 2004

The Inland Fisheries Act focused on the protection of the water habitat and its species, the following sections are useful:

- Section 1 prohibits unlicensed operations of motor fishing boats within the inland waters of Nigeria;
- Section 6 prohibits the taking or destruction of fish by harmful means.

Nigerian Maritime Administration and Safety Agency (NIMASA) Act. 2007

The Nigerian Maritime Administration and Safety Agency, NIMASA, focal areas include effective Maritime Safety Administration, Maritime Labour.

Regulation, Marine Pollution Prevention and Control, Search and Rescue, Cabotage enforcement, Shipping Development and Ship Registration, Training and Certification of Seafarers, and Maritime Capacity construction.

In summary, some relevant functions of the Agency are to:

i. Pursue the development of shipping and regulate matters relating to merchant shipping and seafarers;
ii. Administering the registration and licensing of ships;
iii. Regulate and administer the certification of seafarers;
iv. Regulate the safety of shipping as regards the construction of ships and navigation;
v. Provide directions and ensure compliance with vessel security measures;
vi. Carry out air and coastal surveillances;
vii. Control and prevent maritime pollution
viii. Enforce and administer the provisions of the Cabotage Act 2003;
ix. Receive and remove wrecks; and
x. Provide National Maritime Search, Rescue Services and Maritime Security.

Coastal and Marine Area Protection Regulations, 2010. S. I. No 18. This Regulation provides for the regulatory framework for the application of preventive, precautionary and anticipatory approaches so as to avoid degradation of the coastal and marine environment.

Land Use Act No.6 of 1978

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

Nigerian Urban and Regional Planning Act Cap N138, LFN 2004

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

- Section 30 (3) requires a building plan to be drawn by a registered architect or town planner.
- Section 39 (7) establishes that an application for land development would be rejected if such development would harm the environment or constitute a nuisance to the community.
- Section 59 makes it an offence to disobey a stop-work order. The punishment under this section, is a fine not exceeding N10,000 (Ten thousand naira) and in the case of a company, a fine not exceeding N50,000.
- Section 72 provides for the preservation and planting of trees for environmental conservation.

Town and Country Planning (Building Plan) Regulations of 1986

Section 3(3) of the Town and Country Planning (Building Plan) Regulations of 1986 states that "where the application submitted is in respect of any development areas of 4 hectares and above and other institutional/commercial/industrial complexes, such application shall be accompanied with an environmental impact analysis report, giving an economic environment, traffic, ecology and communication network duly prepared by Town Planner registered to practice in Nigeria".

Factories Act, Cap F1, LFN 2004

The Factories Act promotes the safety of workers and professionals exposed to occupational hazards. Under this Act, it is an offence to use unregistered premises for factory purposes. In particular: Section 13 allows an inspector take emergency measures or request that emergency measures be taken by a person qualified to do so in cases of pollution or any nuisance.

Forestry Act

This Act of 1958 provides for the preservation of forests and the setting up of forest reserves. It is an offence, punishable with up to six (6) months imprisonment, to cut down trees over 2 feet in girth or to set fire to the forest except under special circumstances.

Endangered Species Act

The Endangered Species Act (Control of International Trade and Traffic) Cap.108 Law of Nigeria, 1990 prohibits the hunting, capture and trade of endangered species.

Federal Land Use Act

Federal Ministry of Transport Act

Federal Ministry of Mines and Steel

Federal Ministry of Power Act

Subject to the provisions of this Act, all land comprised in the territory of each State in the Federation are held in trust and administered for the use and common benefit of all Nigerians.

Criminal Code

Section 247 of the Nigerian Criminal Code makes it an offence, punishable with up to six (6) months imprisonment for "any person who: a) 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 b) 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".

National Building Code

The Federal Republic of Nigeria published a National Building Code (2006) to guide stakeholders in the Building Industry. The need to provide this Code arose from the following existing conditions of Nigeria cities and environment:

- the absence of planning of towns and cities;
- incessant collapse of buildings, fire infernos, built environment abuse and other disasters;

•dearth of referenced design standards for professionals;

•use of non-professionals and quacks;

•use of untested products and materials; and

•lack of maintenance culture.

State Governments are implored to integrate the provisions of this Code into their local laws particularly those relating to Design, Construction and Maintenance (Post Construction) and efficiently monitor the implementation of the Code.

1.7.14 International Guidelines and Conventions

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

African Convention on the Conservation of Nature and Natural Resources

Adopted on the 15th of September 1968 in Algiers, Algeria, the African Convention entered into force on the 9th of October 1969. It objectives are "to encourage individual and joint action for the conservation, utilization and development of soil, water, flora and fauna for the present and future welfare of mankind, from an economic, nutritional, scientific, educational, cultural and aesthetic point of view." It commits signatory parties (the Parties) to adopting "measures necessary to ensure conservation, utilization and development of soil, water, floral and faunal resources in accordance with scientific principles and with due regard to the best interests of the people." The Parties (Nigeria inclusive) agree to use resources wisely, to manage populations and habitats, to control hunting, capture and fishing, and to prohibit the use of poisons, explosives and automatic weapons in hunting. They also agree to prevent and control water pollution, establish conservation areas and consider ecological factors in development plans (www.unep.ch/regionalseas/legal/afr.htm).

United Nations Guiding Principles on the Human Environment

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

Principle 2

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

Principle 4

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

Principle 8

Economic and social development are essential for ensuring a favourable living and working environment for man and for creating conditions on earth that are necessary for the improvement of the quality of life.

World Heritage Convention

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

The Ramsar Convention

The convention was developed and adopted by participating nations at a meeting in Ramsar on February 2, 1971, and came into force on December 21, 1975. The Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilization of wetlands, that is, to stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.

Vienna Convention for the Protection of the Ozone Layer

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

World Bank Operational Manual

The World Bank Operational Directive 4.01: ''Environmental Assessment'' of 1989. This manual is designed as a tool to ensure that projects proposed for World Bank financing are environmentally sound, improve project performance and enhance their overall quality and sustainability. It does so by providing the rules and procedures that allow borrower decision makers and Bank operational staff the flexibility to ensure that the project options under consideration are environmentally sound and sustainable.

World Bank Environmental Assessment Sourcebook

The World Bank has provided in its Environmental Assessment Sourcebook, Guidelines for Urban Development. The guidelines are to ensure sustainable urban growth.

United Nations Conference on Environment and Development

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

Principle 1

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

Principle 5

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

Principle 17

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

Convention on Biological Diversity

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

United Nations Framework Convention on Climate Change

The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys universal membership with 193 countries having ratified. Under the Convention (entered into force on 21 March 1994), governments:

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

The Copenhagen Accord

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

IFC Environment, Health and Safety Guidelines

The IFC and the World Bank Group have developed a set of Sectoral Environment, Health and Safety (EHS) Guidelines specific to particular industries sectors or types of projects. The guidelines provide minimum limits, measures etc required for each industry or sector.

Equator Principles

The Equator Principles (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk. Equator Principles Financial Institutions (EPFI) provides loans only for projects that conform to the Principles (en.wikipedia.org). Two principles specific to environmental assessment and environmental standards are:

Principle 2: Social and Environmental Assessment

For all medium or high risk projects, sponsors complete an Environmental Assessment, the preparation of which must meet certain requirements and satisfactorily address key environmental and social issues.

Principle 3: Applicable Social and Environmental Standards

The Environmental Assessment report addresses baseline environmental and social conditions, requirements under host country laws and regulations, applicable international treaties and agreements, sustainable development and use of renewable natural resources, protection of human health, cultural properties, and biodiversity, including endangered species and sensitive ecosystems, use of dangerous substances, major hazards, occupational health and safety, fire prevention and life safety, socio- economic impacts, land acquisition and land use, involuntary resettlement, impacts on indigenous peoples and communities, cumulative impacts of existing projects, the proposed project, and anticipated future projects, participation of affected parties in the design, review and implementation of the project, consideration of feasible environmentally and socially preferable alternatives, efficient production, delivery and use of energy, pollution prevention and waste minimization, pollution controls (liquid effluents and air emissions) and solid and chemical waste management.

1.7.15 International Policy

1.7.16 World Bank Environmental and Social Safeguards

The World Bank has in place a number of operational and safeguards policies, which aim to prevent and mitigate undue harm to people and their environment in any development initiative involving the Bank. The Nigerian EIA Act and the World Bank safeguard policies are similar; designed to help ensure that projects proposed for Bank financing are environmentally and socially sustainable, and thus improve decision-making. The Bank has twelve safeguards policies and these are:

Environmental:
- OP 4.00 Use of Country Systems
- OP 4.01 Environmental Assessment;
- OP 4.04 Natural Habitats;
- OP 4.36 Forests;
- OP 4.09 Pest Management;
- OP 4.11 Physical Cultural Resources
- OP 4.37 Safety of Dams;

Social:
- OP 4.12 Involuntary Resettlement;
- OP 4.10 Indigenous People;

Legal:
- OP 7.50 Projects on International Waterways;
- OP 7.60 Projects in Disputed Areas

Others:
- Access to Information Policy
- Piloting the Use of Borrower Systems

The triggered safeguard policies for this project are discussed below.

Environmental Assessment (OP 4.01)

Environmental Assessment is used in the World Bank to identify, avoid, and mitigate the potential negative environmental and social impacts associated with Bank's lending operations early on in the project cycle. In World Bank operations, the purpose of Environmental Assessment is to improve decision making, to ensure that project options under consideration are sound and sustainable, and that potentially affected people have been properly consulted and their concerns addressed. This policy is triggered if a project is likely to have potential adverse environmental and social risks and impacts in its area of influence. The EA has various tools that can be used, including amongst others Environmental & Social Impact Assessment (ESIA) or Environmental and Social Management Plan (ESMP).

Involuntary Resettlement (OP 4.12)

This policy can be triggered if the project will involve involuntary taking of land and involuntary restrictions of access to property, protected areas, etc. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts. It promotes participation of displaced people in resettlement planning and implementation. The main objective of this policy is to assist displaced persons in their efforts to improve or at least restore their incomes and standards of living after displacement. The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects.

Physical and Cultural Resources (OP 4.11)

This policy is to assist countries to avoid or mitigate adverse impacts of development projects on physical cultural resources. For purposes of this policy, "physical cultural resources" are defined as movable or immovable objects, sites, structures, groups of structures, natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings, and may be above ground, underground, or underwater. The cultural interest may be at the local, provincial or national level, or within the international community. Typical with most people in

Nigeria, people are in tuned with their cultural heritage and express apprehension whenever they experience any form of relocation. During consultation members of the communities expressed apprehension towards the project.

Pest Management (OP 4.09)

This policy is to (i) promote the use of biological or environmental control and reduce reliance on synthetic chemical pesticides; and (ii) strengthen the capacity of the country's regulatory framework and institutions to promote and support safe, effective and environmentally sound pest management. More specifically, the policy aims to (a) Ascertain that pest management activities in Bank-financed operations are based on integrated approaches and seek to reduce reliance on synthetic chemical pesticides (Integrated Pest Management (IPM) in agricultural projects and Integrated Vector Management (IVM) in public health projects. (b) Ensure that health and environmental hazards associated with pest management, especially the use of pesticides are minimized and can be properly managed by the user. (c) As necessary, support policy reform and institutional capacity development to (i) enhance implementation of IPM-based pest management and (ii) regulate and monitor the distribution and use of pesticides.

Natural Habitats (OP 4.04)

Any project or sub-project with the potential to cause significant conversion (loss) or degradation of natural habitats, whether directly (through construction) or indirectly (through human activities induced by the project). Shear Butter plant plantation was predominant in the project area. This is a source of economic revenue for the people. During the developmental process, the cashew plantation will be removed, as an intended development will pass through the area.

1.7.16 Nigeria EIA Guidelines and World Bank EA Guidelines

The Environmental Impact Assessment Act No. 86 of 1992 requires that development projects be screened for their potential impact. Based on the screening, a full, partial, or no Environmental impact assessment may be required. Guidelines issued in 1995 direct the screening process. According to these guidelines the Nigeria EIA Categories include:

•Category I projects will require a full Environmental Impact Assessment (EIA) for projects under this category EIA is mandatory according to Decree No.

86. Projects includes large-scale activities such as agriculture (500 hectares or more), airport (2500m or longer airstrip), land reclamation (50 hectares or more), fisheries (land based aquaculture of 50 hectares or more), forestry (50 hectares or more conversion, etc.

•Category II projects may require only a partial EIA, which will focus on mitigation and Environmental planning measures, unless the project is located near an environmentally sensitive area--in which case a full EIA is required.

•Category III projects are considered to have "essentially beneficial impacts" on the environment, for which the Federal Ministry of the Environment will prepare an Environmental Impact Statement. With regard to environmental assessment, the Bank has also categorized projects based on the type of EA required, namely:

•Category A - projects are those whose impacts are sensitive, diverse, unprecedented, felt beyond the immediate project environment and are potentially irreversible over the long term. Such projects require full EA. The Amfani Industrial Park and Smart City project was categorized as Category I or A.

•Category B - projects involve site specific and immediate project environment interactions, do not significantly affect human populations, do not significantly alter natural systems and resources, do not consume much natural resources (e.g., ground water) and have adverse impacts that are not sensitive, diverse, unprecedented and are mostly reversible. Category B projects will require partial EA, and environmental and social action plans.

•Category C - Projects are mostly benign and are likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project, although some may require environmental and social action plans.

•Category FI -A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts.

This World Bank categorization (A, B, & C) corresponds in principle with the Nigeria EIA requirements of Category I, II and III, which in actual practice is done with regard to the level of impacts associated with a given project.

However, in the event of divergence between the two, the World Bank safeguard policy shall take precedence over Nigeria EA laws, guidelines and or standards. Thus for this ESIA, the Nigeria's EIA requirements and World Bank operational procedures were harmonized as far as possible, hence it is made responsive to the objectives of good practice. It is especially made responsive with regard to the followings:

- Consideration of environmental and social issues;
- Identification and early consultation with stakeholders;
- Prevention of adverse impacts through the consideration of feasible alternatives; and
- Incorporation of mitigation measures into planning and (engineering) design.

1.7.17 Other Applicable International Conventions, Treaties and Agreements

Nigeria is signatory to some international agreements and Protocols concerning the environment, notably:

- Convention on Biodiversity
- United Nations Framework Convention on Climate Change (1992)
- Vienna Convention for the Protection of the Ozone Layer
- Montreal Protocol on Substances Depleting the Ozone Layer
- Basel Convention on the Trans-boundary Movement of Hazardous Substances
- Stockholm Convention on Persistent Organic Pollutants
- Conventions on International Trade in Endangered Species of Wild Fauna and Flora (CITIES).
- The Ramsar Convention
- World Heritage Convention
- United Nations Framework Convention on Climate Change
- Equator principles

1.8 EIA Report Structure

This EIA report is presented in eight chapters preceded by an executive summary.

- **Chapter one** contains the introductory part: project background, and outlines the objectives, scope and EIA methodology, and legal framework / data sources.
- **Chapter two** discusses the project setting, and presents the need / benefits, sustainability as well as the project alternatives and options.
- **Chapter three** describes the technical elements, components and processes of the proposed Industrial Park activities from design through construction and operation as well as scheduling.
- **Chapter four** describes the existing ecological (climatic, bio-physical and biological) and Socio-economic baseline condition of the area.
- **Chapter five** describes the associated and potential environmental, social and health impacts of the proposed project on the environment.
- **Chapter six** documents the mitigation measures accrued to the identified potential and associated impacts of the project on the environment.
- **Chapter seven** presents the environmental management plan to be adopted throughout the project life cycle. It also recommends the environmental monitoring program and the waste management plan.
- **Chapter eight** summarizes and concludes on the study findings, making appropriate recommendations.

CHAPTER TWO

2.0 PROJECT JUSTIFICATION

2.1 GENERAL

Hydropolis Investment Ltd(HIL) decided to key into the new concept of the fourth industrial revolution era and the United Nations Sustainable Development Goal number nine by establishing the Amfani Industrial Park and Smart City Project to take advantage of proximity to Kainji Hydro power plant, Kainji lake along River Niger, 100km distance to the border of Benin Republic on the West Africa Coast, proximity to Baro port, Kainji National Park and Kainji Wildlife Park, 23km radius to Auna Irrigation Dam, etc to rejuvenate industrial and socioeconomic activities within this naturally established special economic zone.

2.2 Need for the Project.

Industrial park is one of the modern phenomena adopted according to the speed with which more and more business entities, cities, municipalities and regions in the world are growing. Following the complex changes of the macroeconomic environment, cities across the globe have been getting gradually to the discovery of industrial parks. Among other factors, this development is specifically engendered by structural reforms of the economy and the production spheres that are affected by ever stronger competitive struggle within the constantly changing global market space and the impacts of the global crisis. It is worthy of note that the previous production and industrial structure of economies could not stand; hence this new concept of industrial park development.

The development of Industrial park can be viewed as an integrated solution development and economic growth. Industrial park has proven to be an instrumental tool in ensuring social and economic development in the world. The development of the Amfani Industrial Park will lead to a significant reduction in the need for travel by thousands of people who depend on the surrounding towns like New Bussa, Mokwa, Ibbi, Zugurma, Wara, Auna and as far as Jebba for one basic need or the other. Therefore, in this regard, the importance of the Amfani Industrial park cannot be overemphasized.

In a large and populous state such as Niger State with several satellite rural settlements, widely spread across the state, more commercial and social hubs are required to be developed at areas suitable for both business and social development in order to allow for effective development cutting across the state. Therefore, in the overall consideration the need for construction of an Industrial park at Anfani Village in Magama LGA in Niger State is to meet the demand for sustainable development within and across Niger State and provide opportunities for collaboration amongst business operators for public good enhancement.

2.3 Value/Benefit of the Project

The benefits derivable from the development of Amfani Industrial Park and Smart City Project include but not limited to the following;

(i) Improved electricity supply at lower system cost within the project area.

(ii) Increase economic growth by enhancing the growth of small and medium scale industries.

(iii) Create job opportunities for the Nigerian citizens

(iv) Attract foreign direct Investments to Nigeria

(v) Serve as a major source of economic diversification from the Oil sector for Nigeria.

(vi) Provide opportunities for tourism attraction for Niger state and Nigeria by extension.

2.4 Envisaged Sustainability

Economic Sustainability

The natural and ever-increasing desire for private and corporate business growth in the country by business owners will sustain the need and value of the proposed Amfani Industrial Park project. Given the increasing population and the tendency for settlement within the project area, it is envisaged that major nodal centers for social and economic activity will develop within the project area and its environs over time as observed in the case of other existing industrial park. Secondly, the proposed industrial park will operate under uninterrupted electricity power supply from the Kainji Hydopower Power Plant. This will guarantee continuous operation of the businesses and activities under this industrial park development which would therefore economically sustain the project.

Technical Sustainability

The proposed project would be technically sustainable in view of the proven technologies to be adopted which will be in compliance with strict adherence to international and national engineering design, construction standards and codes of practices at all stages of the development.

Environmental Sustainability

This project would have some potential negative impacts on the environment. It is the policy of HIL to conduct EIAs for its entire major developmental project in accordance with the national guideline. The EIA will identify all potential impacts associated with the proposed Industrial Park and proffer appropriate mitigation/ameliorative measures that will ensure that all the impacts are minimized or completely avoided. However incorporating the findings and recommendation of this EIA, and implementing an effective Environmental Management Plan, at the planning, design, construction, operation and abandonment/decommissioning stages of the proposed project, will ensure its environmental sustainability.

2.5 Project Activities

The activities that are involved in the construction of the Industrial Park project include: -

- Sensitizing the stakeholders
- Delineation of the project area
- Evaluation of the affected properties (i.e. crop, economic trees and structures) for the purpose of compensation
- Payment of compensation to all legitimate claimants
- Clearing the project site of all vegetation and structures.
- Construction of various facilities, including schools, hospitals, hotels, etc, and installation of equipment.
- Construction of jetty, fisheries, farms and other platforms within the Kainji Lake.
- Project commissioning

2.6 Project Development Options

Three development options were considered and weighed against each other in line with the construction of the new Industrial Park in the country.

The Options include: -

Option A: No action

Option B: Alternative Site/Location Option

Option C: Delayed Option

Option D: Site project as proposed

2.6.1 Option A: No Action

No Action Option, The "no development" option will result in zero land take, zero health, safety and environmental impacts. No development options are usually considered in cases where the proposed development will have significant negative impact that cannot be effectively or satisfactorily mitigated. To maintain the status quo is the do-nothing approach. The Niger state Government has overall authority and responsibility for all matters and activities in the proposed project area. The government has permitted industrial development in the area. The area is not a forest reserve or de-reserved forest. The project has a good control technology design that will ensure minimal impact on the environment. From the results of the field investigations there is no IUCN red listed or endangered or threatened or endemic plant species in the area. The project is justified on the basis of its scientific, educational and economical benefits to Niger State, Nigeria and several other West African countries, and it is sustainable. Therefore a "no project" option is rejected

2.6.2 Option B: Alternative Site/Location Option

The selection of the proposed Industrial Park site was based on technical reasons including their suitability for reception and business potential. Technical evaluation of the project design and space requirement indicates that the project location is the most suitable within the state and can promote efficient cost benefit. The location is acquired by the proponent in accordance with extant land laws within the country. There were appropriate consultations with land owners, communities, surveyors and town planning authority for the state. In view of these considerations, the alternative site/location option is considered grossly inadequate, hence the decision to drop the option.

2.6.3 Alternative C: Delayed Project Option

This option means postponing the planned project development to a later date. Such options are usually taken when prevailing conditions are unfavorable to the project implementation such as war, when host communities are deeply resentful of the project or if the economics of the project are unacceptable or unattractive. But none of these conditions are applicable here on the contrary; both the economic and the political environment are favorably disposed towards the project. Furthermore, the overriding need for creation of jobs amongst our teaming youth who are either unemployed or seriously underemployed re-enforced the need for the immediate implementation of the project. Thus delaying the project will negate its purpose. This option was also rejected on the basis of these reasons.

2.6.4 Option D: Site Project as Proposed

The proposed action is for Hydropolis Investment Ltd to carry out the construction and operation of the proposed project in its proposed location. The preliminary master plan and surveys for the project have been essentially concluded; the location, due to its proximity to the Kainji Lake, it has a source for adequate water supply sufficient for all the expected facilities that are to be put in place. Again, its proximity to the Kainji Hydropower Dam will guarantee uninterrupted power supply to the industrial park as the necessary arrangement to ensure it will be realized has since been concluded with the Mainstream Energy-the owners of the dam. The project will have an on-site wastewaters treatment facilities that will cater for all the proposed and expected development that would be put in place. The location is not a forest reserve or of any special ecological or archeological interest that may warrant the relocation of the planned development. Thus, the project development can therefore take place.

CHAPTER THREE

3.0 Project Description

3.1 General

The proposed industrial Part and Smart City project by Hydropolis Investment Ltd conceived as a huge business venture that will not only boost the status of as the nation's industrial hub but also serve as a revolutionary vision of changing the entire economy of the country and the West African sub-region by extension as its objective is in line with the concept of free trade zone which is promoted globally to fast-track industrialization, socio-economics development of designated areas and jobs/wealth creation.

This project is planned to provide a unique business environment for stakeholders of innovation process in Nigeria's industrial sector to interact with each other, attract domestic and foreign venture capital, as well as technological development, transfer and adoption. The uniqueness of this project lies in the fact that it is being executed in agreement with the Mainstream Energy Solutions Ltd to supply uninterrupted electricity to Hydropolis free zone development company, Amfani.

The Amfani project will act as catalyst in transforming the region into a 'focal point' for industry, trade and tourism in Niger State as it will attract investors from domestic and the wider West African region, as well as international investors looking to develop small-medium scale industries and businesses, taking advantage of its strategic location. The project when fully completed will be made up of the following components:-

- A smart city with residential apartments of different sizes with uninterrupted power and internet services.
- High-tech industrial park for low to high technology production.
- Commercial area, business district and financial hub
- World Class Medical Services
- Smart Primary/Secondary Schools
- Hydrpolis University
- Hydropolis Airport
- Recreational area for leisure and sport consisting of Water Park, Amusement Park, Sport Arena, Water Sport and Cruising.
- Hospitality Industry of different grade of world class hotels. Golf Course, International Conference/Convention Facilities.

3.2.1 The Project

The proposed project which is conceived and planned to be executed by Hydropolis Investment Limited is a 100% privately owned industrial park which that will provide most technically advance facilities to meet up with identifies demands and concerns of business community. The project is designed to provide most conducive business environment alongside leisure facilities taking advantage of the proximity of its location to the existing Kainji Lake. On completion, the park would cover an estimated area of about 1000 hectares initially and will provide a range of services and facilities as highlighted earlier have been planned for this development. These will further include access roads, airport, slip way, alternative power source, water supply, fire-fighting station etc. However, the Airport is planned for the next phase of this project. **Fig 3.1** shows the Master Plan for the proposed project while **Fig 3.2** presents the design approach of the master plan.

Fig 3.1: Master Plan

1 Civic Centre

2 Shopping Mall

3 Waterfront

5 Boardwalk with access point to lake

4 Boat Club

6 Golf Course

7 Golf Club House and Hotels

8 Neighbourhood Parks

9 Entrance visitors Centre

10 Sport Centre

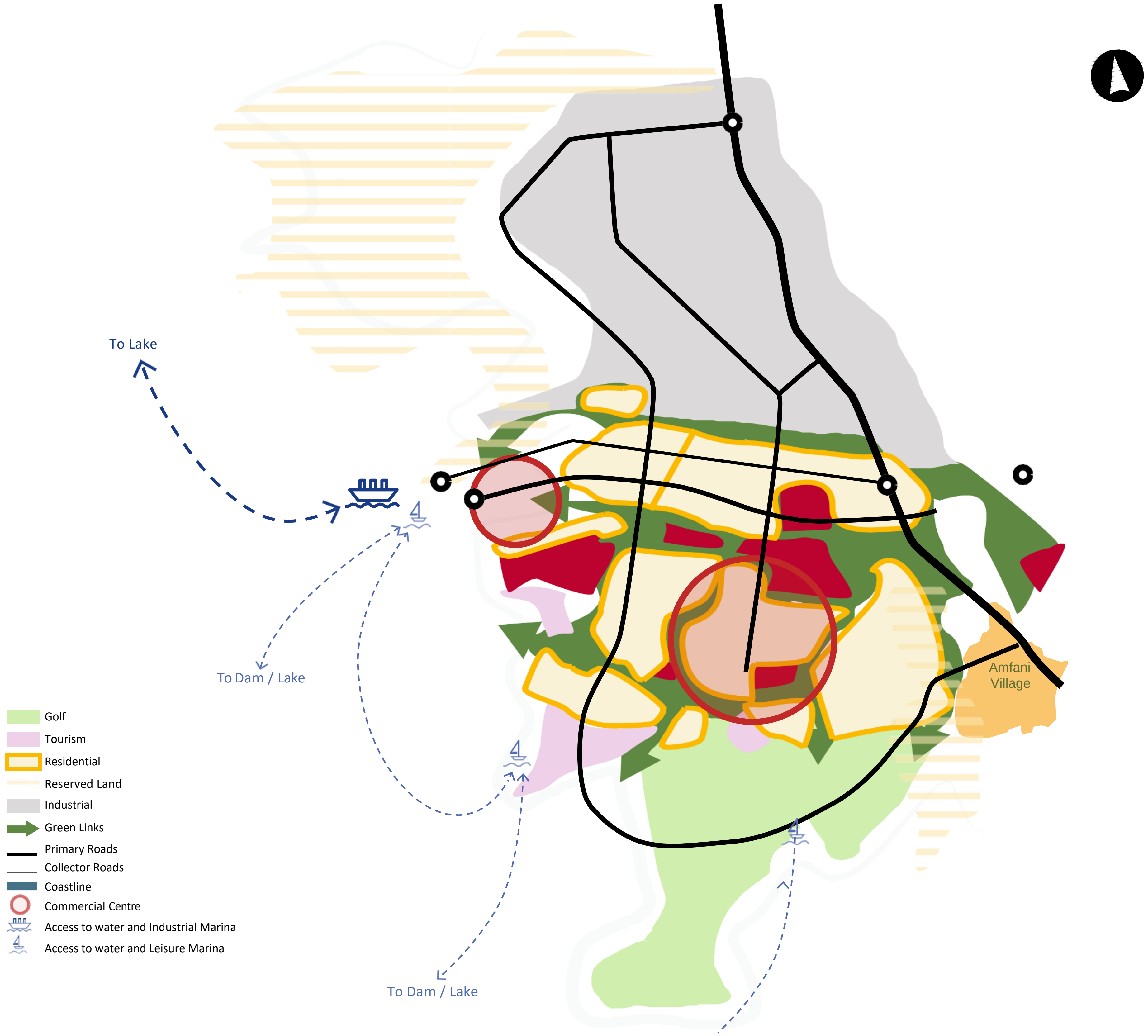
11 Potential polo pitch

12 University Campus

13 Wellness Centre

7

Fig 3.2: Design Approach of the Master Plan



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3.3 DESIGN APPROACH OF MASTER PLAN

The design principles for the Master Plan are as follows:

- The core commercial and residential developments are located in close proximity to the industrial areas in the north. Core Commercial Areas are located centrally with only limited commercial development along the waterfront.
- The Industrial Park is located to the north of the development and is linked with the golf course through a strong commercial axis activated by retail and mixed use development nodes.
- Existing rivers and wet / dry gullies are preserved and integrated within an urban green network.
- City Centres are established along the main green network, and on the lake shoreline.
- Green networks respect the topography. Minimum intervention in close proximity to the water reduce environmental and visual impacts on the natural assets.
- Radial urban structure;
- Segregated residential areas that are developed around the green network create different "cluster" neighbourhoods.
- Primary roads provide a direct link from the city located on the south to the industrial area in the north.
- Industrial and urban vehicular flows are segregated. Lorry routes are segregated from light motor vehicles.
- Tourism areas are distributed in close proximity to the waterfront

  The design approach has been informed by the following design informants that have shaped the key direction of the Master Plan. The design informants have been identified through the findings of the data analysis study conducted and the appraisal of the physical features of the site. The following factors informed the design of the master plan;

  - Wind Direction: Prevalent winds are from the south west and the south-east. The north of the site has therefore been identified as the optimum location for the industrial areas, so as to avoid any potential negative impacts of air pollution.
  - Lake water levels: The water levels in the lake rise to approximately 142.5 meters and the recommended

minimum site elevation is 144m. The 144meters contour has been taken as the maximum extent of waterfront development, minimizing the need to expensive cut and fill and equally minimizing site grading costs.

- Site Contours: the site contours slope gently from the west to the east, and the master plan road networks will need to take this into consideration.
- Golf: The peninsula to the south of the site has been identified as the optimum location for the Golf Course.

3.4 PROJECT CONCEPT

The project will be developed and managed by Hydropolis Investment Ltd in line with relevant national regulations for such business concern. The management will be in such a way as to attract and offer investment opportunities in a special economic zone environment. In this regards, Incentives will be available to local and foreign investors. Hydropolis Investment Limited is a special purpose vehicle established by Mainstream Energy Solution Ltd along with four private investors to midwife and promote assorted types of businesses. Hydropolis Free Zone Development Company, Amfani will work on the infrastructure and facilities to provide industrialists and investors the best environment to live, work and play. The land on which this development will take place was acquired from the Niger state government where four villages within the delineated area were relocated and resettled in the vicinity of the project site to enable them remain around their natural habitat and to serve as source of unskilled labour for the project. As earlier highlighted, the supply of electricity to Hydropolis free zone development company project shall be uninterrupted.

3.5 DEVELOPMENT OBJECTIVE

A world-class industrial business park today requires an environment that strikes a balance between core industries and their supporting services and amenities. Current regional surveys show that a preferred industrial business environment is one that provides the following amongst numerous others:

- Electric Power (2x5-10,000kw);
- Green area;
- Telecommunication services;

- Land and marine access;
- Security;
- Healthcare Facility
- Access roads
- heliport

The design of this project will be a marked departure from the old concept of industrial park as it will put more emphasis on work environment quality that takes due cognizance of personnel and employee welfare. The main objective is to provide a world-class industrial park which provides attractive preferred and business environment in a highly competitive global market. The project intentionally departs from a conventional park approach which caters to a single industrial use. The typical industrial park is designed strictly as a workplace without adequate considerations for the total well-being of its users and visitors.

Specifically, the development objectives of the project will include the following;

- To create a special economic zone that meets global standard
- To provide local and foreign investors with the best business environment to operate.
- To fast-track industrialization and socio-economic development of Nigeria.
- To create employment opportunities, wealth and skills acquisition.
- To facilitate technology transfer and promotion of high-tech industries.
- To provide platform for utilization of Nigeria's abundant resources e.g Raw materials, human capital, etc.
- To be a result oriented free zone, providing creative, innovative and efficient services towards sustainable industrial and socio-economic development in Africa.

3.6 LAND USE PLAN

At the moment, primary land use clusters identified in the adjoining area include Industrial, Commercial and Supporting, Residential, Tourism, Green and Blue links, Primary Roads, Secondary and Local

Roads, Utilities and other open spaces. The land use for the area would be made up of designated areas for various category of development. The land use plan would serve as the basis for all the facility and service needs of the industrial park. Land use plan, category descriptions and allocated land space in hectares and percentage are shown in **Fig 3.3** below, while table **3.1** shows the net land area.

Table 3.1: Net Land Area

Net Land Use Areas: Option 2 - Ecological Option		
Land Use	**Net Land Area (ha)**	**% Net Land Area**
Industry	289.6	32.7%
Commercial and Supporting	68.68	7.7%
Residential	163.24	18.4%
Tourism	93.70	10.6%
Green and Blue Links	90.40	10.2%
Primary Roads	81.74	9.2%
Secondary and Local Roads, Utilities & Other Open Space	98.90	11.2%
	886.2	**100.0%**

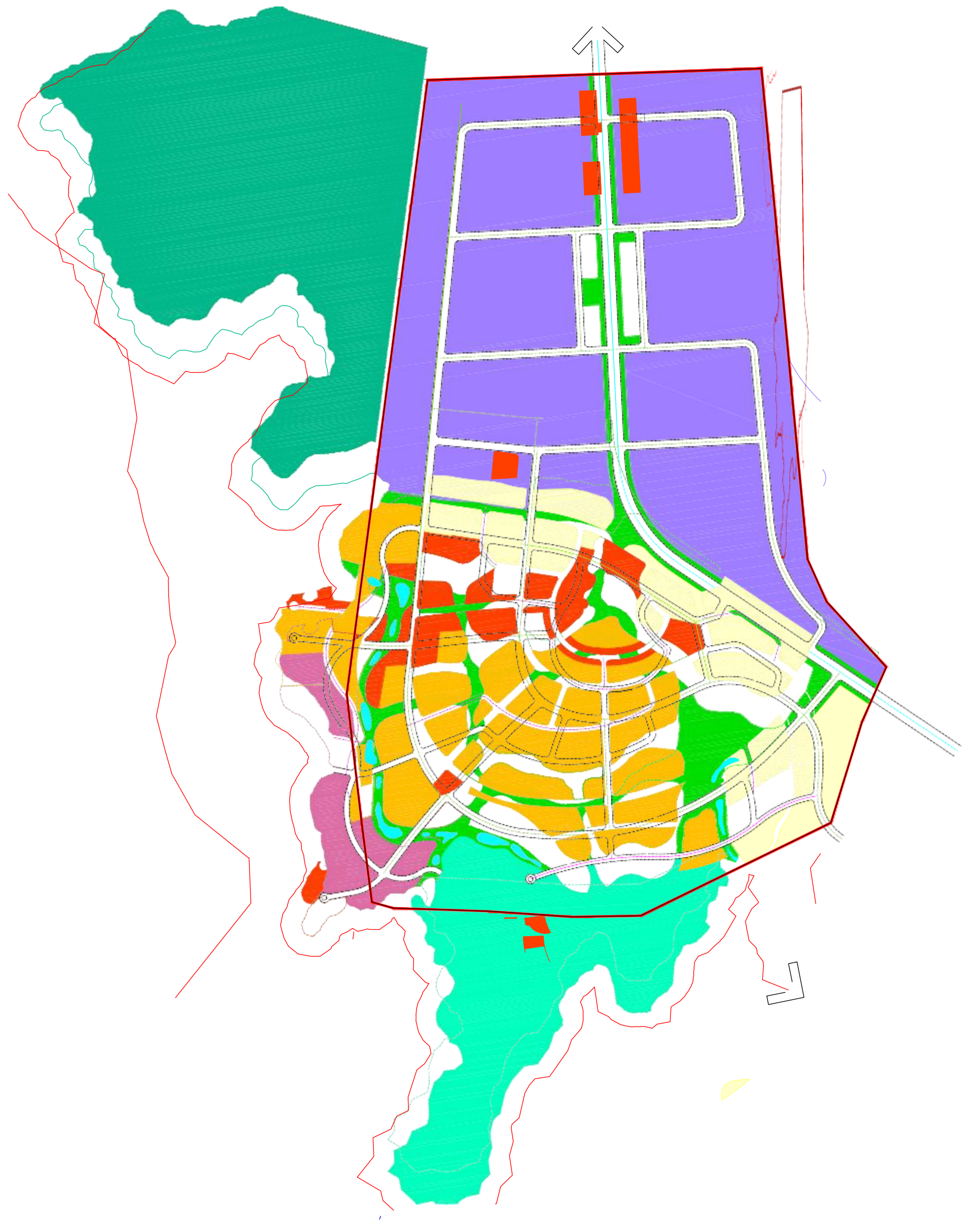


Fig 3.3: Proposed Land Use Area

3.6.1 Design Option

The Lake side agriculture to be carefully controlled shall be adopted with the waterside being generally 100 to 500m away for most of the year, tourism choices need shall be carefully selected. This option will provides that the Lake side agriculture should be avoided due to nitrogen and phosphorous which could be released into the lake. This is a similar case for the provision of a golf course. As the shoreline varies between 100m-500m away, some degree of added protection is assumed. Generally, the industrial area is located away from the lake side. Therefore, the industrial land shall be located north and separated from residential leading to a less adverse effect for residents.

3.6.2 Land Use Plan and Budget

The key features can be summarized as follows:

- The main access corridors continue to the north, while they also segregate the industrial zones from the non-industrial areas.
- The Urban Core is centrally located and has strong linkages to the industrial area.
- Heavy industry is located to the north, away from residential areas and the commercial hub. The light industrial area will act as a buffer between heavy industry and the non-industrial areas to the south of the site.
- The golf course is located to the south and connects with the tourism development and residential development on the western lake front.
- The proposed location of the jetty is "preliminary", based on the review of the all documents provided. The location of the jetty will be confirmed upon the bathymetric survey being undertaken at future stages, i.e the Detailed Design Stages of the Project.

  The key features of the land use plan is presented in **Fig 3.4** and **3.5** below.

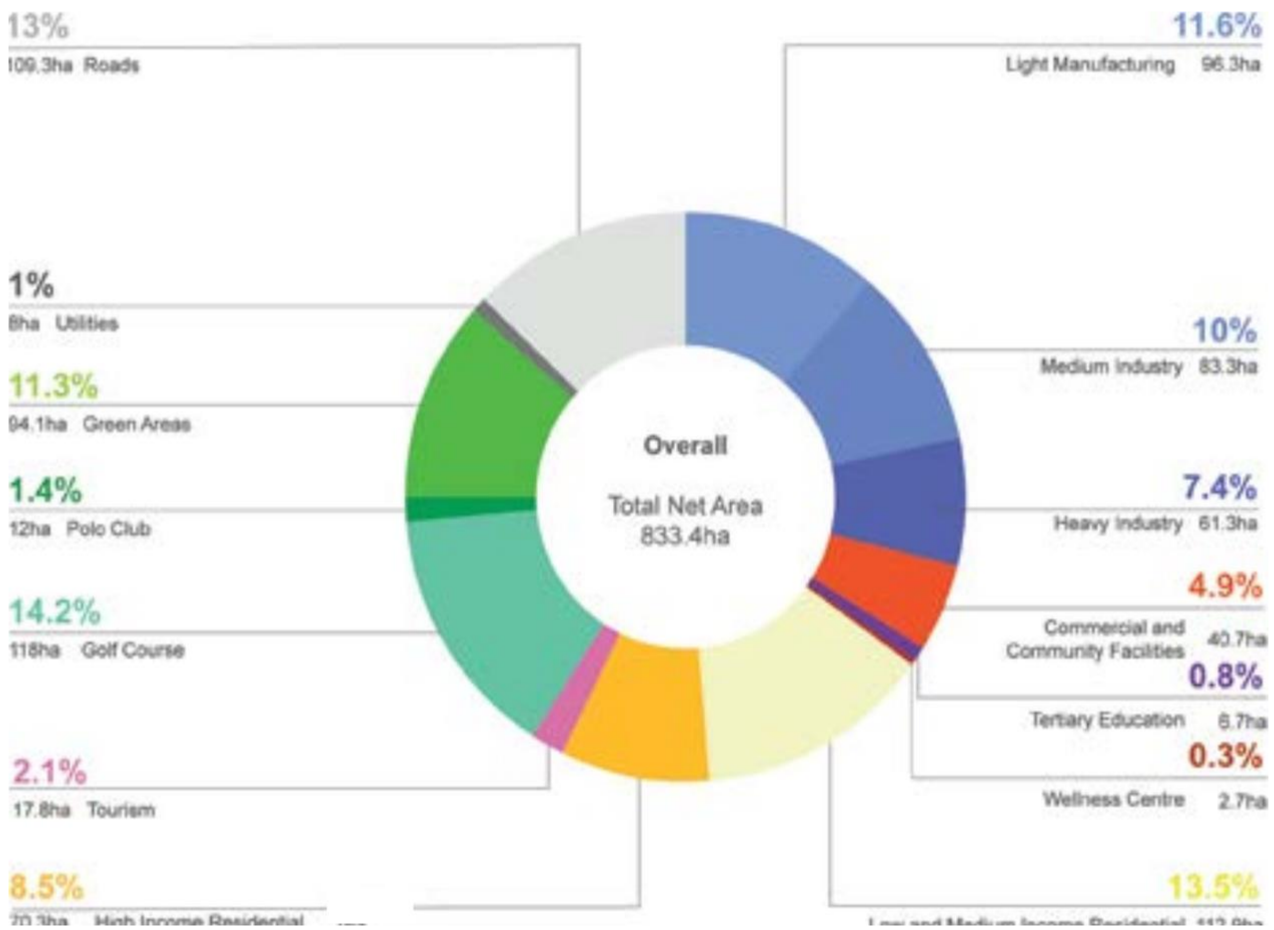
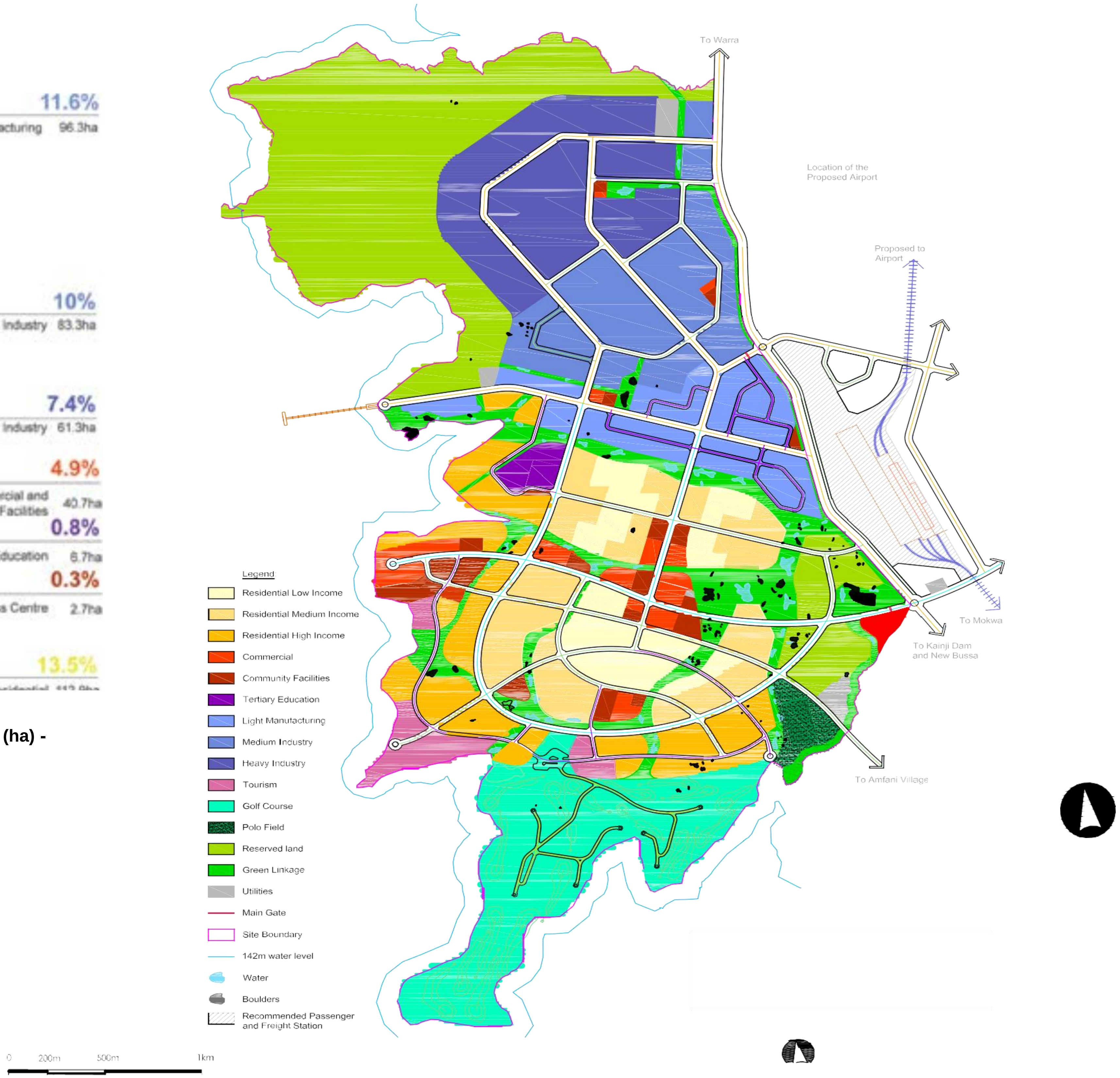


Fig 3.5 Pie Chart Representing the Net Land Use Breakdown of the Developable Area (ha) - Excludes Reserved land

Fig 3.4 Land Use Plan and Budget



The Land Use Budget has been calculated from using target land areas by the DAR economics team. These numbers have been generated by market analysis and forecasts to establish the viable amount of land needed to create a suitable critical mass for the project. The Land Use Budget accommodates the development projections emerging from the Market Analysis study. All minimum thresholds for net land area and net Built-up area are accommodated. The Gross Areas indicated within this Land Use plan will accommodate secondary and local roads, open spaces and parks and community facilities including healthcare and civil defence uses.

Industrial Uses include heavy, medium and light industrial uses, with further demarcation of zones being provided at the Concept Master Plan Development stage.

3.7 PHASING

The phasing diagram is presented in **Fig 3.6** below. The adjacent diagram (**Fig 3.7)** sets out the broad phasing strategy**.** Phase 1 focuses on establishing a core residential and commercial node in close proximity to the industrial area and will include development of the Coastline: Golf Course, Tourism, Commercial and Industrial. Phase 2 will involve extension of the uses towards the centre of the site along the main roads, with high end villas along the golf course. While phase Phase 3 will involve development of low income residential uses and industries along the highway. Phase 0 implements the main Hydropolis sites throughout the Site (**Fig 3.8)**

Fig 3.7: Broad Phasing Strategy

Phase 1 - Development of the Coastline: Golf Course, Tourism, Commercial and Industrial

Phase 2 - Extension of the uses towards the centre of the Site along the main roads, with high end villas along the golf course

Phase 3 - Development of low income residential uses and industries along the highway

Fig 3.6: Phasing Diagram

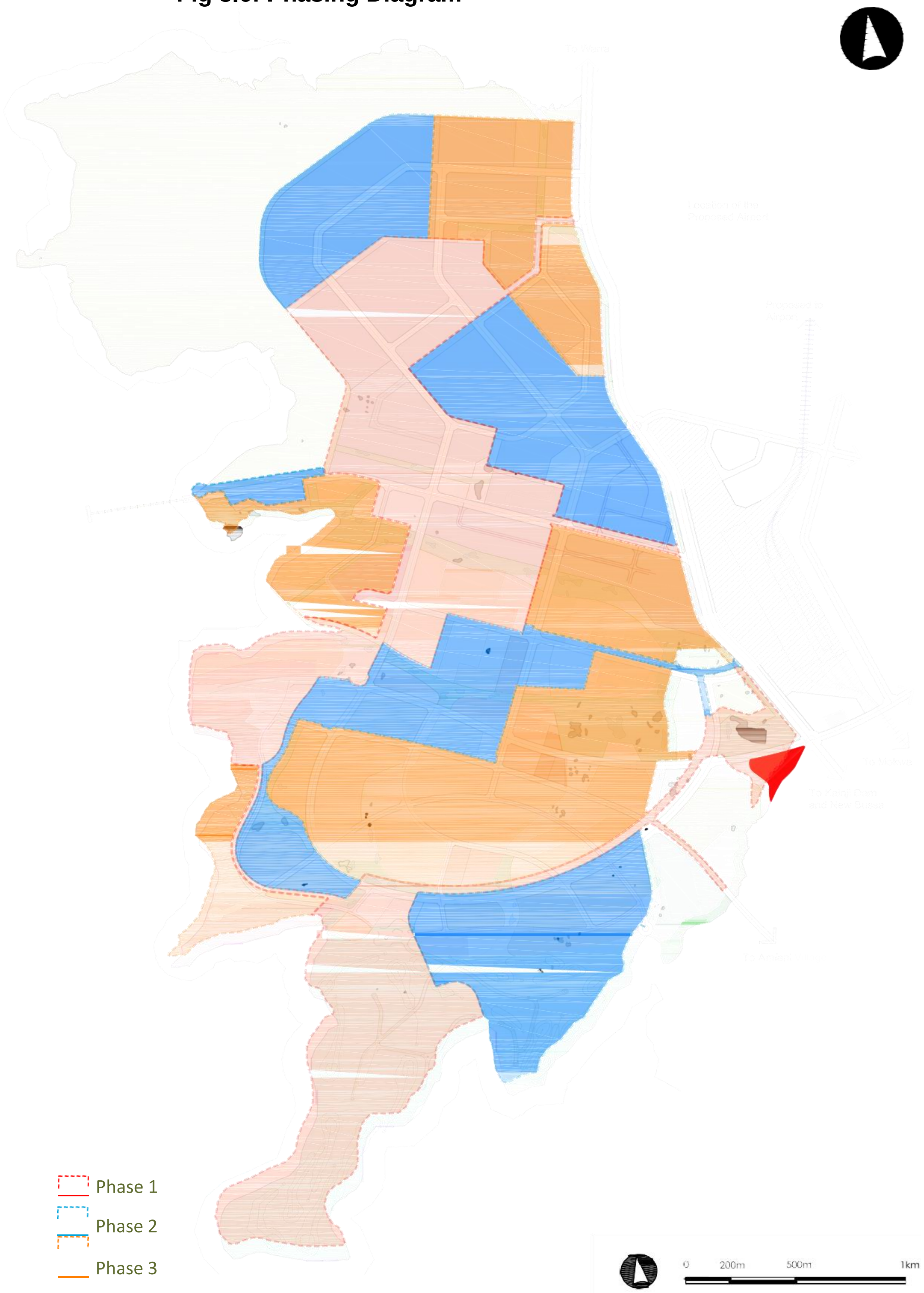
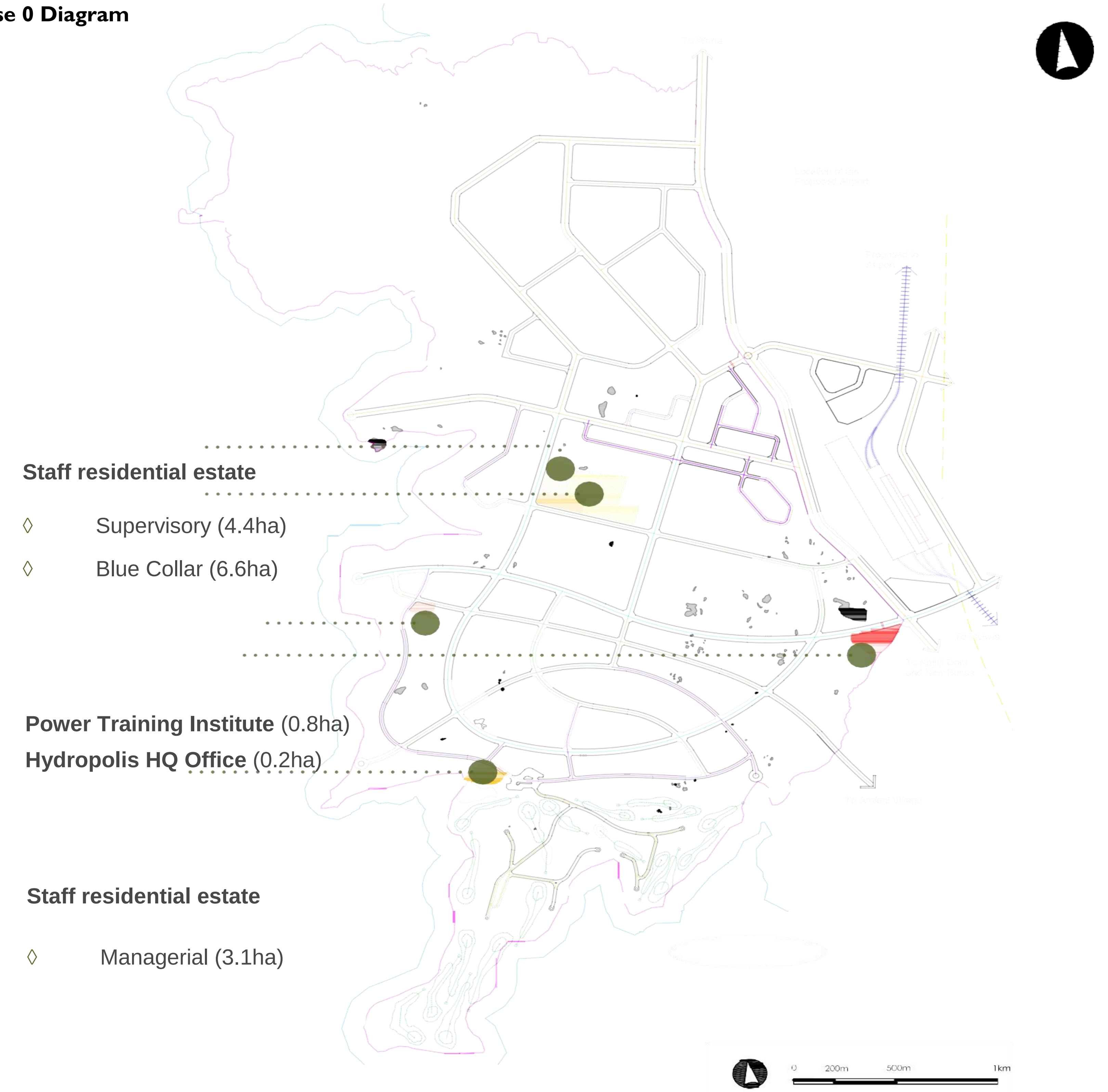


Fig 3.8 **Phase 0 Diagram**



3.8 LANDSCAPE STRATEGY

The location and site conditions of the proposed project which feature the Kainji Lake in close proximity provide ample opportunity to explore other forms of recreational activities to be engaged by working population of the companies resident in the park.

3.8.1 Functional Arrangement/Zoning

Industrial zone will be located in the North of the site. Main Civic area, commercial district and market area located more centrally to the site, and at the heart of the development. This location provides direct contact to all of the adjacent functional zones. The residential zones have been divided into smaller areas creating a tight urban fabric using landscape interventions to delineate the different areas. Within the residential zone, the areas allocated for workers are closest to the industrial area.

Recreational, leisure and tourist activities are also located close to the residential zones, while also allowing great access from the city centre. A lakeside location also provides a great setting for relaxing endeavours. High end residential developments positioned bordering recreational, leisure and tourist activities.

Golf course positioned to the south of the development, on the peninsular, and extended eastwards towards Amfani village into the site, allowing adequate overall area for golfing activities. Landscape interventions, using existing topography landscape features, will provide buffer zones between functional zones, and also provide exciting public open space with integrated play elements.

Vehicular Access

Main vehicular route enters development, via the proposed regional highway at new mid-way access point minimizing vehicular disturbance to the existing Amfani village. Large vehicular traffic has direct access to the industrial area to the north lighter vehicular traffic to be directed internally to serve the non-industrial zones. Secondary ring roads and tertiary connecting street networks allow access throughout development.

Coastal Condition

Coastal development and landscape intervention will occur when adjacent active functions and zones. Landscape intervention options along the coastal development area are varied. These include wide boulevards, lake side play areas, lakeside fitness zones, native species planting areas, informal raised walkways, flood tolerant planting zones, cafes and kiosks, informal seating and many more options. No major landscape interventions adjacent to proposed agricultural development area or to the golf course zone (Flood tolerant plant species may be planted to try and stabilize the quality of the soil).

3.8.2 Wet/Dry Gullies - Landscape Corridors

Existing dry gullies, evolved over millennia to disperse storm water, have created a network of routes and courses throughout the site area. These dry gullies follow the natural low points in the topography and create a natural web/grid. The landscape concept is to follow these dry gullies, insert them into the Master Plan and to use them as linkages throughout the development. This provides the scheme with the natural solution to run off during wet weather conditions, is sympathetic to the existing condition, will provide the base for a flexible external realm design, and create a new city layout unique to Amfani, identified by natural landscape formations.

The gullies can also be developed to cater for a multitude of uses. If the gully as located on a boundary of the industrial zone, then we can use this linear route to plant screening barriers of native species trees and shrubs. These buffer zones will physically block the views into the industrial zone while also acting as a sound and pollution barrier too. If the gulley is located in or around residential areas, then we can adapt the design to provide more functional zones for social use. We can incorporate play areas, cafes and kiosks, water features / ponds along with native planting creating an overall network of green routes through the development connecting all of the adjacent areas.

Natural wet/dry gullies will allow water to disperse effectively during wet weather events, but dry up during dry periods. A landscape buffer along a wet/dry gully separating the industrial zone from the residential zone will act as a visual filter to separate and distinguish these two zones. Wet/dry gullies and landscape corridors provide informal linkages throughout the development. A variety of options are available here from naturalistic zones, to meeting space, play areas, informal seating, and many more.

Artificial water bodies will be introduced into the wet/dry gulley system. These will provide direct access to water's edge. All water bodies to be adequately maintained to ensure no stagnancy. Water bodies will provide excellent social and recreational benefits while also being aesthetically pleasing. A wider network of connection connects the whole development. The landscape corridors are integrated into the Master Plan design through the use of the existing wet/dry gully features.

3.8.3 Lakeside Interventions

The topography has informed many of the landscape interventions as well as the Master Plan design. The coastal edge particular attention has been paid to ensure a permanent green planted strip along the coastal edge. With the fluctuation of water levels on the reservoir there will inevitably be a zone between high water and low water where planting will struggle to establish. The zones where plants are able to survive will gradually diminish and recede the closer you get to the low point water level. Planting will be added to these zones in an attempt to strengthen and consolidate the underlying ground surface.

The water levels in the reservoir fluctuate between a 130m low level and a 142m high level depending on season as well as HEP requirements from the dam. As the shoreline between these levels will vary we propose informal raised walkways extending into this flood zone to allow people better access to the lake. At some times the walkways will float above a verdant green planted zone, while when water levels are at their highest they will hover over the water's edge.

Currently the lake edge is difficult to access due to the swampy and waterlogged nature of the underlying terrain. Floating walkways will allow all year round access to the lake edge encouraging and strengthening the links between the lake and the land. In the coastal zone that is higher than the 142m flood zone and within the 144m contour level an evergreen edge that acts as a buffer between the low tide flats will be developed and the architectural proposals provides a natural lakeside shoreline. This area acts as a flood risk zone based on 100 year flood predictions. By ensuring no built development lower than

144m we minimize the flood risk potential. All built forms and structures are to be constructed in zones outside of the flood risk area. All proposed built elements will be located on or above the 144 level, avoiding any flooding issues (based on forecasts for 100 year flood event).

3.8.4 Planting

The preliminary selection of plant species intends to be coherent with the natural environment and specific climate of the site. In general, native plants are better than non-native plants, especially in such a natural environment characterized by a strong presence of water. For this reason, endemic species are to be preferred, spontaneously requiring great amounts of water as this special habitat offers and requiring little maintenance issues due to this factor. In addition to this, native wildlife will also benefit from native species, as local animals and native vegetation co-evolve and profit from each other. The overall Master Plan strategy also provides protection and continuity of the wildlife corridor along the river, where fishing villages have established. Not only human activities in correlation with nature take place here, but an important fauna and flora portion has to be respected and buffered.

Typologies:

- Streetscapes
- Public footpaths
- Plazas / Event spaces Parks
- Private open spaces
- Car Parking

Tree Preservation

The master plan should ensure existing trees are preserved as much as possible. Where possible, mature trees should be retained in their current location. However, if necessary they can be raised and relocated into a nursery areas for holding before being moved into its new permanent location such and the green network parks and buffers.

In the detail design stage, existing trees need to be accurately surveyed to assess age and value of existing trees. Before development starts, mature trees will have to be raised and moved to an on-site temporary nursery, where they will be tended to until their relocation throughout the site.

Benefits:

- Reduce landscape costs
- Retain the site's natural ecological assets.
- Fully established trees from the start of the development.

3.8.5 Design Approach

Soft landscape is a key and integral element of an open space environment. The primary purpose of planting material is to enhance the character of an area, promote biodiversity by augmenting the existing plant palette, provide shade and amenity, screen or delineate user zones, create visual identity for spaces within Amfani and to reinforce the overall design of the open spaces. Plant selection may serve the following functions:

- Provide shade
- Screen and buffer
- Create special identity
- Form shelterbelts

3.8.5.1 Green Buffers

Other than public parks and water bodies, green buffers are also part of the overall landscape system of the proposed Industrial Park. Green buffers would generally be developed at the allocated area and along the peripheries of the park. Their main purpose would be to act as both a demarcation of the park from its surrounding as well as to project a green environment to outsiders. The buffer zones play an important role in the development of the landscape strategy.

The nature of Amfani means that buffer planting is required not just to surround the development and screen off adjacent roads or visually poor zones, but internal screening is also required along the railway line, industrial zone, urban structure and lakeside. A buffer has also been added along the Amfani village boundary. We propose to enhance the capabilities of the buffer planting to provide noise / visual reduction potentials by planting trees and shrubs on raised earth bunds where required.

Benefits include:

- Reduction of noise pollution to the adjacent urban development from roads and railway.

- Reduction of air pollution to the adjacent urban development from roads and railway.
- Increase aesthetical landscape quality by mitigating views towards roads and railway.
- Enhanced ecological corridors.

The master plan should ensure existing trees are preserved as much as possible. Where possible, mature trees should be retained in their current location. However, if necessary they can be raised and relocated into a nursery areas for holding before being moved into its new permanent location such and the green network, parks and buffers.

3.8.6 Fencing/Gateway Entrance

Amfani Park is fenced as a free trade park. The facility will have a landscaped entrance gateway to welcome visitors to the park. The entrance gateway will serve as an indication that visitors are entering a different environment and will be fitted with appropriate signage.

The first main gateway connects the industrial area to the main highway, the proposed train station and airport roads. A second main gateway to the Site is proposed for the Residential City Centre on the main highway, at the South East corner of the Site. A check point will also be placed by the jetty.

3.8.7 Road Reserves

Road reserves will also be required to have planting strips incorporated in two (2) main areas - by the side of the road reserves as well as in the central median, if present. The landscaping will be implemented and maintained as part of the overall greenery effort of the park.

3.9 Planning Control

For the purpose of the proposed project, Planning Control Guidelines will be introduced to ensure optimal usage of land resources and to co-ordinate the integrated development of different building types. They serve to guide design and construction programs for the sole purpose of maintaining a pleasant environment, which in turn, will have significant impact on the overall success of the project.

3.9.1 Infrastructure Design Considerations

The design work for the Infrastructure Master Plan encompasses both the schematic routings and the preliminary estimates for the major infrastructure and utilities, namely:

- Landfilling & Earthwork Scheme;
- Surface Drainage;
- Water Supply & Distribution;
- Sewerage System;
- Solid Waste Disposal;
- Road Design;
- Power generation/ supply;
- Telecommunications; and
- Security

3.9.2 Proposed Earthwork Scheme

Early work for the site will require site fill to reclaim large portion of the area under threat of inundation to a prescribed datum that will ensure all facilities are designed above predictive 100 year flood conditions.

Higher ground level is proposed so as to protect against sea water flowing onto the site. Measures would be taken to ensure that coinciding of storm water flowing out of the site during the occurrence of heavy rain with the high tide (of surrounding surface water bodies) do not cause flooding of the park.

The principles that would govern drainage and sewerage systems would be based on gravity. The ultimate discharge point for surface runoff from the development, that is, the invert level at the final outlet of the drainage system shall be generally higher than the highest tide level to avoid back flow from the sea during high tide. The proposed road level shall be lower than the platform levels of individual plots for connection of plot drains to the drainage network of the development.

The proposed development ground level will result in filling up most areas of the site with additional earth as well as leveling of the existing highland area to match the proposed platform level.

3.9.3 Drainage

Presently, there is no any form of development on the proposed site and as such, there is no existing man-made drainage. Thus, there is no other outlet nearby as the site is mainly vacant land. Rain water within the site is channeled to the Kainji Lake which serves as the final discharge point.

3.9.4 Proposed Drainage System

The proposed drainage system is designed to cater for the surface runoff within the project area solely by gravity flow. Covered drains will be used for the proposed drainage system in the development. This will reduce unauthorized garbage disposal into the drains and prolong service life of the underground drains since they are protected against the elements. Drains will be maintained, to ensure proper flow; maintenance would include inspection, de-silting, repair of any damaged drains and monitoring solid waste disposal. The following highlights how drainage system would be constructed. It should be noted that values presented here are estimates.

- All drains to be constructed are proposed along the roads;
- Drainage type would be closed box drain with reinforced concrete construction;
- Proposed minimum gradient would be 1:1000;
- All secondary drains are expected to discharge to the primary drains;
- Primary drains are proposed to discharge to the Kainji Lake;
- The maximum primary drain width would be 2.5 m but the depth varies from 1.4m to 2.5m; and
- The maximum secondary drain width would be 1.5m but the depth varies from 0.6m to 2.0m.

3.10 SUSTAINABLE GOLF COURSES

Fancourt Country Club

Fancourt Country Club boasts unbelievable mountain views and undulating dune landscapes integrated into the edge of the urban form of Fancourt, South Africa. The course has an impressive 8,000 yards, par 72, on land covering 5,881- 6535 yards. Transformed from an airfield into an amazing landscape of environmental and golfing excellence. The Clubs environmental sustainability has been awarded as a Certified Audubon Cooperation Sanctuary. Environmental initiatives include:

- Wildlife and Habitat management,
- Education on the benefits of achieving sustainable Resorts.
- Chemical use reduction and safety
- Water conservation and other environmental factors.

Coventry Golf Club

Coventry Golf Club is praised for its efforts towards creating an environmentally friendly golf club. It was certified as the first eco GEO standard club in the United Kingdom achieved through a number of different ways including energy consumption, water management and habitat creation, explained below:

- Energy consumption and course maintenance
    - Self-sustaining on-site solar panels, integrated into green keeping maintenance equipment and members electric buggies.
    - Utilizing smart energy systems to prevent energy wastage such as motion sensor lighting, sustainable conditioning system and an efficient boiler.
    - Encourage employees at the club to en role on a cycle to work scheme which will set to reduce the carbon footprint.
- Landscape initiatives:
    - Wildlife boxes and log piles have been erected with additional land allocated for wildflower meadows creating opportunities for birds and small mammals.
    - Turf grass species have been selected for the benefits on the demand on water and fertilizers needed to keep the grass green and lush through the year. Both

an environmental and economic befit to the Golf club.

- Investing in grey water from Severn Trent and other on side water management process

These management strategies and options will be adopted in the operations of the Golf course in this project.

3.11 ROAD SECTIONS

Road network is pivotal to the overall operation of the proposed Industrial Park. Roads are necessary ingredients as they support smooth operation in terms of movement of goods, services and personnel within the park. For the purpose of this project, network of roads would account for 1.81% (2.39 hectares) of the park's total area. This include primary road of about 2.38km long and secondary road of 1.45km.

3.11.1 Industrial Primary Road

Design Intent

- Public spaces within the road corridor should not impede through circulation of pedestrians on footpaths and should provide seating and lighting to make them attractive and functional places and can in some cases temporarily occupy the on-street parking lane.
- Create well-lit public seating areas along road to create a more comfortable pedestrian environment.
- Provide a design link to the municipal community plaza and amenities.

The Road requirements will include the following;

- 3.7m wide public footpath, including seating and flowerbed planting;
- 2.5m wide side planting rain garden;
- 1.6m wide dedicated cycle lane (both sides);
- 2.5m wide median planting, including trees and lighting;
- 3 lane road each way. Lane width is 3.65m;

Sustainable Urban Drainage System (SUDs)

Street drainage uses a network of streetscape swales and water retention areas that are integrated in the streetscape framework. These are variable, according to street typologies, and are designed to function with the conventional drainage infrastructure. The landscape strategy also includes a Sustainable Urban Drainage System (SUDS).This system works to direct rainwater and run-off away from the industrial premises and into the natural drainage system. The increase in area of hard surfaces will affect the management of the water, and a SUDS system would alleviate potential flooding.

3.11.2 Urban Primary Road

Design Intent

- Public spaces within the road corridor should not impede through circulation of pedestrians on footpaths and should provide seating and lighting to make them attractive and functional places and can in some cases temporarily occupy the on-street parking lane.
- Create well-lit public seating areas along road to create a more comfortable pedestrian environment.
- Provide a design link to the municipal community plaza and amenities.

Road Requirements:

- 4.75m wide public footpath, including seating and flowerbeds planting;
- 2.5m wide side planting rain garden;
- 1.6m wide dedicated cycle lane (both sides);
- 6m wide median planting, including trees and lighting;
- 2 lane road each way. Lane width is 3.65m;

SUDs

Street drainage uses a network of streetscape swales and water retention areas that are integrated in the streetscape framework. These are variable, according to street typologies, and are designed to function with the conventional drainage infrastructure. The landscape strategy also includes a Sustainable Urban Drainage System

(SUDS).This system works to direct rainwater and run-off away from the industrial premises and into the natural drainage system. The increase in area of hard surfaces will affect the management of the water, and a SUDs system would alleviate potential flooding.

3.11.3 Secondary Road

Design Intent

- Public spaces within the road corridor should not impede through circulation of pedestrians on footpaths and should provide seating and lighting to make them attractive and functional places and can in some cases temporarily occupy the on-street parking lane.
- Create well-lit public seating areas along road to create a more comfortable pedestrian environment.
- Provide a design link to the municipal community plaza and amenities.

Road Requirements:

- 3.95 m wide public footpath, including seating and flowerbeds planting;
- 1.8m wide side planting rain garden;
- 1.6m wide dedicated cycle lane (both sides);
- 1 lane parking bays each way. Lane width is 3m;
- 1 lane road each way. Lane width is 3.65m;

SUDs

Street drainage uses a network of streetscape swales and water retention areas that are integrated in the streetscape framework. These are variable, according to street typologies, and are designed to function with the conventional drainage infrastructure. The landscape strategy also includes a Sustainable Urban Drainage System (SUDS).This system works to direct rainwater and run-off away from the industrial premises and into the natural drainage system. The increase in area of hard surfaces will affect the management of the water, and a SUDs system would alleviate potential flooding.

3.11.4 Local Road

Design Intent

- Public spaces within the road corridor should not impede through circulation of pedestrians on footpaths and should provide seating and lighting to make them attractive and functional places and can in some cases temporarily occupy the on-street parking lane.
- Create well-lit public seating areas along road to create a more comfortable pedestrian environment.
- Provide a design link to the municipal community plaza and amenities.

Road Requirements:

- 3m wide public footpath, including seating and flowerbeds planting;
- 1.8m wide side planting rain garden;
- 1 lane wide parking bays one way. Lane width is of 3m;
- 1 lane wide road each way. Lane width is 3.65m;

SUDs

Street drainage uses a network of streetscape swales and water retention areas that are integrated in the streetscape framework. These are variable, according to street typologies, and are designed to function with the conventional drainage infrastructure. The landscape strategy also includes a Sustainable Urban Drainage System (SUDS).This system works to direct rainwater and run-off away from the industrial premises and into the natural drainage system. The increase in area of hard surfaces will affect the management of the water, and a SUDS system would alleviate potential flooding.

3.12 GEOLOGICAL BOULDER TRAIL

Numerous outcrops of exposed boulders are scattered around the Amfani site. These rocks have, over very long periods of time, been pitted, etched, grooved, or polished by wind-driven sand particles. These geomorphic features are most typically found in arid environments where there is little vegetation to interfere with Aeolian particle transport, where there are frequently strong winds, and where there is a steady supply of sand. These boulder outcrops are dominant features in the landscape and are clearly visible from a distance. These features will be retained and enhanced, augmenting their prevailing prominence.

The visibility of the boulders through the landscape make them influential in locating gateways into the development. An architectural gateway feature into the development that creates unique and distinct welcome to Amfani will be developed. A built form that is architecturally coordinated with the rock boulder outcrops the considerate architectural design could link the built form to the natural boulder elements creating a world class gateway experience themselves.

Residents and tourists alike would drive into Amfani, passing this centre at the gateway. People could stop off at this information centre have access to material regarding Amfani: what facilities are available, what events are on or being planned and maps explaining the nature trails, boulder trails and cycle networks. The centre would also have refreshment capabilities with a café or restaurant with access to public conveniences.

During the earlier phases of work the built form could be used as a sales office to help generate business and welcome potential investors into the development. This could become a very valuable tool in welcoming potential customers as well as providing a setting to inform, present and entertain them.

The further outcrops of boulders scattered around the site are planned to be integrated into the natural pedestrian and cycle network throughout Amfani. The urban design of the scheme has recognised the rock outcrops and ensured the development does not encroach on the boulders locations. The boulders visibility will have a beacon affect working as a natural way finding element creating nodes and destination points throughout the natural trails proposed within the scheme.

These nodes could be further enhanced to provide educational and artistic zones providing learning and creative environments, as well as being linked to tourism and recreation or the raising of environmental awareness through the use of information boards, photographs and pictures, maps or plans, display cases and models, slides, sound or multimedia devices

3.13 FLOATING JETTIES

The Kainji Lake shoreline fluctuates across an annual cycle of approximately 8-10 metres between low water in July and August and high water in January and February. Due to the gently sloping terrain in proximity to the lake, estimated at a slope angle of about 2%, this vertical change of 8-10 m can potentially translate into a horizontal change of 400m to 500 m. In order to be able to access the lake water throughout the year, there will be a requirement for a long jetty to extend out towards the water's moving shoreline. At the shoreline's furthest extent (low water) perhaps a further 3 m depth must be taken into consideration to accommodate the draft of berthing boats and barges. The combination of meeting the low water shoreline, and allowance for the draft of boats will mean that the jetty will potentially be up to 700m long.

To design a standard jetty of this length, which at furthest extent towards the lake would be sitting perhaps 13 m above the lake bed, would be a significant and potentially costly undertaking, and require extensive piling into the lake bed. An alternative solution is to design a floating jetty that for much of the year may sit at ground level on the exposed lake bed, but as the water encroaches inland is designed to float and raise up. The jetty will be designed of robust materials and be able to accommodate trucks as required.

This jetty will have a direct connection with the industrial primary road running east-west through the Amfani site, and subsequently connecting to the proposed railway station. The jetty will also sit between the industrial area to the north and residential city to the south, ensuring the jetty can be utilized for leisure and industrial purposes.

3.14 FLOATING FARMS

Floating fish farm systems are growing in popularity across the world due to the many advantages that fish farming have over typical fishing techniques. Fish farming involves the raising of juvenile fish in a controlled and commercial manner.

The use of enclosures such as tanks or small ponds can be used on land. Alternatively Fish farming can also occur in floating systems in both fresh and salt water conditions.

The advantages of fish farming include:

- Sustainable and managed fishing.
- Creation of new jobs and improved local revenue
- The Protection of wild juvenile fish is to improve reservoir stock.
- Reduction on angler effect on Lake Kainji ecosystem.

Traditional fishing methods can cause detrimental environmental impacts. Overfishing on lakes, rivers and streams can threaten entire ecosystems and result in drastic reductions in total fish stocks. The use of the wrong sized nets causes significant problems by removing juvenile fish that cannot reach maturity. This has a negative overall impact on the quantity of mature fish in Lake Kainji. The long-term risk has the potential to cause huge risks to food scarcity for the local communities in the future unless appropriate interventions are made. The health of Lake Kainji would benefit from the implementation of a fish farming strategy due to the releases of juvenile fish into the wild improving natural fish supplies.

The Proposal shown in the rendered image shows an organic aquaponics system inspired by a design submission by Aqua Pura Farms for the RICS cities for our future challenge. The system shown integrates floating fish farming with hydroponic agriculture (aquaculture). This method of farming is a highly sustainable approach of producing food in a circular economy with little to no waste. This Method utilizes the waste by-product produced by fish in the form of ammonia from excretion that produces organic fertilizer. In return, the agricultural waste can be transformed into food pellets to feed the fish. A system like this could be an enormous benefit to the overall health and long term future of Lake Kainji.

3.15 PEDESTRIAN AND CYCLE NETWORK

The pedestrian and cycle networks are split into two different categories; Urban Tracks and Natural Trails.

Urban Tracks:

- Linked Directly to the road network.
- Majority of roads provide an independent pedestrian footpath and cycle lanes.
- Quick and easy access throughout site.
- Designed for short journeys internally or to connect to nature trails.

Nature Trails

- Linked to the green network of connections across Amfani.
- Nature trails developed for pedestrian only and cycle only traffic.
- Routes follow natural topographical features and dry gullies.
- Possible to walk or cycle to all destinations using Nature Trails.
- No conflict with roads and vehicular traffic, so safer environment to travel in.
- Boulder routes, lakes and water bodies, play areas and rest stops will provide a dynamic and varied network of routes.
- Will promote health and wellbeing and encourage more active pursuits.

3.16 CATTLE GRAZING

Grazing can be used as a natural landscape management strategy using the cattle to keep vegetation down when it grows to fast. This also has the benefit of not displacing local farmers who currently use the land seasonally. The water front can also be grazed when the water levels are retreating.

Cattle Grids:

Cattle grids are a type of obstacle used to inhibit livestock, such as sheep, goats cattle, pigs, horses from passing along a road or railway which penetrates the fencing surrounding an enclosed piece of land within the Amfani development. Amfani may use cattle grids to control the movement of cattle grazing through the green corridors.

Benefits include:

- Natural landscape management strategy.
- Agro tourism.
- Inclusive development.
- Respect of natural heritage.

3.17 POLO CLUB

The polo club design has been integrated into same location as the golf course towards the south of the site to leverage on existing facilities. The location of the Polo club has also been chosen due to its proximity to the golf club. Its location on the periphery of the site mitigates the potential odour of the polo horse.

Design Requirements include:

- The full size playing area is 274m in length (goal posts to goal posts) by 183m in width if un-boarded and 146m if boarded. The minimum length is 229m.
- For safety it is recommended that the run-off area extends 9m beyond the boards or side lines and 27.5m beyond the back line.
- Stables to house 52 Polo horses.
- A club house will also be required for leisure and entertainment purposes.
- mitigating views towards roads and railway.
- Enhanced ecological corridors.

3.18 TRANSPORTATION

3.18.1 Road Hierarchy

The Master Plan includes the following road hierarchy:

- Industrial Primary Roads;
- Urban Primary Roads;
- Secondary Roads;
- Local Roads.

The road hierarchy adopted within the Industrial Park aims at achieving an efficient road network whereby conflicts between the roadway and the adjacent land use are minimized and the appropriate level of interaction between the roadway and land use is permitted. A clear hierarchy will also act as the backbone for the development of local bus services. A structured hierarchy for the road network is proposed, as follows:

- Principal Roads: roads of regional or national significance that connect the major economic centres of Nigeria and connect those centres to the Trans-African Highway network. They will often be expressways, with restrictions on access and prohibitions on stopping.
- Primary Roads (Industrial & Urban): these connect the main industrial and urban areas within the park, and connect these areas to the Principal Road network.
- Secondary Roads: these collect traffic within urban and rural areas and feed that traffic onto the Primary or Principal Road networks.
- Local Roads: these provide access to industrial and residential areas.

The Principal Road network connecting the Industrial Park is the A1 and A125, linking Lagos with Ilorin-Kaduna- Kanu and the A124 connection Mokwa-Bida-Abuja. These roads are part of the Trans-African Highway which connects major Nigerian cities with their neighbouring country counterparts across Africa.

Typical road cross-sections will be used in different parts of the network considering the urban space available for the right of way, the need for expropriation where settlements reside (which will be minimized as much as possible), the road function, and provision of parking and prevailing local urban activity.

3.18.2 Bus Routes

Two main bus routes are planned to serve the Site:

- Line 1 will serve the Train Station and Commercial/Tourist Areas.
- Line 2 will connect the Industrial Zone with the Residential Areas.

The main depot is located by the Railway Station, along with a refuel station. These lines will be equipped with electric buses that can each carry up to 16 people.

Railway Station

A Freight and Passenger Railway Station is proposed on the East Border of the site. It will be directly connected to both the city centre and the industrial area with primary roads. A connection to a future airport will also be planned to the north-east of the Site.

3.18.3 Public Transport

3.18.3.1 Rail

The proposed railway station will be located to the east of the Industrial Park, approximately 84km North-east of Mokwa railway station. The proposed railway station is located adjacent to the Industrial Park on its east side. A new rail line will link the station to Mokwa railway station, connecting the Industrial Park to the National Rail Network. However, the rail link is to a large extent dependent on the development plans for the National Rail Network and will be subject to the completion of upgrades to the railway line between Lagos and Kaduna.

The location of the proposed railway station is shown within the airport boundary where it can be integrated with airport facilities. Alternatively, the station can be located further south adjacent to the proposed highway. Where the proposed railway line crosses under existing overhead power lines, minimum vertical clearances must be achieved as specified in current design standards. Overhead line diversions may be required where this is not possible.

The station will provide train services for residents and workers, support future business development and handle freight movement generated by land uses within the Industrial Park. The station design will incorporate public transport interchange facilities, including multi-storey car parking, cycle parking and access from the road network.

3.18.3.2 Aviation

The proposed domestic airport will be located to the east of the Industrial Park. Access can be made via the north-south access road. The airports facilities will provide efficient movement of passengers, ensure time savings for workers travelling via frequent short shuttle services and facilitate the movement of freight through the provision of an integrated Public Transport Interchange. However, the development of the airport is not included in the initial plan.

Pylons and overhead power cables run north/south through the airport site. Where flight paths cross over existing overhead power lines, minimum vertical clearances must be achieved as specified in current design standards. Overhead line diversions may be required where this is not possible. Alternatively, the airport site can be relocated to the east of the Industrial Park, immediately after the overhead power cable line.

3.18.3.3 Ports and Inland Waterways

The proposed port will be located in the north-west region of the Industrial area. Access can be made via the principal road network and along the Niger River linking with Baro Port.

3.18.3.4 Upstream trade

Yelwa is an important upstream river port which has made extensive use of River Niger's navigable waters. Yelwa, is a Local Government Area in Nigeria's Kebbi State, and the location of the Yauri Emirate. It lies on the road between Kontagora and Birnin Kebbi. The town remains the traditional seat of the emirate and its most important market centre. Onions, rice, and cotton, which are cultivated in the nearby extensive floodplains of the Niger, are the chief crops grown for export; but Yelwa also has considerable trade in sorghum, millet, cowpeas, peanuts (groundnuts), sugarcane, shea nuts, tobacco, kola nuts, peppers, beans, fish, cattle, and guinea fowl.

3.18.3.5 Navigability

Along the length of the Niger, navigation is possible for large flat-bottomed boats upstream to Onitsha (1,127 kilometers from the ocean) throughout the entire year, and even farther upstream to Jebba (1,448 kilometers) from August to February. Various projects are underway to improve the navigability. Provision of adequate river ports and places for handling freight is increasingly along its middle section. And efforts are in place to reactivate navigational activities by dredging.

3.18.3.6 Facilities

Transhipment facilities and services will allow the port to handle the loading/ unloading of cargo as well as the transportation of people along the Niger River. The construction of new port facilities will be the subject of further studies and assessment work as appropriate. Facilities for boating related activities may include:

- Commercial berths to service proposed industries. The layout of berths will be designed to meet the appropriate Nigerian Standards.
- An area for recreational berthing and boating facilities, comprising a series of floating finger pontoons.
- Service berth comprising re-fuelling would be a shared facility for both commercial and recreational vessels.
- Provision for a possible future regional commuter/tourism ferry service.
- Additional pedestrian recreational access and use (promenading, fishing).

Portarlington Safe Harbour provides berthing for a fleet of commercial aquaculture and commercial fishing vessels and Port Phillip Ferry operations which run scheduled services from Melbourne to Portarlington.

3.18.3.7 Parking

Parking for the industrial zones should be provided on-site. In the mixed use areas it is recommend that parking is provided as shared parking in public car parks; On-street parking should only be permitted on designated local roads and access roads, where it can be provided such that it does not impact adversely on road safety, traffic flow or the environment. All on-street parking in non-residential areas where demand is expected to be high, should be controlled and subject to regulations that will ensure it is used efficiently and to the maximum benefit of the local areas it serves.

Good Vehicle Parking Requirements

All goods vehicle parking requirements for the normal operation of facilities should be provided on-site. However, some off-site parking should also be provided to accommodate goods vehicles that have to park for a period before accessing or after leaving facilities. Goods vehicle parking should be located where it is accessible from the main routes into and out of the Industrial zones. It should also be dispersed within the Industrial Park to be accessible to those zones while minimizing additional vehicle kilometres operated in accessing an off-site parking facility rather than going direct to or from industrial zones.

3.19 UTILITIES NETWORK

Utility infrastructure comprises various types of utilities such as wet utilities, dry utilities and solid waste management.

3.19.1 Wet Utilities

The wet utility infrastructure networks considered for AMFANI Industrial park consists of the following networks:

- Storm water drainage
- Water supply and Firefighting
- Wastewater collection
- Irrigation

The design criteria are in accordance with the International standards and the Nigerian guidelines and regulations. The below national standard and regulations applicable in Nigeria will be applied in the concept master plan of wet utilities:

- Drainage Federal Republic of Nigeria (Federal Ministry of Works) - Highway Manual Part 1: Design - Volume IV: Drainage Design
- National Environmental Protection (Effluent Limitation) Regulations [S.I.8 of 1991.]
- Federal Republic of Nigeria – Federal Ministry of Water Resources – National Water Sanitation Policy (November 2004)

The following sections cover the wet utilities networks;

3.19.1.1 Storm Water Drainage Network

This system will consist of gravity channels along the arterial and collector roads. As such it will follow the general topography of the site with assumption of some minimum grading works along roads to adjust the natural topography.

Design Criteria

The following design criteria have been adopted in the design of the storm water drainage network:

- A 10 year design storm frequency with no encroachment of flood water onto the carriage way.

- Ditches: the flattest grade recommended for design is 0.25% for earth ditches and 0.12% for paved ditches. This provides a velocity of about 0.7m/s which is non-silting.
- A minimum time of concentration of 10min is considered in the estimation of design flows.
- The runoff flows are collected by gravity and discharged into the lake and the adjacent natural streams.

3.19.1.2 Rainfall Data

As previously discussed in Phase 1 under the data collection report, the rainfall station covering the project area is Kainji station which is located about 5 km to the south of the project site. Rainfall data from Kainji station has been obtained and analyzed. This data is shown on Table 3.2 below.

Table 3.2: Intensity-Duration-Frequency (IDF) Values at Kainji Rainfall Station.

		Duration (minutes)									
		5	10	15	30	60	120	180	360	720	14 40
Return Period (years)	2-y	125.3	102.0	86.5	60.8	39.5	24.3	18.0	10.6	6.2	3.6
	5-y	160.0	130.1	110.5	77.6	50.4	31.0	23.0	13.6	7.9	4.6
	10-y	183.2	149.1	126.5	88.9	57.7	35.6	26.3	15.5	9.0	5.2
	50-y	233.7	190.1	161.4	113.3	73.6	45.3	33.6	19.8	11.5	6.7
	100-y	255.2	207.6	176.2	123.8	80.4	49.5	36.7	21.6	12.6	7.3
	1000-y	325.9	265.2	225.1	158.1	102.7	63.2	46.9	27.6	16.1	9.3

3.19.1.3 Flood Risk Assessment

The water levels in Kainji reservoir for the period 1981 to 2013 are extracted from KJHYD report. The maximum level reached during that period is seen visually to be less than 142 m. The normal spillway water level elevation according to the report is 141.73 m (KJHYD report Table 11, Page 55). On the other hand, frequency analysis of the water level indicates a 1000-year return period maximum water level of 141.92 m and 142.88 m based on the Gumbel Extreme Value (GEV) and Lognormal distributions, respectively. The values for other return periods are given in Table below.

Table 3.3: Kainji lake level frequency analysis.

	Return Period					
Distribution	2-year	5-yr	10-yr	50-yr	100-yr	1000-yr
GEV	141.643	141.838	141.884	141.916	141.919	141.922
LN	141.499	141.876	142.073	142.419	142.542	142.886

Source:

Based on the above water levels and according to lognormal distribution the extreme flood event of 1 in 1000-Year will reach the shoreline at 142.88m level. While the ground level of Amfani masterplan starts at 163m, and thus no flooding risk is to be considered from the high water level of the Lake.

3.20 WATER SUPPLY SYSTEM

There is no pipe borne water supply system in close proximity to the project area. The park will thus utilize groundwater from deep bore holes as influent to the proposed water treatment plant. The Amfani project area is located at the shoreline of Kainji Lake which is the source of water to feed all components within the project area (Industrial, Residential…etc.). Water from Kainji Lake will be treated through a water treatment plant (WTP) located at the shoreline prior to be distributed into the network. The treated water will be pumped to an elevated water tank located at a high point in order to allow supplying the site by gravity and avoiding additional pumping stations.

3.20.1 Water Demands Estimation

The water demands estimation is done according to the following rates:

- Residents: 250 l/day/person
- Visitors: 60 l/day/person
- Students/Patients: 30 l/day/person
- Hotel Guests: 300 l/day/person

- White Collar Staff: 60 l/day/person
- Blue collar Staff: 60 l/day/person
- Domestic Staff: 60 l/day/person

As such, the average daily water demand is given in the following table based on the population:

Table 3.4: Average Daily Water Demand

Landuse Zones	Population	Average Water Demand (L/D)
Residents	63,850	15,962,500
Visitors	10,551	633,060
Students/Patients	7,053	211,590
Hotel Guests	1,200	360,000
White Collar Staff	10,572	634,320
Blue collar Staff	11,836	710,160
Domestic Staff	2,633	157,980
TOTAL	107,695	18,669,610

The capacity of the water treatment plant (WTP) will be according to the average water demand estimated in the above table with 15% contingency, a total capacity of 22,000 m3/day. The proposed water reservoir will be feeding the water and fire network. The size of the reservoir is based on 2 days water storage plus the volume required for firefighting at the ultimate phase. As such the capacity of the reservoir shall be of 38,000 m3 capacity to cater for the water and firefighting demands.

3.20.2 Water Intake

As indicated above, the source of water will be Kainji Lake where a pipe water intake of 2Ø600mm will be connected to the Water Treatment Plant (WTP) through a pump station located at the shoreline of the Lake. Following the treatment process, water from the treatment plant will supply the elevated water tank through a force main pipe Ø500mm where water from the elevated tank will feed the proposed network.

3.20.3 Water Supply and Firefighting Network

A combined network will be provided for the domestic Water Supply and Fire Fighting. The following are the main design considerations:

- The domestic and firefighting water network has been designed based on the peak daily demand and fire flow event assuming that the plots will be provided with their own storage tanks to cater for the peak hourly.

- The Hydraulic design is done based on Hazen-Williams equation given by;

Q = 0.85AChwRh0.63S0.54
Where: Q = discharge flow (m3/s)
A = Area of pipe (m2)
Chw = roughness coefficient of pipe
Rh = Hydraulic radius = D/4 for circular pipe (m) S = Head loss per unit length (m/m)

- Minimum pipe diameters 200mm
- Minimum Pressure in the distribution system not less than 2 bars
- Maximum Velocity 2 m/s
- The design is based on a 2 fire flow events supplying a total flow of 34 L/s, with a duration of 2 hours ,operating at a minimum pressure of 1.5 bars sufficient to fill the fire trucks.
- Fire hydrant will be placed at about 150 to 200m spacing along the pipe network.
- The network design is based on closed loops which provides the best performance.
- The hydraulic design has been done using WaterGems software from Bentley.
- The distribution network pipe material shall be HDPE or UPVC for diameter up to 350mm and Ductile Iron or GRP for pipes with larger diameter. The service connections pipe material shall be Polyethylene.
- The total length of the network is about 34 Km. the diameters and lengths of the pipes are given in the below.

Table 3.5: Pipe Sizes and Lengths

Pipe size (mm)	Length (m)
200	26,076
300	5,327
400	2,227
500	92

3.20.4. Waste Water Collection System

This section describes the waste water collection, disposal, and recycling for Amfani industrial and residential estate. The sewage system will collect the waste water and convey it to the disposal location which is a proposed waste water treatment plant (WWTP). This will allow the re-use of the treated effluent (TSE) for irrigation purposes.

3.20.5 Waste Water Generation

The waste water generation is estimated based on the water demands where Average Waste Water generation = 80% of average domestic water demand.

Table 3.6: Waste Water Generation

Landuse Zones	Population	Average Water Demand (L/D)
Residents	63,850	12,770,000
Visitors	10,551	506,448
Students/Patients	7,053	169,272
Hotel Guests	1,200	288,000
White Collar Staff	10,572	507,456
Blue Collar Staff	11,836	568,128
Domestic Staff	2,633	126,384
TOTAL	**107,695**	**14,935,688**

Accordingly, and based on the average water demands estimated in the previous. As Table 3.xx indicates, the total daily average waste water generation is 15,000 m3/day. The treatment of this waste water will allow the production of about 10,455 m3/day of TSE (estimated at 70% of the waste water). This amount will be used for irrigation purposes.

3.20.6 Waste Water Disposal

A Waste water treatment plant (WWTP) will be proposed at the shoreline which is the lowest area in the project in order to allow collecting the waste water by gravity and reduce the number of lift stations as much as possible. The WWTP will treat the collected waste water from the proposed network where the treated water will be reused for irrigation. The capacity of the WWTP is calculated based on the maximum daily flow which is generally 1.5 times the average flow, about 22,500 m3/day. The area required for the plant will be about 50,000 m^2.

3.20.7 Proposed Sewage Network

The Sewage network will be based mainly on gravity. However, lift stations will be provided when the network becomes too deep and could not be reconnected to the main network by gravity. The design of the network is taking into consideration the following design parameters:

- The network design will be based on the peak flow:

Peak Flow = Peak Factor x Average Flow The peak factor is as follows:
PF = 5/P0.167 where P is the population in thousands

- The pipes will be designed 80% full.
- Minimum pipe diameter is 200mm.
- The hydraulic calculations for the gravity pipelines are done based on

Manning's equation for open channel flow, given by:
V = 1/nR2/3S1/2
Where: V is the flow velocity (m/s)
S is the hydraulic gradient R is the hydraulic radius (m)
n is the Manning's roughness coefficient (0.013 for smooth pipelines)

The hydraulic Calculations are done using the SewerCAD software from Bentley. The sewage collection network will be made of pipe connected by manholes spaced about 80 to 100m. UPVC pipes will be used up to 300mm diameter, larger diameter will be GRP pipes. Sewage collection network will be made by gravity. However, due to the topography, the network will be divided into 4 sections each served by a lift station which will discharge into adjacent network flowing towards the plant.The total network length will be about 31.5 Km. Pipe diameters and lengths are given in the Table below

Table 3.7: Pipes Sizes and Lengths

Pipe size (mm)	Length (m)
Pipe size (mm)	Length (m)
200	16,190
300	6,298
400	1,166
500	385
600	760
700	944
Force main	5,793

3.21 IRRIGATION NETWORK

A fully automated irrigation system will be provided for the planted areas of the Project. The automatic control system is expected to conserve water and facilitate operation and maintenance. The proposed irrigation network consists of the following components:

- Proposed reservoir and pumping station to store the water and deliver the required irrigation demand.

- Main irrigation network designed in a looped system supplying the secondary irrigation network.
- A secondary irrigation network consisting of remote control pressure reducing valves, manifolds, laterals and irrigators.

3.21.1 Source of Water

Different sources of water can be envisaged for irrigating the planted areas of the Project:

- TSE produced on site
- Water from existing lake

3.21.2 Water Requirements

The calculation of daily water requirements for irrigation will be based on the peak irrigation demand of the project area and the total soft landscape area. Accordingly, the water requirements are given in the following table (Table 3.xx) based on the evapotranspiration from the nearest weather station KANO, where the Gross Irrigation Requirement (GIR) is 12 mm/day.

Table 3.8 Demand for the Green Areas

Zone	Area in m2	% Planted	Planted Area in m2	Demand in m3
Measured greens	1,492,000.00	60	895,200.00	10,742.4
Roads + open spac- es + utilities included in the gross areas	2,094,000.00	20	418,800.00	5,025.6
Golf Course	1,300,000.00	50	650,000.00	7,800
Total			1,964,000.00	23,568

Demand (m3) = Area (m2) x GIR (m/day)

3.21.3 Design Criteria

3.21.4 Distribution System:

The main irrigation distribution networks will be looped around the area to be irrigated to ensure uninterrupted water supply and adequate pressure at any point in the site.

3.21.5 Service Pressure:

The minimum pressure required in the system depends on the type of irrigators used. For the purpose of this report, it is assumed at a minimum of 3.0 bars in the main network at the control valves for external soft landscaped areas.

Pumping Requirements:

An irrigation pump station will be required in the following cases:

- The source of water is the potable water network, and the pressure is not enough for the irrigation system
- The source of water is existing TSE network, and the pressure in the network is not enough for the irrigation system
- The tentative pump characteristics will be as follows:

Head: 35 meters

Assume 10 hours of irrigation:

Flow = total demand (m3) / 10 hrs = 23,568 m3 / 10 hrs = 2,356.8 m3/hr = 654.7 L/s

Flow: 654.7 Lps

Pipe Velocity and Friction Loss:

The upper velocity is 2.0 m/s to limit the friction losses in pipes. The network design will be carried out using the Hazen-Williams Formula.

3.21.6 Valves and Pipe Cover:

Valves shall be provided at every branch. Washout valves shall be provided at low points and air valves at high points in the main network. Automatic remote control (solenoid) valves shall be provided to command the secondary network. A minimum cover of 1.2 m above pipe crest is recommended. However, where pipes have to be shallower because of site constraints and could be exposed to heavy traffic, concrete protection shall be provided. The pipe cover for the secondary irrigation network shall be 45-60 cm or depending on site constraints.

3.21.7 Irrigators Selection:

The secondary network will be composed of irrigators on lateral pipes, commanded by the solenoid valves. Irrigators such as bubblers, drippers, and sprinklers will be selected as required.

3.21.8 Pipe Material and Sizes:

Pipes for main network shall be GRP for large diameter pipes and HDPE for small diameter pipes, and for secondary network shall be PE pipes and has been sized according to flow and pressure requirements at the site.

23.21.9 Frequency of Irrigation:

The continuous supply of water to the plant roots is a basic requirement in maintaining and promoting growth. This supply requires that depleted water in the root zone be replenished immediately. Irrigation should preferably take place before the plant has taken up all of the water available in the root zone. The design shall be flexible enough to accommodate the different weather conditions.

3.22 Power Supply and Distribution

3.22.1 Power Supply

The project site for the proposed Industrial Park is virtually unoccupied and devoid of any meaningful economic activity. Operation of a project of such magnitude requires constant and reliable source of electricity which has been a great challenge throughout the country. This makes the provision of power supply fundamental to the success of the proposed industrial park as no industry can be sustained without adequate and reliable source of energy supply.

3.22.2 Lighting System

In order to ensure adequate security and clear vision for motorists and road users within the park, adequate street lighting shall be provided especially at night time. Effective street lighting would illuminate streets and sidewalks within and around the park. Electrical energy supply requirements for the project will be assessed, based on the maximum demand loads of the master plan planning parameters.

3.22.3 Codes and Standards

All electrical systems shall be designed and specified in compliance with the recommendations, codes and standards, as follows:

- Latest edition of the “British standard”- Europe norms (BS –EN).
- Standard Handbook for Electrical Engineers, published by Mc Graw Hill Handbooks,Donald G. Fink and H. Wayne Beaty
- Nominal characteristics of all equipment forming part of the electrical works shall be specified to conform to the relevant BS Standards or “National Electrical Manufacturing Association” (NEMA) and the “International Standards Organization”(ISO).

3.22.4 Ambient Conditions

All electrical equipment, apparatus, materials, and accessories are designed, specified and derated for a continuous and trouble free operation in the ambient conditions of the area, which are as follows:

1 Altitude: Sea Level (Coastal)
2 Maximum ambient temperature: 40°C (in the shade)
3 Minimum ambient temperature: 21°C
4 Maximum relative humidity: 88%

3.23 EXISTING UTILITIES

3.23.1 Power Plants:

The nearest existing power plants to Amfani industrial park is Kainji Hydro- Plant. This power plant is equipped with eight turbine- alternator groups comprised of four Kaplan type rated at 80MW, two turbines also Kaplan type rated at 100MW and two propeller turbines at 120MW. The overall total installed capacity of this plant is 760MW. Currently the maximum available capacity of the plant is 460 MW owing to the decommissioning of five units in year 2000. The power capacity of the plant will be increased by adding future four units each of 120MW resulting into a total increased of 480MW by MESL (Main Stream Energy Solution Ltd). The overall installed capacity at that time will be 940MW capable to provide the Park with the required demand loads.

3.23.2 Transmission Lines:

The main power plants of Nigeria are interconnected using overhead transmission lines operated at different voltage 330, and 132KV. Two OHTL circuits operated at 330KV and another at 132KV are passing nearby Amfani Industrial park connecting Kianji with other power plants such as Jebba and Kebbi. There is no information about the loading of these OHTL to assess from where Amfani project can be connected to the Grid. Therefore, further coordination with the power authorities should be conducted to confirm both the source and the network that will feed the project with the required demand loads.

3.23.2.1 Load Estimate

Amfani industrial park is comprised of industrial, residential and commercial areas. Load density factors for each area type (based on common practice / previous similar projects in Nigeria) and diversity factors from international standards will be applied to estimate the total electrical demand load for the master plan.

Design Guidelines of Power Supply

The guidelines for the design of the power supply network for the project are as follows:

- The proposed power supply network will be designed to accommodate the peak load demand, reliably and safely.
- The 33 kV distribution from the power supply network will be in- stalled in phases.
- The ultimate power supply source will be derived from the proposed 132/33KV substation.
- Ultimately, the external power plant (Kainji) is proposed to deliver its output power at the 132 kV level, through 132 kV underground/overhead transmission cables, which will in turn supply one 132/33 kV primary sub-station. The primary substation is outside the scope. However, the related implications on the Master Plan; i.e. plot requirements, corridor reservations, etc, will be covered.
- The 132/33 kV primary substation will deliver various 33 kV underground cables, which will in turn supply various 33/0.4 kV substations to the different plots in loops.
- Each plot will be provided with a medium voltage connection (at infra-structure stage). Later on, this MV connection will supply power to the various facilities inside each plot. 33/0.4KV transformers with the appropriate rating and type will be dedicated for each building/facility inside each plot based on the total demand load at user level.
- The 33 kV system, including the cables and outdoor substations, is within scope. The outdoor 33/0.4 kV substations will supply road lighting feeder pillars, miscellaneous outdoor loads (traffic signals, pump stations, etc), through underground low voltage cables. In general, the coverage area of each substation is around 250m.
- The indoor 33/0.4 kV substations serving major buildings, however, are part of the buildings rather than the infrastructure works.

3.23 TELECOMMUNICATION NETWORKS

Telecom service is critical infrastructure for the success of all operations in this facility. To ensure effective communication, the park management will partner the current service providers in the country to provide sufficient infrastructure for efficient communication with outside world. This will further attract investment into the area.

This section describes the works needed to meet the forecasted telecommunication requirements for Amfani Master Plan. The design is proposed to derive the services of the telecommunication network from Nigeria Communication

Commission (NCC) or an authorized telecom service provider, offering and delivering fixed telephone, Internet and TV services over the same network, namely a Fiber-To-The-Home (FTTH) network fanning from a telecom exchange that should be provided for the Amfani development area.

3.23.1 Scope of work

The scope of work of the Telecom is only limited to Outside Plant (OSP) civil works including ducting systems, hand-holes, manholes, etc... On the other hand, the supply, pulling, installation, termination, testing, etc. of all cabling and equipment for the Telecom network are outside the scope of work and will be carried out by an authorized service provider.

3.23.2 Existing Network

There is a shortage of information on the existing telecommunication network installed in Amfani. Further investigations need to be made to acquire more data about the infrastructure of this network. Some queries are sent to the authorities regarding this matter looking forward to get back with the required information that would be needed to base the new design on.

Collected Data from Internet web sites has provided a summary about the national backbone fiber network especially what is near Amfani development. The local operators have implemented a fibre optic backbone linking the different states of Nigeria; a fiber optic backbone passes through Kontagora city 87 km to the east of the development.
This fiber would be useful to connect Amfani development to the National Nigerian Backbone network.

3.23.3 Projected Telecom Design

The infrastructure design of the telecommunication will incorporate the community needs for the basic and enhanced actual telecommunication services offered and will be ready to support future advanced services.

The vision is to have a converged telecommunication network framework to serve the plots and consequently connect and provide every residence, hotel, office, retail shop, facility, etc. with narrowband and broadband triple play services (voice, TV and internet connection). Amfani development area will thus be served by a Fiber-To-The-Home (FTTH) network supplied from NCC or authorized service provider. This FTTH network will be connected to Nigeria national network.

3.23.4 FTTH GPON System for the Triple Play Telecommunication Services

The FTTH design, selected for the triple play telecommunication network for Amfani development area, will be based on the GPON technology (Gigabit Passive Optical Network). The data stream, depending on PON technology, can range from 20Mb/s up to 10 Gb/s; the most established streams are the EPON (for 1 Gb/s) and GPON (2.5 Gb/s). The 2.5 Gb/s GPON stream will be considered in this design to deploy and cater for any necessary demand for subscribers.

PON topology is a shared medium in which a fiber is 'passively' split into many end user connections. The term passive refers only to the optical splitter installed along the FTTH network and does not require external electrical power to function. The OLT (Optical Line Terminal) is the main PON streamer, to be installed within the exchange building, provides the PON data stream and requires electrical power. The splitter splits the signal coming from the OLT equally into each downstream branch; for instance in a 4-way splitter, the stream from the OLT is split into 4 equal streams.

The ONU (Optical Network Unit) is the end-user premises device which reads the fiber signal coming from the OLT and converts the data into an electrical signal suitable for indoor usage thus providing services including voice, data, internet, video/TV, etc… Between the OLT and the ONU one or more stages of passive splitters may be used. These splitters will be needed to split the connection to multiple end points.

3.23.5 Design Criteria for the Triple Play Telecommunication System

A) Objectives, Constraints and Special Considerations

The concept of the triple play telecommunication system as defined and selected:

- Complies with applicable codes and standards.
- Meets the specified communications requirements of other systems and equipment.
- Offers the base for reliability and scalability for the present and future services.

While achieving the conceptual plan objectives, the following important factors are to be considered:

- Cost effectiveness.
- Coordination with other design elements.
- Simplicity of installations, operation and maintenance.

B) Regulations and Standards

The triple play telecommunication system' installations will conform to requirements of referenced industry standards, applicable sections, and will be compliant with local requirements, applicable local regulations and code requirements of authorities having jurisdiction. Unless otherwise stipulated or approved, the triple play telecommunication system' infrastructure will, also, be compliant with the following standards and codes as applicable:

- Local authority Nigeria Communication Commission (NCC) requirements and practices and the relevant ITU-T recommendations for outside plant distribution "OSP" and BICSI "Customer-owned outside plant".
- System components, parts and installation shall comply with the corresponding recommendations of the Electronic Industries Association (EIA), and the International Electro-technical Commission (IEC).
- The latest issue of several material and test standards, which have been developed and published by Institute of Electrical and Electronics Engineers (IEEE) for data communications industry.
- ITU (International Telecommunications Union) recommendations.
- Building Industry Consulting Service International (BICSI

C) Design Criteria for Estimating the Demand of the FTTH Triple Play Telecom Network

The present section is given for reference and guidance only considering that scope of the Telecom Network of the present project covers only the civil works for the telecom infrastructure. The GPON network to be adopted delivers 2.5Gb/s per each fiber optic strand. This stream can be subdivided into 1/2, 1/4, 1/8, 1/16, 1/32, 1/64 and can be up to 1/128 or a mixture of any of those. As such any premise can have 2.5Gb, 1.25Gb, 625Mb, 325Mb, 160Mb, 80Mb, 40Mb, 20Mb, etc; other subdivisions can be provided as needed.

At this stage and with the current available data of the development area, the capacity of the GPON Fiber Optic cables and distribution network is calculated based on the following planning parameters and assumptions. The bandwidth at this stage will be mainly estimated based on the number of units and number of people/guests/employees within each of these units. These figures would have to be reviewed and assessed by NCC or authorized service provider.

The calculation of the telephone network demand and the estimated data demands is based on the following common practice ratios and assumptions:

GPON (2.5Gb/s) stream can be considered for the various land uses.

- For residential Buildings:
  - For apartment buildings managerial, each unit should have a subdivision of 1/32 of the 2.5Gb/s stream, equaling 77.75 Mbit/s.
  - For residential supervisory: each unit should have a subdivision of 1/64 of the 2.5Gb/s stream, equaling 39.06 Mbit/s.
  - For Residential Blue Collar: each unit should have a subdivision of 1/128 of the 2.5Gb/s stream, equaling 19.5 Mbit/s.
- For Hospitality:
  - Each guest will have 5Mb/s
  - Each employee 2Mb/s
- For conference facility: each employee will have 2Mb/s
- For Health and social services:
  - Each patient /student will have 5Mb/s
  - Each employee will have 2Mb/s
- For education:
  - Each student will have 5Mb/s
  - Each employee will have 2Mb/s
- For food and restaurants, each employee will have 2Mb/s
- For Admin, Support & Misc Services, each employee will have 2Mb/s
- For Retail, each employee will have 2Mb/s
- For main stream training,
  - Each student will have 5Mb/s
  - Each employee will have 2Mb/s
- For agricultural market, each employee will have 2Mb/s
- For industries, each employee will have 2Mb/s

D) Calculations Results for the Triple Play Telecommunication Network

The bandwidth calculations are based on the criteria and planning parameters as applied in the above section. The bandwidth calculations for the study area, denoting the telecom needs for phases 1, 2, and 3 and all summed phases are as follows; Bandwidth Grand Total Phase 1 is 92,008.81 Mb/s; Bandwidth Grand Total Phase 2; 152,912.94 Mb/s; Bandwidth Grand Total Phase 3 203,491.37 Mb/s.

3.23.6 Telecommunication Exchange Building

New exchange building will be required to be built in the study area in order to provide the anticipated telecommunication services. The location of the new exchange building have been selected based on best service provisioning, optimum coverage and appropriate distribution scheme. The total bandwidth to be served by all the exchange is estimated at 450 Gbps.

The area size of the exchange building plot should be approximately 35 x 35 sq.m, to be confirmed by NCC or local telecom authorities. This exchange building should be equipped with convenient technical rooms to house the primary cable terminations as well as voice, data and TV/video active PON equipment and transmission equipment in addition to components, power supplies, rectifiers and backup generators for maintained power availability. The building should, also, contain offices for administration and operation purposes. The exchange building and all related equipment are outside the scope of the general infrastructure works, but the plot requirements of the related exchanges will be secured at a later stage.

To note that this new exchange building will be connected to the local telecom transmission network through a fiber connection to the main fiber optic backbone passing by Kontagora city (87 km away to the east of the development).

3,23,7 FTTH Triple Play PON Network Distribution and Architecture

The study area will be equipped with a new Outside Plant distribution network to supply triple play network services (voice, internet and TV) to all its tenants over the GPON fiber optic cables technology. The Outside Plant, OSP, distribution network will, mainly, be composed of primary and secondary networks.

A) Primary Cable Network

The primary network is the cabling network stretching from the exchange's location up to cross connection cabinets, namely GPON Fiber Distribution Terminal (FDT) cabinets. The primary feeder cables, with sizes of 144-fiber- strand that will be running from the exchange through ducts, shall later be split at some point into multiple 48-strand cables; each will be reaching a separate FDT cabinet. Each duct can accommodate up to 3 primary feeder cables by utilizing sub-ducting.

B) Secondary Network

Multiple GPON FDT cabinets (an FDT space requirement of 2mx3m is adequate) will be required serving as distribution points or hubs for subzone areas. The cabinet is considered as the main hub of the secondary network that will be used to feed the plots, over secondary cables, either directly or through subcabinets, namely Fiber Access Terminals (FAT). Furthermore, GPON splitters shall be mainly located in the buildings and FAT cabinets.

The FDT cabinet is mainly used to patch the primary feeder cables and the secondary cables. It is also used for maintenance purposes and to allocate spare fiber optic strands for future plots. Splitters can also be added in the FDT cabinet so that each primary fiber strand can be split into numerous FO secondary cables and each of these strands would feed one plot/building or a FAT subcabinet. Splitters to be installed inside FDT cabinets can be cascaded with the ones used at the plots/buildings/FAT if needed.

All cabling, splitters, cabinet shelves and equipment are considered outside the scope of work; however, estimating their sizes and types is crucial to size the civil works accordingly.

3,23.8 Civil Works For the FTTH Triple Play GPON Telecom Network

The civil and cable works infrastructure is the basic item in implementing a durable telecom system transport network. As the evolution of technology is forcing new generation of cabling systems and technologies to carry larger amount of bandwidth, civil works shall be designed to cope with the ever growing demand. Duct bank capacity infrastructure should allow for flexible network growth and upgrading. The civil works, which include ducting systems, hand-holes, manholes, etc, shall be designed to comply with international standards and local authorities requirements. The hand-holes/manholes should be chosen to fit the duct bank capacity and F.O. cable splicing. However, the cable works themselves and all corresponding equipment are considered outside the scope of work as stated earlier.

The duct bank infrastructure for the telecommunication system shall be mainly placed underneath the sidewalks (on both sides or on one side, as needed).

3.23.9 Reservation for GSM towers

Reservations should also be allocated for provisional GSM related infrastructure; however, the GSM system is considered outside the scope of work. The design shall be based on the assumption that several mobile operators would be sharing the same infrastructure unless otherwise specified by NCC or local telecom authorities.

3.24 SOLID WASTE MANAGEMENT

This Solid Waste Management (SWM) section presents a brief description of the main types, characteristics and quantities of solid wastes that could potentially be generated from Amfani Industrial Park and City. This refers mainly to generated solid waste materials during the operational stages of the project. A proposed solid waste management strategy (SWMS) for handling potential generated waste from the various land uses has been prepared by the Consultants in the form of general guidelines that can be reviewed, refined where necessary, brought forward to progressive design stages, and enforced by relevant parties.

Based on available data from similar projects and research, the following waste types are expected from this project: cut pieces, cotton waste, metal scraps, plastic/ rubber, paper, card board, rags, glass, wood, stones, spent chemical/ oil and waste minerals amongst others. The design of solid waste disposal system shall be based on the unit rate of waste generation. The general type of wastes expected from project of this nature is presented in **table 3.9** below.

Table 3.9: Expected Wastes Sources and Types

Waste Generation Sources	**Waste Category**		
	Solid	**Liquid**	**Gaseous**
Construction phase	Papers, cartons, metals, plastics, cans, packaging materials, wood, caked cement, debris, excavated top soil and litters	Sewage	Emissions from vehicle usage e.g dust CO_x, NO_x and SO_x, etc
Administrative offices/ shops	Papers, waste packages, plastics, polythene bags, metal scrap, cans, glasses, food wastes etc	Sewage	
Oil and gas (refining, storage and blending units)	Oil sludge, metal scraps, oily rags, paints,	Spilled & spent oil, paints, aerosols,	CO_x, NO_x, SO_x VOC's and hydrocarbon emissions
Recreational areas	Food remains, bottles, plastic glasses, cans, papers/ packages, rags, leather, leaves, wood, electronic wastes	Waste water, sewage, chemicals, expired juice Etc	
Ship/ Boat Yard	Scrap metals, cans, plastics, rags,	Residual paints, spent Oil	Fumes from machineries
Logistic & Stacking Area	Scrap metals, cans, plastics, rags, electronic-waste, copper cores, aluminum, wood scrap, papers, solidified waste paints	Waste water, chemicals, spent oil, detergents, sewage etc	Fumes from vehicles and other machineries
Power generating units	Generator/ metal scraps, rags, plastics, electrical cable waste fire extinguisher's, cans	Waste water, grease, spent oil degreasing agent, paint	CO_x, NO_x and SO_x emissions from power plants

3.25 SUSTAINABLE ASPIRATIONS

In order to adopt a concept that follows a sustainable flexible approach and suits any potential future progress in SWM at the State-wide level (in terms of plans, policies and regulations), source separation practices based on 3 streams is proposed in the city. The Consultants believe such an approach would result in the establishment of an infrastructure that may suit and aid future sustainable plans set by relevant authorities at the Municipal level.

Based on the above, a 3 streams source separation was proposed as follows:

- Organic Waste
- Dry Recyclables (Paper/Cardboard, Plastics, metals, Glass)
- General Waste

The introduction of source-separation practices will aid in provision of flexibility during the handling of such waste streams at the downstream end of the entire SWM chain (i.e. treatment/disposal schemes) at offsite Municipality facilities. However although it is good practice to propose sustainable solutions in line with a chronological order of preference displayed in the Waste Hierarchy presented in the figure below. It is of also important to uphold feasible solutions, on environmental and economic scales.

Fig 3.9: Sustainable Waste Hierarchy

3.25.1 Solid Waste Minimization

This refers to all the activities generating waste whether residential, logistics, retail or industrial. Waste generators should adopt all practical and feasible efforts to minimize the amount of material to be discarded as 'waste'. Basic measures to be taken by waste generators, specifically at the industrial and logistics areas, include:

- Implementing good housekeeping through adopting environmental management systems and standards (EMS) such as ISO 14000 series,
- Conducting regular environmental audits particularly for solid waste involving material flow charts and optimized material balance models as applicable,
- Utilizing efficient and environment friendly raw material and technological processes in their activities,
- Using recycled material, where applicable,
- Reusing discarded material prior to storage,
- Establishing a waste exchange scheme and reusing material prior to disposal, i.e. taking into consideration that one industry's waste could be the other industry's raw or input material.

3.25.2 Industrial Symbiosis / Waste Exchange Program

Industrial Symbiosis (IS) engages traditionally separate industries and other organizations in a network to foster innovative strategies for more sustainable resource use (including materials, energy, water, assets, expertise, logistics, etc.) Through the network, business opportunities are identified leading to mutually advantageous transactions for innovative sourcing of required inputs, and value-added destinations for non-product outputs. Organizations are also exposed to best practice and knowledge transfer, resulting in cultural and process changes.

The principle behind industrial symbiosis is simple; instead of being thrown away or destroyed, surplus resources generated by an industrial process are captured then redirected for use as a 'new' input into another process by one or more other companies, providing a mutual benefit or symbiosis. Put simply, industrial symbiosis challenges the business world to operate in the same way as the natural eco-system where everything has a place and function, and nothing goes to waste.

Although geographic proximity is often associated with industrial symbiosis, it is neither necessary nor sufficient nor is a singular focus on physical resource exchange. In practice, using industrial symbiosis as an approach to commercial operations – using, recovering and redirecting resources for reuse – results in resources remaining in productive use in the economy for longer. This in turn creates business opportunities, reduces demands on the earth's resources, and provides a stepping-stone towards creating a circular economy.

The onsite SWM strategy includes a Solid Waste exchange program to facilitate the exchange process between industries. This will increase waste diversion from landfilling, reduce carbon emissions, cut on waste disposal costs, storage, transport and material purchasing costs, creates new jobs, and saves on the purchase of raw materials.

Left-out waste materials unwanted by the available industries should ultimately be transported to final destination sites by a special service provider under a special contract with the Client for the provision of services.

3.25.3 Solid Waste Types and Sources

Solid wastes will be generated form basically all activities within Amfani Park. The present land use plan depicts various industrial activities with associated logistics and accommodation. Most of these activities will generate mainly solid waste that is typical of the Municipal Solid Waste (MSW) stream, such as accommodation, educational facilities, retail centers, etc. However, specific industrial land uses could, in addition to MSW, also generate industrial wastes which in turn could be non-hazardous and hazardous.

The following SW characterization is used for the purpose of this project:

Municipal Solid Waste (MSW): generated from residential and commercial land use areas and may typically contain food waste, paper, cardboard, plastics, uncontaminated textiles, glass, wood, metals, inert debris, yard trimmings, and other bulky items.

Industrial Waste (IW): generated from industrial facilities and comprising the following:

- Industrial Non-Hazardous Waste (INHW): similar in nature to MSW, however the various components might have different proportions, sizes and characteristics depending on industry size and type; and

- Industrial Hazardous Waste (IHW): likely to be hazardous in nature and exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity.

IHW may comprise used filters, sludge, empty oil/solvent drums, rubber, wood and containers, batteries, used electronic items, etc. in solid form. IHW may also appear in semi-solid or liquid form such pigments, paints, adhesives, spent oils/solvents, etc. The determination whether the waste is listed as a hazardous waste constituent should comply with applicable regulations such as the United States Environmental Protection Agency (US-
EPA) and European Union (EU) definitions1. Other types of waste may include:

- Landscape waste: green waste from landscaped areas is likely to be generated in the project area and should be properly managed by the Landscape Contractor under a special contract signed with the Client.
- Construction and Demolition (C&D) waste: This kind of waste will be generated during the construction stages of the project and should be managed by the Contractor in full compliance with Environmental Management Plan requirements.
- Medical waste: Medical waste will also be generated in limited quantities from Healthcare facilities, with about 10% to 20% of its entire content considered potentially hazardous in nature (sharps, infectious non- sharp waste, expired or unwanted pharmaceuticals, etc.) and requires special handling. Such limited waste category is expected to be stored at dedicated clinics/ generation locations for collection by specialized contractors to avoid double handling. The remaining portion of the medical waste stream (around 80% - 90%) is considered to constitute discarded materials that are similar in composition to MSW and thus can be handled in a similar way.

3.25.4 Solid Waste Management System Basic Concept

Based on the initial assessment of waste characteristics, and at this planning stage where specific function/data regarding the individual industrial activities/facilities is yet to be fully defined, the consultants envisage that the main options for the proposed SWMS should take into consideration the following general planning aspects:

- The likely generation of both MSW/INHW as well as an anticipated lesser portion of IHW raises the need to handle such waste types separately;
- The adequate management of different waste types from different facilities within the project sites encourages the need to establish pertinent Health and Safety operational unit and environmental guidelines for enforcement and monitoring within the industrial districts;
- As part of a long-term vision towards achieving sustainable practices, waste minimization measures in the form of applying the 3R's (Reduce, Re-use, and Recycle) are of utmost importance to minimize any potential impacts from future operations. In practice, this can be complemented within the industries by establishing a waste exchange policy and programs;
- As part of their duty of care, tenants should be given the responsibility of proper storage and handling of their generated waste within their own premises, in close coordination with/authorization by the Amfani Management prior to transfer of MSW to the Transfer Station (TS) or ultimate dispatch of Industrial Waste to offsite approved destination site(s);
- The management of upstream collection services for all waste types is encouraged to be handled by licensed Contractors under special agreements with tenants and in close coordination with the Amfani management authority;
- The handling of downstream component (treatment/disposal of the various waste streams) should be incorporated with current approved operations and future plans set by the SWM relevant authorities.

3.25.5 Solid Waste Generation and Composition

Various sources are available that estimate generation rates with respect to various types of land uses. Table 3.xx below presents the adopted solid waste generation rates for the land use areas envisaged to generate MSW. The types and quantities of IW (both INHW and IHW) varies widely and depends on the individual industrial facility's characteristics such as type, size, processes, technology, materials involved, waste minimization practices, and quality environmental standards adopted and can only be best verified during operational stages using IW inventories.

Adequate and sufficient data on current waste generation practices/ quantities, waste inventories/classification, and types of future industries in both districts remain essential elements to anticipate potential future waste. Table 3.10 shows the Municipal Solid Waste Generation rates estimated for the project area.

Table 3.10: MSW Generation Rates

<table>
<tr><th colspan="2">Land Use</th><th>Rate</th><th>Unit</th></tr>
<tr><td colspan="2">Agriculture Market</td><td>790</td><td>L/100m2FA
/d</td></tr>
<tr><td rowspan="3">Industrial
*</td><td>Light</td><td>23</td><td rowspan="5">kg/employee/d</td></tr>
<tr><td>Medium</td><td>38</td></tr>
<tr><td>Heavy</td><td>234</td></tr>
<tr><td colspan="2">Retail, Food, Restaurant and Hotel</td><td>4.23</td></tr>
<tr><td colspan="2">Offices</td><td>0.68</td></tr>
<tr><td colspan="2">Education</td><td>0.23</td><td>kg/student/
d</td></tr>
<tr><td rowspan="2">Residenti
al</td><td>Low Income</td><td>0.303</td><td>kg/student/
d</td></tr>
<tr><td>High Income</td><td>0.688</td><td>kg/capita/d</td></tr>
<tr><td colspan="2">Hotel</td><td>0.91</td><td></td></tr>
<tr><td colspan="2">Golf Course</td><td>0.23</td><td>kg/m2/d</td></tr>
<tr><td colspan="2">Health**</td><td>1.05</td><td>kg/patient/d</td></tr>
<tr><td colspan="4">Assumptions:
*85% of generated waste is considered to be non-hazardous and is handled as part of gener- ated MSW
**80% of generated waste is considered to be non-hazardous and is handled as part of gen- erated MSW</td></tr>
</table>

Typical distribution of percentage MSW composition (by weight) for the main land uses is presented in the figure below. Table 3.11 is the adopted MSW compositions. To better estimate the solid waste volumes that will require storage, a loose solid waste density for each constituent of the entire solid waste quantities waste was used. The adopted densities of the various waste materials are presented in the Table below.

Table 3.11: Solid Waste Density by Main MSW Constituency

Main SW Components	Solid Waste Densities (kg/m3) Range		Adopted Average
Food/Organic Waste	130	480	305
Paper/Cardboard	40	180	110
Plastics	40	130	85
Metals	80	520	300
Glass	160	480	320
Others	90	180	150

Based on the adopted waste compositions and densities addressed above, total quantity and volume of MSW constitutes expected to be generated, are estimated as shown in the Table below.

Table 3.12: Estimated MSW Quantities and Volumes

	Organic Waste		Dry Recyclables		General Waste		Tot al	
	Est. Qty. (t/d)	Est. Vol. (m3/d)	Est. Qty. (t/d)	Est. Vol. (m3/d)	Est. Qty. (t/d)	Est. Vol. (m3/d)	Est. Qty. (t/d)	Est. Vol. (m3/d)
Agriculture Market		4.14		5.72		0.52	**0**	**10.37**
Retail, Food, Restaurant, Hotel	2.50	305.00	24.39	815.00	4.38	150.00	**31.27**	**1270.00**
Offices	0.43	1.40	1.29	11.96	0.17	1.13	**1.88**	**14.48**
Education	0.53	1.75	0.77	6.74	0	0	**1.30**	**8.50**
Health	0.18	0.60	0.81	7.35	0.17	1.16	**1.16**	**9.11**
Residential - High Income	9.12	29.89	2.88	21.53	1.26	8.39	**13.25**	**59.81**
Residential - Low Income	6.62	21.71	3.60	28.07	3.29	21.92	**13.51**	**71.71**
Hospitality	0.27	0.88	0.29	2.49	0.03	0.20	**0.59**	**3.56**
Industries – MSW	38.79	127.16	607.64	5073.38	0	0	**646.42**	**5200.55**
Total	**58.44**	**492.53**	**641.66**	**5972.24**	**9.30**	**183.31**	**709.39**	**6648.08**

3.25.6 Solid Waste Storage And Collection

3.25.6.1 Storage

Municipal Solid Waste

Source-separated MSW generated at Amfani, should be temporarily held at generation locations, and the transported for storage at proposed onsite Transfer Stations (TSs). Recovered MSW materials (in single streams) will then be further dispatched to the approved offsite destination site(s) such as recycling facilities or dedicated end-users.

Before being transported to the TSs, solid waste will be stored in satellite waste rooms/areas available in each land use. The source-separation practice should be maintained in storage areas at each generation point. Storage rooms/areas at all generation points will be provided with adequate provisions, made suitable to the specific aforementioned waste types, constituents, and categories. Such provisions for specific waste types/ categories shall include, but not necessarily be limited to, the following:

- Adequate capacity and durability of containers with respect to their contained waste,
- Adequate sizing of storage areas and their provision with all requirements to render them operational and safe to both public health and the environment,
- Adequate accessibility and manoeuvrability of containers to arrive from all storage locations to the collection vehicle standing point,
- Minimizing vehicle compaction efforts for source-separated dry recyclable materials (Plastics, metals, glass) to preserve their end- market value.

3.25.7 Solid Waste Transfer

MSW consolidation and storage at two TSs is likely to be cost effective i.e. by reducing MSW volumes (the major waste type in terms of quantities), thus reducing direct hauling costs associated with travel distance to offsite further handling or disposal destinations. At this preliminary project stage, the TSs are proposed to comprise a two- level arrangement structure with actual MSW handling operations occurring within an enclosed building to minimize health, safety, and environmental impacts/nuisance. The TSs are located at the periphery ends of Amfani. An indicative rough area and cost estimate of each presented in the Table below.

Table 3.13: Indicative Estimated Area and Rough Cost Estimate

	TS-1		TS-2
Estimated Area (Ha)	130	480	305
Estimated Cost (M$) for Transfer Station and Equipment	40	180	110
Main Assumptions	*excludes land cost *excludes the cost of transport of waste to offsite treatment/ disposal facilities, all of which are considered as part of operational cost *equipment life-span is 5 years – cost of renewal is excluded *quantities increased by 20% to cater for any unforeseen events		

The TSs will act as an interface/transition points between onsite SWM operations and downstream/offsite Municipal services, whereby transfer/ transport of the three source-separated MSW streams will be conducted by relevant Municipality body or their Representative from the TSs to the approved downstream and offsite destination site(s).

Onsite waste collection vehicles arriving at each TS from various MSW generation locations within project area will be directed to the upper level of the station through a ramp. The vehicles will directly unload waste contents at each dedicated bay through hoppers and eventually to designated processing equipment, comprising either hook-lift containers or compaction units at the lower ground level.

In addition to MSW generation quantity estimates, space allocations for the MSW TSs are generally driven by operational-related aspects. This mainly includes, among other issues:

- Truck circulation requirements inside the mezzanine floor of the station in accordance with anticipated collection trucks, intended for use by the end-user (onsite Waste Collection Contractor/Operator),
- Storage duration at the station, and
- The anticipated frequency of collection of waste from the TS to approved offsite facilities by end-user(s).Furthermore and in order to minimize excessive storage of MSW at the TSs and hence avoid its over-sizing, the design could be based on a one- day storage prior to further dispatch of the stored MSW to approved offsite destination site(s), such as recycling facilities or dedicated end-users.

In addition to the waste management operational areas, the TSs could accommodate offices and support facilities designed to overlook the station's operations. As such, these will best be located at the upper level of the station. The main arrangement and design of each TS shall be considered in line with the provision of necessary MEP and other adequate design requirements to render it environmentally sound, hygienic, and safe.

Industrial Waste

Once all practical and feasible measures are taken to minimize potential waste generation, individual industries should involve an assigned team to overlook source-separation practices of IHW and INHW are maintained at all times. The collection, treatment, transportation and final disposal of waste shall be the responsibility of the industry or facility generating the waste. As such, temporarily storage of source-separated waste should be done in adequate containers located at temporary and dedicated holding bays within the industry premise. These containers should be of standard specification suitable to safely accommodate the waste material it contains in accordance with applicable regulations and international good standards of practice.

As per US-EPA regulations and under the Resource Conservation and Recovery Act (RCRA) hazardous waste management program, the generating quantities of an industry determine the related guidelines for storage, transport and disposal of its wastes; such as the duration of time that hazardous substances and waste may be kept in storage, and also the nature of the storage which varies with quantity. The following guidelines are adopted by US-EPA. However, it is of utmost importance to note that the below is given for guidance and applicable local regulations should govern.

- Generators of 1000 kg/month of hazardous waste or >1 kg/month of acute hazardous waste are considered large quantity generators (LQGs). LQGs may accumulate hazardous waste on-site for up to 90 days. LQGs do not have a limit on the amount of hazardous waste accumulated on site.
- Generators of >100 kg/month but <1000 kg/month of hazardous waste are considered small quantity generators (SQGs). SQGs have up to 180 days to accumulate hazardous waste or up to 270 days if waste is been transported to a distance greater than 300Km. The quantity of hazardous on site waste must never exceed 6,000 kilograms.

3.25.8 Solid Waste Collection

The solid waste collection system should adhere to a separated solid waste collection process. The particular items to be considered in this regard include mainly:

- Waste collection vehicles should be able to accommodate for the various types and sizes of waste storage containment; these should be specific for collection of all types of generated waste; thus could be of the compacting and non-compacting type.
- Frequency of collection shall be minimized to at least daily, where food or other organic MSW is anticipated to be generated and could vary for potential hazardous waste, depending on the generated solid waste quantities and adopted storage guidelines.
- Collection times and truck routes should be coordinated with traffic administration to minimize traffic congestions and nuisance.
- Collection trucks should be of different capacities in accordance with the frequency of collection.
- The transportation of potential hazardous waste should be performed by specialized and licensed service providers in dedicated enclosed vehicles to avoid spillage. The transportation operations should be complemented with consignment notes as part of a manifest system for departure and delivery. This should take into account the types and quantities of material shipped, the transporter and receiver information, and any other measure deemed necessary by concerned public authorities.

3.25.9 Solid Waste Treatment and Disposal

As aforementioned, treatment and disposal of MSW generated from Amfani Industrial Park and City should be adequately integrated with dedicated solid waste treatment/disposal facilities in accordance with Municipality requirements.

3.25.10 Project Schedule

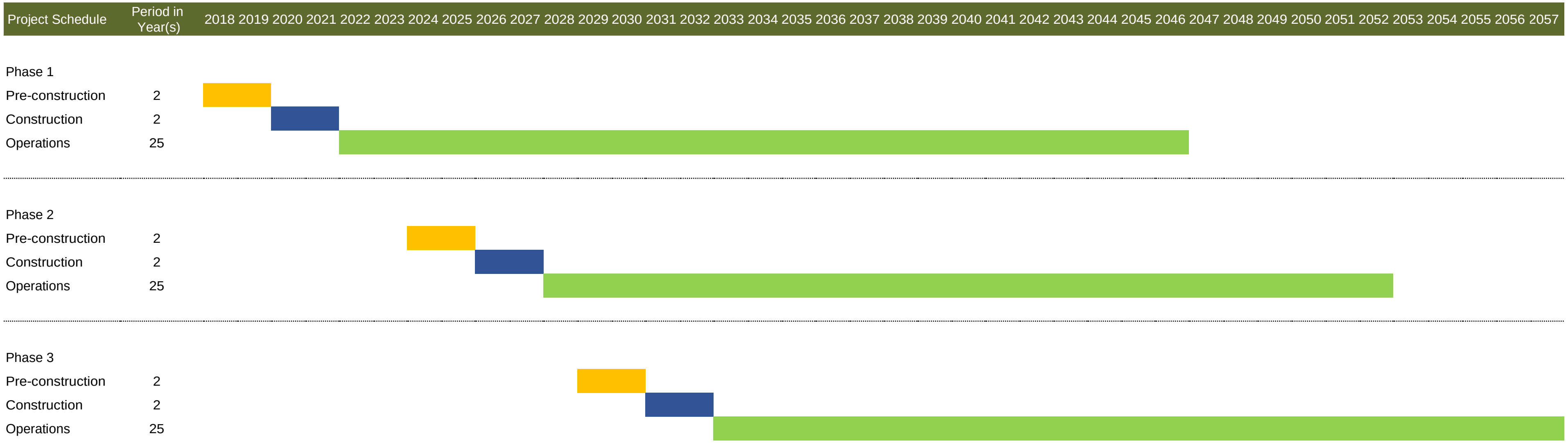
The proposed Amfani Industrial Park project planned Perpetuity Project Period is 29 Years. The analysis period is as follows;

- 2 Years, Pre-construction
- 2 Years, Construction
- 25 Years, Operations

Pre-construction Period is defined as the period before start of construction.

The construction is when the real assets are created. The development Period is between Pre-construction and end of Construction. The operation is the post-construction when the revenue generation starts and the activities of the facilities are in full use. The project period is between start of Pre- construction and end of Operations. It has scheduled that 40% of the project to be completed in Year 1, while the remaining 60% will be completed in Year 2. Fig 3.10 below shows the chart for the phases of the project implementation schedule. Approval for the Environmental Impact Assessment of the project is expected to be granted by the regulator, Federal Ministry of Environment before the commencement of the project.

Fig 3.14: Project Schedule



3.2.5.11 Decommissioning/ Abandonment

This is the last phase of the project activities. It refers to the dismantling, decontamination and removal of process equipment and facility structures, the removal of surface installations, and re-contouring the land and planting vegetation to prevent soil erosion. The project lifespan is estimated at 25 years.

In line with statutory requirements, the programme is planned during the project conception and design phases. Such decommissioning and abandonment activities are expected to incorporate remediation/restoration of the project environment at the end of the project/facility lifespan.

At the close of the proposed Industrial Park and Smart City project, all buildings, machineries and equipment will be dismantled and the whole area re-instated. This process will be in accordance with the Environmental Management Plan (EMP) for this project, which addresses the mitigation and restorative measures required to leave the project site for sustainable future use. However, should there be change in this plan due to exigencies of time, the facility will be converted to most appropriate use that will guaranteed maximum benefit to the stakeholders.

The planned decommissioning may take place either stepwise or the entire infrastructure together with factories, warehouses, associated equipment/ machines may be decommissioned at once, dependent on specific industrial/operational preferences and priorities at that time.

Furthermore, contractors conducting the work will be required to operate according to similar management systems. The general order of preference of decommissioning options available for redundant structures and equipment include:

- Re-use: By sale and/or transport to another project or company;
- Re-cycle: Breaking down structures and equipment for raw materials. The majority of metals will be recycled. The break-up of structures can be performed in-situ or after transport to a

breaking or salvage yard, depending upon ease of transport and safety conditions; and

- Disposal: Some materials are not suitable for recycling and must be disposed of by a licensed waste management facility.

At this stage, it is difficult to give precise details about the way in which the process of decommissioning will proceed because technology and science will have changed within the project life. However, a risk assessment study which will describe the processes and activities needed for the closure/decommissioning will be developed during the operational phase of the industrial park. This study will make a full assessment of potential impacts and describe methods of minimizing adverse environmental effects and will be executed, evaluated and implemented in close co-operation with stakeholders. There will however be certain principles during the de-commissioning/closure phase which can be established now which include sharing of risk assessment report with regulators. If the site is no longer to be used, full restoration and landscaping will be carried out. This would involve consultation with authorities and other stakeholders and re-instatement to the original vegetation type. Where necessary however, additional actions shall be taken that comply with any regulations existent at the time of decommissioning.

CHAPTER FOUR

4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 GENERAL BASELINE STUDY APPROACH

The overall study approach for the environmental baseline study took cognizance of the fact that EIA is an environmental characterization study that is commonly employed to fully establish in details the contemporary baseline status / conditions of the study area. It is considered as a process of getting detailed information about the environmental conditions of an area through the review of available reports, maps, and combining these with detailed field investigation and laboratory analyses of the various environmental media that could have been collected during the field study. The purpose is to be able to adequately predict the possible potential and associated impacts that may arise if the study area is put into specific developmental use. It also enhances the determination of the impacts of an existing project or facility on the ecosystem of the project area, and on the socio-cultural, economic and health status of the communities around the project and or facility. With these considerations, an interdisciplinary approach was adopted to acquire relevant environmental data covering the physical, biotic and social components of the environment of the proposed site.

Extensive review of available literature on the study area and on the facilities in and around the proposed site was conducted. This was with a view to acquiring all relevant background information on the environmental characteristics of the area. Furthermore, the field investigations and sampling strategies were planned and executed on the environmental issues outlined below:

4.1.1 Field Quality Assurance and Control Measures

Quality assurance / quality control formed an integral part of all aspects of the field work and was put in place to prevent sample contamination and deterioration. Sample chain of custody forms were used for the registration and tracking of samples from the field to the laboratory. The adopted QA/QC strategies employed were as follows;

The work was carried out in accordance with the terms of reference and the specification given by FMEnv.

- The study methodology was consistent with those approved by Niger

State Ministry of Environment or Niger State Environmental Protection Agency and FEPA (now Federal Ministry of Environment, FMEnv) in 1991. Only the standard and commonly accepted field procedures were used. The study design adequately covered the entire project area, including the surrounding areas.

4.2 ENVIRONMENTAL FIELD SURVEY

In order to effectively characterize the ecology of the study area, a two season comprehensive field data gathering exercise was carried. The wet season field exercise was carried out between 20th and 24th November, 2019, while the dry season field exercise was conducted between 27th and 29th January, 2020. It is worthy of note that the wet season which extended to November, 2019 may be as a result of part of the impacts of climate change on the environment. However, in the overall consideration for each of the seasons, the following biophysical data samples were collected within the project area and analyzed in a FMEnv's accredited laboratory known as LACH Consult and Scientific Support Ltd in Lagos state; 75 soil samples and a control point, 7 sediments samples and a control point, 15 surface water samples and a control point, 7 ground water samples and a control point, 10 vegetation samples and a control point, and 50 Air quality/noise level samples and a control point.

During the sampling exercise, field observations were made and documented in field notebooks and still photographs (details of these are presented in subsequent sections of this chapter). Features observed include water and soil characteristics, biodiversity, and socio-economic setting. The environmental components sampled include soil, surface water, sediment, air, and biodiversity and socio cultural features. Soil sampling stations were established to ensure the major soil types that characterize the project area were adequately covered. Also surface water and sediment sampling as well as hydro-biological studies were carried out in line with applicable procedures. Air quality / noise were sampled along chosen sensitive sampling points. Furthermore, socioeconomic and health surveys were conducted within identified host communities in Magama Local Government Area of Niger state.

The overall goal of the field exercise was to generate environmental baseline data that would be sufficient to characterize the ecological, socio-economics and health status of the project area and provide sound basis for the EIA of the proposed project. The specific objectives and scope of the fieldwork ensured that all aspects of the environment within the project area were completely characterized.

4.2.1 Sampling Design

The sampling design and methods were selected in the context of the project objectives, relevant (FMEnv, 1995, ASTM 2005, etc.) regulations and guidelines, environmental sensitivities, and with consideration to expected surface, sub-surface / geologic conditions, access constraints and local equipment availability and costs. The field sampling design is in line with the FMEnv guidelines for EIA. The stations were distributed to adequately cover the entire study area.

4.2.2 Sampling Location

The various sample stations (on land and water) were located by the aid of hand held Global Positioning System (GPS). The sampling points were logged into the GPS prior to mobilization. The coordinates of sampling stations, sampling requirements and codes are presented in **Table 4.1**.

Table 4.1: Sampling Points Coordinates and Requirements

S/No	Longitude	Latitude	Coordinate Codes	Requirements
1	4° 38.037'	9° 55.368	AMSS1/AMAQ1	Soil, Air Quality and Noise
2	4° 37.197'	9° 58.140	AMSS2/AMAQ2	Soil, Air Quality and Noise
3	4° 37.050'	9° 58.000	AMSS3/AMAQ3	Soil, Air Quality and Noise
4	4° 36.647'	9° 58.047	AMSS4/AMAQ4	Soil, Air Quality and Noise
5	4° 37.455'	9° 57.729	AMSS5/AMAQ5	Soil, Air Quality and Noise
6	4° 37.230'	9° 57.490	AMSS6/AMAQ6	Soil, Air Quality and Noise
7	4° 36.892'	9° 57.370	AMSS7/AMAQ7	Soil, Air Quality and Noise
8	4° 36.965'	9° 57.774	AMSS8/AMAQ8	Soil, Air Quality and Noise
9	4° 37.296'	9° 57.243	AMSS9/AMAQ9	Soil, Air Quality and Noise
10	4° 37.200'	9° 57.010	AMSS10/AMAQ10	Soil, Air Quality and Noise
11	4° 37.469'	9° 57.049	AMSS11/AMAQ11	Soil, Air Quality and Noise
12	4° 37.764'	9° 56.920	AMSS12/AMAQ12	Soil, Air Quality and Noise
13	4° 36.835'	9° 56.355	AMSS13/AMAQ13	Soil, Air Quality and Noise
14	4° 36.450'	9° 56.160	AMSS14/AMAQ14	Soil, Air Quality and Noise
15	4° 36.758'	9° 56.082	AMSS15/AMAQ15	Soil, Air Quality and Noise
16	4° 36.570'	9° 55.860	AMSS16/AMAQ16	Soil, Air Quality and Noise
17	4° 36.620'	9° 55.620	AMSS17/AMAQ17	Soil, Air Quality and Noise
18	4° 36.960'	9° 55.590	AMSS18/AMAQ18	Soil, Air Quality and Noise
19	4° 37.248'	9° 55.486	AMSS19/AMAQ19	Soil, Air Quality and Noise
20	4° 36.947'	9° 55.317	AMSS20/AMAQ20	Soil, Air Quality and Noise

21	4° 36.665'	9° 55.346	AMSS21/AMAQ21	Soil, Air Quality and Noise
22	4° 36.569'	9° 54.741	AMSS22/AMAQ22	Soil, Air Quality and Noise
23	4° 37.167'	9° 55.131	AMSS23/AMAQ23	Soil, Air Quality and Noise
24	4° 37.464'	9° 55.485	AMSS24/AMAQ24	Soil, Air Quality and Noise
25	4° 37.615'	9° 55.230'	AMSS25/AMAQ25	Soil, Air Quality and Noise
26	4° 37.698'	9° 55.568'	AMSS26/AMAQ26	Soil, Air Quality and Noise
27	4° 37.887'	9° 55.867'	AMSS27/AMAQ27	Soil, Air Quality and Noise
28	4° 37.835'	9° 56.110'	AMSS28/AMAQ28	Soil, Air Quality and Noise
29	4° 37.667'	9° 55.959'	AMSS29/AMAQ29	Soil, Air Quality and Noise
30	4° 37.344'	9° 55.824'	AMSS30/AMAQ30	Soil, Air Quality and Noise
31	4° 37.690'	9° 55.720'	AMSS31/AMAQ31	Soil, Air Quality and Noise
32	4° 37.403'	9° 55.677'	AMSS32/AMAQ32	Soil, Air Quality and Noise
33	4° 37.155'	9° 55.755'	AMSS33/AMAQ33	Soil, Air Quality and Noise
34	4° 36.872'	9° 55.826'	AMSS34/AMAQ34	Soil, Air Quality and Noise
35	4° 37.081'	9° 55.985'	AMSS35/AMAQ35	Soil, Air Quality and Noise
36	4° 37.295'	9° 55.986'	AMSS36/AMAQ36	Soil, Air Quality and Noise
37	4° 37.617'	9° 56.141'	AMSS37/AMAQ37	Soil, Air Quality and Noise
38	4° 37.773'	9° 57.175'	AMSS38/AMAQ38	Soil, Air Quality and Noise
39	4° 37.336'	9° 56.330'	AMSS39/AMAQ39	Soil, Air Quality and Noise
40	4° 37.529'	9° 57.348'	AMSS40/AMAQ40	Soil, Air Quality and Noise
41	4° 36.957'	9° 56.198'	AMSS41/AMAQ41	Soil, Air Quality and Noise
42	4° 37.792'	9° 57.479'	AMSS42/AMAQ42	Soil, Air Quality and Noise
43	4° 37.270'	9° 56.520'	AMSS43/AMAQ43	Soil, Air Quality and Noise
44	4° 37.553'	9° 57.539'	AMSS44/AMAQ44	Soil, Air Quality and Noise
45	4° 37.827'	9° 57.649'	AMSS45/AMAQ45	Soil, Air Quality and Noise
46	4° 37.250'	9° 56.721'	AMSS46/AMAQ46	Soil, Air Quality and Noise
47	4° 37.021'	9° 56.690'	AMSS47/AMAQ47	Soil, Air Quality and Noise
48	4° 36.749'	9° 56.614'	AMSS48/AMAQ48	Soil, Air Quality and Noise
49	4° 36.793'	9° 56.931'	AMSS49/AMAQ49	Soil, Air Quality and Noise
50	4° 36.927'	9° 57.111'	AMSS50/AMAQ50	Soil, Air Quality and Noise
51	4° 37.688'	9° 57.041'	AMSS51	Soil,
52	4° 37.591'	9° 56.882'	AMSS52	Soil,
53	4° 37.552'	9° 56.726'	AMSS53	Soil,
54	4° 37.753'	9° 56.771'	AMSS54	Soil,
55	4° 37.681'	9° 56.654'	AMSS55	Soil,
56	4° 37.706'	9° 56.535'	AMSS56	Soil,
57	4° 37.756'	9° 56.386'	AMSS57	Soil,
58	4° 37.749'	9° 56.218'	AMSS58	Soil,
59	4° 37.498'	9° 56.259'	AMSS59	Soil,
60	4° 37.441'	9° 56.094'	AMSS60	Soil,
61	4° 37.513'	9° 55.914'	AMSS61	Soil,

62	4° 37.554'	9° 55.771'	AMSS62	Soil,
63	4° 37.563'	9° 55.610'	AMSS63	Soil,
64	4° 37.222'	9° 55.612'	AMSS64	Soil,
65	4° 37.072'	9° 55.428'	AMSS65	Soil,
66	4° 37.079'	9° 55.615'	AMSS66	Soil,
67	4° 36.816'	9° 55.452'	AMSS67	Soil,
68	4° 36.775'	9° 55.628'	AMSS68	Soil,
69	4° 37.004'	9° 55.727'	AMSS69	Soil,
70	4° 37.020'	9° 56.915'	AMSS70	Soil,
71	4° 37.054'	9° 57.311'	AMSS71	Soil,
72	4° 36.915'	9° 57.577'	AMSS72	Soil,
73	4° 36.635'	9° 57.589'	AMSS73	Soil,
74	4° 36.166'	9° 57.390'	AMSS74	Soil,
75	4° 36.317'	9° 57.143'	AMSS75	Soil,
76	4° 36.944'	9° 59.095'	AMSS76	Soil, Soil, Air Quality & Noise (control)
77	4° 36.711'	9° 57.842'	AMSW1/AMSD1	Surface Water and Sediments
78	4° 36.022'	9° 57.844'	AMSW2/AMSD2	Surface Water and Sediments
79	4° 36.006'	9° 57.158'	AMSW3/AMSD3	Surface Water and Sediments
80	4° 36.141'	9° 56.945'	AMSW4/AMSD4	Surface Water and Sediments
81	4° 36.498'	9° 56.833'	AMSW5/AMSD5	Surface Water and Sediments
82	4° 36.495'	9° 56.493'	AMSW6/AMSD6	Surface Water and Sediments
83	4° 36.306'	9° 56.163'	AMSW7/AMSD7	Surface Water and Sediments
84	4° 36.381'	9° 55.830'	AMSW8	Surface Water
85	4° 36.357'	9° 55.567'	AMSW9	Surface Water
86	4° 36.576'	9° 55.248'	AMSW10	Surface Water
87	4° 36.388'	9° 54.817'	AMSW11	Surface Water
88	4° 37.069'	9° 55.051'	AMSW12	Surface Water
89	4° 37.546'	9° 55.020'	AMSW13	Surface Water
90	4° 38.161'	9° 55.061'	AMSW14	Surface Water
91	4° 37.108'	9° 55.825'	AMSW15	Surface Water (stream within project site)
92	4° 36.474'	9° 59.295'	AMSW16/AMSD16	Surface Water and Sediments(control)
93	4° 37.213'	9° 58.136'	AMGW1	Underground Water
94	4° 37.060'	9° 58.070'	AMGW2	Underground Water
95	4° 37.190'	9° 58.194'	AMGW3	Underground Water
96	4° 37.050'	9° 58.000'	AMGW4	Underground Water
97	4° 38.093'	9° 55.293'	AMGW5	Underground Water
98	4° 37.724'	9° 55.308'	AMGW6	Underground Water
99	4° 37.920'	9° 55.480'	AMGW7	Underground Water
100	4° 36.954'	9° 59.186'	AMGW8	Underground Water(control)

4.2.3 Sampling Procedures

Sample collection was done in line with recommended procedures and practices for environmental data collection in Nigeria. An overview of sampling procedures for each parameter and observation made are discussed in the following sub-sections.

4.2.3.1 Vegetation

A reconnaissance survey provided insight into the selection of appropriate location, number, size, position and orientation of the transect. The study was conducted in approximately 7 belt transects, 1000m x 10m = 10,000 m^2, each. Transects were established at intervals of approximately 1 km, alternating on the right and left flanks of the proposed route and including, as much as possible, all vegetation types along the proposed route within each transect the associated vegetation was characterized using the segmented belt transect techniques, to ensure maximum chances of finding most of the component species in the area. Blocks of 1mx1m were laid on randomly chosen sides of each transect for detailed studies. Such alternately spaced observation points which cover the entire area as demarcated by these transects are generally more efficient statistically, than the contiguous or 100% assessment on smaller length of transect . Among the parameters investigated in each transect were floristic composition, community structure and maximum tree height.

For each transects, there followed photographic records of representative segments. After assessing the general condition and status of the vegetation, all the plant species were, as much as possible, identified and listed on the field. The taxonomically difficult forms that could not be identified with certainty were collected with a secateur (including the twig, flower, fruits, etc.), properly labeled and taken to the Herbarium, Federal Capital Territory (FCT), Department of Parks and Recreation in black polythene bags, for further keying and identification. All identification followed the keys of Hutchinson and Dalziel (1968) and Keay *et al* (1959) for trees, and Akobundu and Agyakwa (1998) for weeds. Fig 4.1 shows map of project area showing vegetation sampling points, while plate 4.1 and 4.2 show vegetation sampling at the project site and Riparians at Kaiji Lake respectively.

Plate 4.1: Vegetation Sampling at the Project Site

Plate 4.2: Riparians at Kaiji Lake

4.2.3.2 Wildlife

Studies on the wildlife diversity occurring along the proposed transmission line were conducted between 7am and 6.00pm local time by a consortium of herpetologists, ornithologists and mammalogists. Thus, various conventional techniques; both direct and indirect methods (Moshby 1974; Dasmann 1964; Sutherland 2000; Davies 2002, etc.) were adopted. Principal objectives were to produce a comprehensive checklist of fauna, determine their distribution and conservation status (prior to commencement of the project), against which future changes and magnitude of change in wildlife populations would be detected. Considering the dependence of wildlife on vegetation for shelter, food, perching, nesting site, etc, sampling stations were established along vegetation transects. Critical habitats and microhabitats such as log, litter, forest undergrowth, crevices and burrows were ransacked with the aid of 1m long probe to dislodge any hiding herpetofauna and mammals (Heinen, 1992). To increase the chances of sighting wild animals or their evidence of presence, the search was carried out radially, along the northern, southern, eastern and western axis of each transect. With respect to amphibians, Visual Encounter surveys (VES), Dip-netting (DN), Acoustic encounter surveys (AES), were applied, while Pitfall traps with drift fence were used for reptiles, and ground-running mammals such as rodents (in the way of Heyer, et al, 1994; Rodel and Ernst, 2004, Nago et al, 2006, and Akani, 2008).

Each transect was sampled for about two hours, five times (once in two days) during the period, between 7am and 6pm local time. All dislodged and sighted animal were identified to possible taxonomic levels, using the exquisite field guides and Keys of Happold (1987), Kingdon (1997), and Powell (1995) for mammals; Peterson (1980) and Borrow and Demey (2001) for birds; Branch (1988) and Spawls and Branch (1995) for reptiles; and Schiotz (1963,1969), and Rodel (2000) for amphibians. When and wherever possible, photographs were taken to demonstrate field observations.

Further information on diversity and conservation status of wildlife in the prospect area were acquired from (i) biodiversity reports of tertiary institutions and forestry departments in Niger state, (ii) previous biodiversity reports of environmental assessments within the area and of similar habitats (iii) through inspection of animals displayed for sale in bush meat markets within the project area, and (iv) by interviewing hunters concerning the variety of wildlife captured in the area, local names, dates of last kill or sighting, sites of high faunal density, seasonal abundance, hunting techniques and degrees of success. At their homes hunters were urged to present for examination and identification any preserved animal remains or trophies such as – skin, skull/skeleton, horn, hoof, scale, shell, etc - in their bags, caught in the area, as well say the last time they sighted or killed each animal discussed

4.2.3.3 Soil

A soil survey was undertaken during the wet and dry season to characterise the soil's baseline physico-chemical characteristics and determine any existing contamination. A hand auger was used to collect samples at each station, at two depths, namely of 0-15 centimetre (cm) and 15–30 cm. Samples were characterised on site in terms of soil colour, soil texture and drainage characteristics. Samples were collected in plastic containers for chemical analysis. Samples were analysed at the laboratory for soil nutrients (sodium, potassium, magnesium, calcium, nitrate, nitrite, phosphate and sulphate), heavy metals (manganese, iron, nickel, vanadium, cadmium, chromium, lead, zinc and mercury), cations (sodium, potassium, magnesium and calcium) parameters were recommended by the laboratory to conform to FMEnv requirement. Fig 4.2 presents map of project area showing soil sampling points, while plate 4.3 and 4.4 show pictures of soil sampling at project site and project area respectively.

Plate 4.3 Soil Sampling at project site Area

Plate 4.4: Soil Sampling at The Project

4.2.3.4 Surface water / Sediment

Surface water samples were gotten from the Kainji Lake using a beaker. The beaker was lowered into the lake, and water was drawn to the surface. Water samples were transferred directly into appropriate containers for preservation and subsequent analysis. In-situ analyses were immediately carried out to determine the following parameters with short holding time; pH, turbidity, conductivity, total dissolved solids and dissolved oxygen. Water samples for heavy metal analysis were collected in 2ml plastic bottles and acidified with 10% HNO3. Sediment samples from the river bed were collected in corresponding surface water stations from Kainji Lake using an Eckman Grab (ASTM 2005). Fig 4.3 presents map of project area showing surface water and sediments sampling points, while plate 4.5 and 4.6 show in-situ surface water and sediments sampling at Kainji Lake.

Plate 4.5: In-situ Surface Water Sampling at Kainji Lake

Plate 4.6: Sediments Sampling At Kainji Lake

4.2.3.5 Ground Water

Ground water sample was collected from the existing boreholes facilities within the project area and analyzed in the laboratory. In-situ measurement was also conducted on the ground water. Fig 4.4 shows map of project area showing ground water sample points, while plate 4.7 shows ground water sample collection pictures.


Plate 4.7: Ground Water Sample Collection

4.2.3.6 Plankton

Planktons from Kainji Lake near the proposed Industrial park Smart City were collected using plankton net and the particles trapped was washed into a plastic bottle. Zooplankton samples were collected by dropping and pulling plankton net with mesh size of 0.063mm vertically on the surface of the river. A weight (iron rod) was attached to the cord holding the net; it was lowered into the river and then pulled back to the surface for collection. The samples were preserved with 10% formalin, labeled and stored for identification in the laboratory. Phytoplankton sample collection was done by lowering the plankton net to 0.5m on the water surface and towed (horizontally) on the waterway at a speed of about 1.5knots per hour for 5 minutes.

Plate 4.8: Plankton Sampling At Kainji Lake

4.2.3.7 Benthos

Benthic macro fauna samples were obtained by washing residual sediment samples through a 1 mm-mesh sieve using water obtained from the lake on board the sampling boat. The benthos samples obtained were placed in a plastic container and preserved in 20% buffered formal saline and stored in the ice coolers.

4.2.3.8 Air Quality / Noise

Air quality and ambient noise studies were conducted at 50 designated air quality / noise stations within the project area and a control point. Measurement methods and principles adopted for each parameter were based on sensitivity, stability, repeatability and capability for calibration during analysis. Fig 4.5 presents map of Project Area Showing Air Quality/Noise Level Measurement Points.

Plate 4.9: Air Quality/ Noise Level Measurement

4.2.3.9 Socio-economics / Health Studies

Socio-economic and health assessment involves studying affected host communities in Magama LGA. Information on socio-economics and community health data was acquired using household questionnaires as well as other relevant socio-economic and health survey Tools. Key informant interviews and focus group discussions, physical evaluation of health status as well as consultations with the various sections of the host communities provided relevant information on socio-economics and health profile of the area.

4.2.3.10 Laboratory Analysis

Laboratory analysis was generally in line with international American Society for Testing and Material (ASTM) and American Public Health Association (APHA) as well as FMENV Standard protocols. Quality Assurance/ Quality Control (QA/QC) measures adopted for laboratory analyses are in Accordance with FMEnv recommendations. Other QA/QC measures adopted are as follows:

- the use of trained personnel at all phases of the study;
- written analytical standard operating procedures were followed during analyses and
- routine auditing and checking of analyses results, including control solutions.

4.3 CLIMATE AND METEOROLOGY

Meteorological data were collated from the Nigerian Meteorological Department (NIMET), Abuja, for the Project Area covering 1983 -2018.

4.3.1 Pattern of Climate and Meteorology of the Study Area

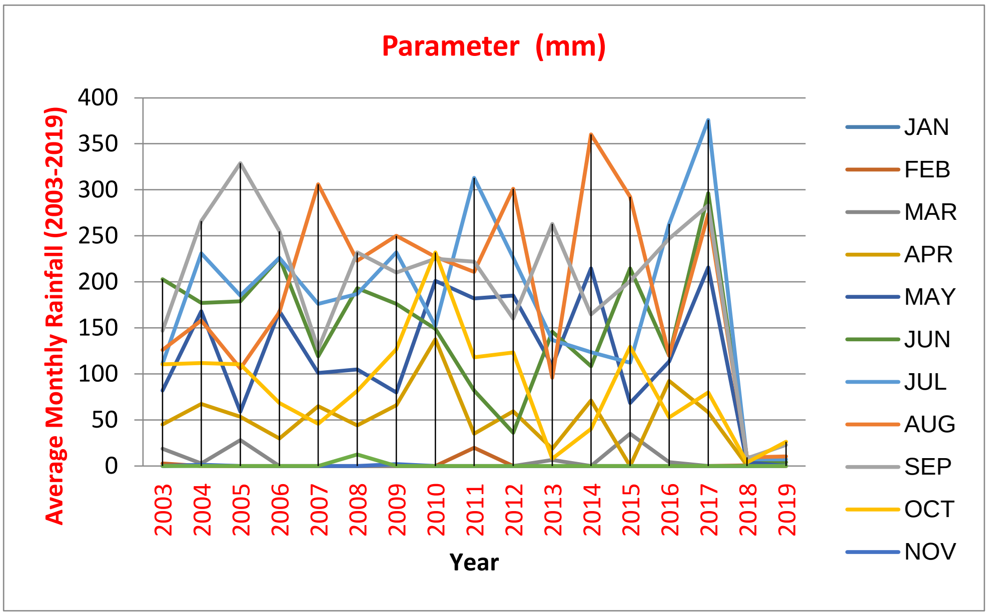
Niger State experiences distinct dry and wet seasons with annual rainfall varying from 1,100mm in the Northern part of the State to 1,600 mm in the southern parts. The maximum temperature is recorded between March and June, while the minimum is usually between December and January. The rainy season lasts for about 150 days in the Northern parts and about 120 days in the Southern parts of the State. Generally, the climate soil and hydrology of the State permit the cultivation of most of Nigeria's staple crops and still allows sufficient opportunities for grazing, fresh water fishing and forestry development with high temperature and humidity follows a tropical pattern with the raining season starting about April and ending in September, followed by dry season. The climate of the project area is tropics (i.e. semi-hot equatorial). It is controlled by latitudinal locations, prevailing (seasonal) winds and nearness to the Atlantic Ocean. There are two dominant air masses, namely:

- The dry north easterly winds otherwise referred to as the Tropical Continental air mass (cT) blows from across the Sahara, north of the West African region, and
- The wet south westerly winds otherwise referred to as Tropical Maritime air mass (mT) blows from across the Atlantic Ocean in the south.

Separating the two air masses is an Inter Tropical Convergence Zone (ITCZ), often referred to as Inter-Tropical Discontinuity (ITD) or Inter-tropical Front (ITF). The front oscillates with the apparent location of the sun towards the north and south of the equator thereby accounting for the dominant seasons of the area. Marginal alterations are also recorded due to other landform characteristics, especially the dominant ocean currents, configuration of surrounding shoreline and the generally flat topography of the region.

4.3.1.1 Rainfall

Rainy season is from April-September, while dry season is from October-March. Fig 4.6 shows the trend of rainfall in the area over a period (2003-2019). The average monthly rainfall ranges from 0.12mm to 375.6mm with a high proportion of the rain witnessed within the months of May and September. The northern part of the state is mainly of degraded forest vegetation (due intensive human activities which severely impacted the forest vegetation cover). The Central part falls in the rain forest belt while the southern part of the State has mangrove swamp vegetation type.

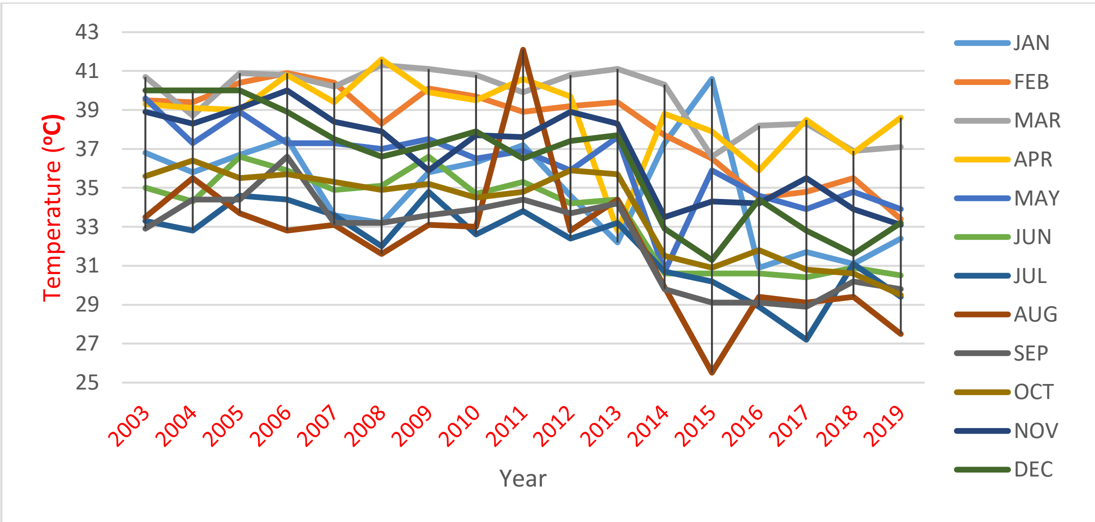


(NIMET 2020)

Fig 4.6: Mean Monthly Rainfall Pattern for the period, 2003-2019

4.3.1.2 Temperature

Temperature values are high throughout the year over the project environment. Fig 4.7 shows the Average Maximum Temperature Pattern for the Period (2003-2019). However, the temperature is usually higher during the dry season, while it is lower during the peak of the rainy season.

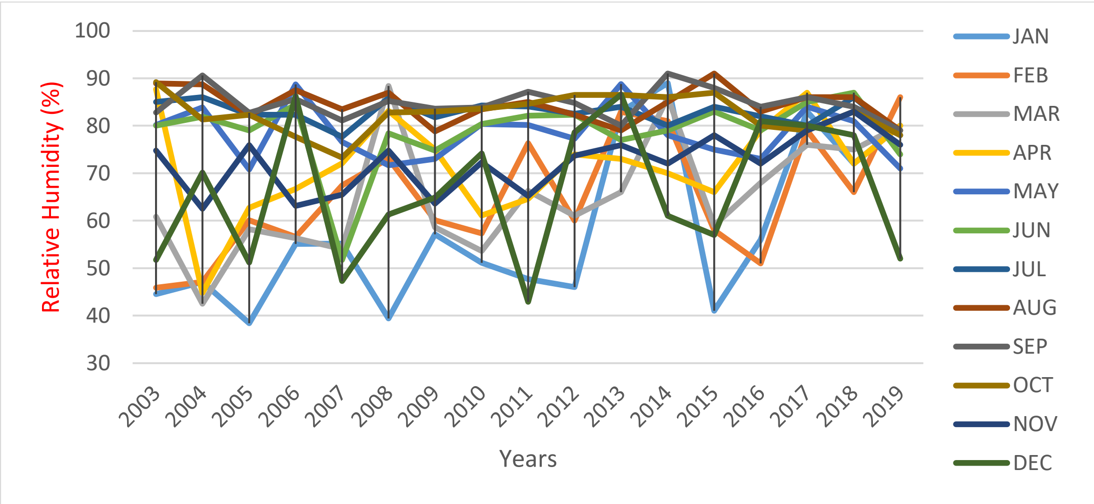


(NIMET 2020)

Fig 4.7: Average Maximum Temperature Pattern for the Period 2003-2019)

4.3.1.3 Relative Humidity (RH)

RH in the project area varies between 85% in the august and lowest January with 25%. The relative humidity is highest in august which is the highest rainy month and lowest in January where there is no rain fall. This is understandable given the geographical location been in the Guinea Savanah. It has two peaks within the year, namely, the highest peak, which occurs at peak of rainy season (July to October) and the lowest peak, which occurs at the peak of (dry season). Fig 4.8 shows the Average Relative Humidity of the study area for the period (2003-2019).



(NIMET 2020)

Fig 4.8: Average relative humidity for the period, 2003 – 2019

4.3.1.4 Wind speed

The average monthly wind speed of the project area is presented in Table 4.2. The North East trade wind is characterized by dry and low humidity weather during the dry season with dust and haze, while the South-West trade wind is responsible for rainfall. The wind speed in the area ranges from 0.12m/s to about 225.09m/s.

Table 4.2: Average Monthly Wind Speed (m/s) (2003-2019)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2003	168.50	145.32	184	218.1	212.36	149.10	144.30	126.04	110.12	112.22	100.2	156.22
2004	166.15	177.18	225.09	193.8	204.35	169.56	134.92	118.57	112.52	95.17	109.5	91.46
2005	213.58	247.56	166.78	157.8	209.32	23.30	133.30	102.05	89.27	110.36	97.5	88.37
2006	193.76	143.08	175.46	135.00	167.02	137.32	134.63	122.60	109.23	99.82	62.7	65.12
2007	186.61	145.88	192.82	135.5	151.95	217.78	149.12	112.26	101.92	113.15	85.5	48.35
2008	187.56	177.19	163.68	139.5	174.26	142.81	118.86	86.47	360.61	100.75	58.5	42.26

2009	104.48	69.16	73.78	73.53	48.41	111.05	78.10	29.15	29.70	126.48	29.4	29.46
2010	41.22	46.69	68.21	77.12	51.02	40.22	38.72	33.53	24.62	28.52	10.2	21.71
2011	64.49	212.24	39.06	72.01	74.98	53.29	44.52	32.51	28.97	21.08	7.2	23.86
2012	58.29	61.6	65.72	103.8	111.40	52.58	54.93	54.43	146.37	44.02	22.2	45.58
2013	100.42	93.8	103.53	164.4	143.16	121.23	72.66	72.84	45.33	33.48	33	64.46
2014	2.12	2.69	2.81	4.58	2.88	2.29	2.22	0.96	0.78	0.46	0.18	1.12
2015	2.32	1.07	1.04	0.69	2.03	1.34	2.71	1.21	1.89	1.67	2.23	5.92
2016	5.13	6.66	5.29	5.18	4.79	2.84	1.95	1.55	1.72	0.91	0.5	1.52
2017	2.49	2.47	2.52	4.33	3.54	2.87	1.25	2.54	1.55	1.05	0.52	1.93
2018	2.17	2.52	1.34	1.63	1.55	0.81	0.51	0.31	0.54	0.42	0.12	0.22
2019	0.12	0.37	0.31	0.18	1.13	0.55	0.37	0.21	0.35	0.18	0.07	0.06

Source: (NIMET 2020)

4.4 GEOLOGY AND SOILS

4.4.1 Geology

The project area is made of the Cretaceous sediments of the down faulted and failed rift that is the Benue Trough which occur in a series of sedimentary basins that extend north east of the confluence of the Niger and Benue Rivers, bounded by the Basement Complex strata to the north and south of the Benue River. The Lower Benue Basin consists of shales, silts and silty shales with subordinate sandstones and limestone's intruded by dolerite dykes.

The Upper Benue Basin consists of a thick succession of continental sandstones overlain by marine and estuarine deposits. The basal formation is the Bima Sandstone. The Bida Basin runs North West from the confluence of Niger and Benue rivers from the Anambra Basin in the southeast and to the northwest towards the Sokoto Basin. The basin contains Cretaceous age mainly continental sandstones, siltstones, claystones and conglomerates. The Middle Niger Basin at the confluence of the Niger and Benue rivers, contains 500 to 1000m of increasingly marine sediments. Quaternary to Recent age alluvial deposits occur along the main river valleys. These deposits range from thin discontinuous sands to thick alluvial deposits up to 15 km wide and 15 to 30 m thick along the Niger and Benue rivers. The alluvial deposits include gravel, coarse and fine sand, silt and clay. Thin deposits of unconsolidated and mixed sands and gravels occur along the courses of ephemeral Fadamas in northern Nigeria. Fig 4.9 shows topographic map of project Area.

Geomorphology

Geologically, Project area is underlain by sedimentary and undifferentiated Basement Complex of mainly Gneiss, magmatite and schist (Obaje, 2006). It is characterized by sandstones and alluvial deposits. The project area is characterized by low relief with minor rock outcrops and has a gentle undulating surface. The project site ranges from flat to gentle slope thereby directing natural drainage from the north to the south.

4.4.2 Soils

Soil types

Soils in the study area are ferruginous tropical soils and are hydromorphic in depressions and valley bottom positions, while those around the inselbergs and other residual hills, and at the bed of rivers, are weakly developed soils (Jaiyeoba and Essoka, 2006). There are some poor sandy soils in Niger State; the soil is generally fabric with a good number of streams and rivers with fertile valley. Over 90% of soil in Niger state is underlain by Nupe sand stone, and the rest is by basement complex. The areas are underlain by Upland soil and Depositional soils.

Up land soils: The soils are generally acidic, they are either loamy sand or sandy loams which are easily degradable and cannot sustain high yield for long period of use.

Depositional soils: This is also not fertile and unsuitable for agriculture, which is a coarse sand or sandy clay. Therefore, the coarse soil is different in their capacity to retain moisture against the pull exerted by gravity and by plant roots. These coarse soils such as those consisting of mostly sand, tend to hold water less than those with finer texture, such as those with a greater proportion of clays, these make the soils in the project area.

Niger state is also prone to erosion because of its historical farming background, as constant tilling and plugging of soil, uphill or downhill. Others include grazing and engineering construction each of which involves clearing of vegetation. The effect of this activity is quickly felt, for instance, when scanty vegetation is soon destroyed by over grazing, over cultivation leading to the exposure of soil to the full erosive forces by water and wind. The process makes the soil particles loosen and rainfall or wind could wash or move away the top soil surface and make the area unproductive and unsuitable for agricultural activities. Soil forms the basic natural resources and the living soil provide the mechanism for making the plant hospitable. There is also a presence of soils ferrasol which follows the bed of sedimentary rocks with free iron oxide profile characteristics from the forest regions to south eastern part of the dry savanna region. And because of it, red and yellow sand interact with clay deposit. Organic matters in the past are high, but now seem to be broken up and deeply eroded. The ferrasols loams and sandy loam are easily cultivated under traditional agriculture, but suffer from an extensive internal drainage and intense leaching and giving the soil a strong reaction. The loose sandy soil has broken down structurally as a result of over-cultivation, soils have washed down the slopes leaving fragments of degraded lateritic scattering over the land surface.

Though the Nupe sand soils (which are dark reddish brown) are less leached because of the lower mean rainfall and also because of low population densities which have made it possible for longer fallow periods and richer organic matter supply, but presently these advantages have been lost eventually with rising population. Except new management technique are employed to reduce the stress on the soil which may lead to erosion, their texture which is lateritic sandy loam can affect many other physical chemical properties of the particle size. The soils in the area, because of their behaviour, their consistency is slightly sticky and some break up when exposed. All these factors mentioned above make the soils in Niger state prone to erosion.

4.5 AIR QUALITY/NOISE LEVEL ASSESSMENT

The air quality/noise level assessment is presented in table 4.3 for wet season and table 4.4 for dry season below.

Table 4.3: Air Quality/Noise Level Measurement (Wet Season)

ID	Sample Points	NO_2 Ppm	SO_2 Ppm	CO Ppm	H2S Ppm	VOCs	Noise dB(A)	SPM mg/ m^3	Temp. 0C
1	AMAQ 1	0.01	0.01	0.1	0	0.0	55.8	0.19	36.5
2	AMAQ 2	0.01	0.01	0.2	0	0.0	55.0	0.19	36.5
3	AMAQ 3	0.01	0.00	1.2	0	0.0	40.7	0.18	36.5
4	AMAQ 4	0.01	0.01	1.0	0	0.0	48.0	0.19	37.0
5	AMAQ 5	0.01	0.01	1.0	0	0.0	45.5	0.17	37.5
6	AMAQ 6	0.01	0.01	1.0	0	0.1	47.3	0.19	37.1
7	AMAQ 7	0.01	0.01	1.0	0	0.0	46.5	0.19	37.5
8	AMAQ 8	0.01	0.01	0.2	0	0.0	50.0	0.18	36.6
9	AMAQ 9	0.01	0.00	0.3	0	0.0	50.5	0.19	36.3
10	AMAQ 10	0.01	0.00	1.0	0	0.0	42.5	0.20	36.5
11	AMAQ 11	0.01	0.00	1.2	0	0.0	50.8	0.20	36.5
12	AMAQ 12	0.01	0.00	1.2	0	0.0	40.5	0.20	36.6
13	AMAQ 13	0.01	0.00	1.0	0	0.0	43.6	0.20	36.7
14	AMAQ 14	0.01	0.00`	1.0	0	0.0	50.0	0.20	36.7
	AMAQ 15	0.01	0.00	1.2	0	0.0	48.2	0.20	36.5

15									
16	AMAQ 16	0.01	0.00	1.2	0	0.0	40.9	0.20	37.2
17	AMAQ 17	0.01	0.00	1.0	0	0.0	50.5	0.20	378
18	AMAQ18	0.01	0.00	1.0	0	0.0	50.6	0.20	36.9
19	AMAQ19	0.01	0.01	0.8	0	0.0	44.4	0.20	36.7
20	AMAQ20	0.01	0.00	0.9	0	0.0	46.8	0.20	36.3
21	AMAQ21	0.01	0.00	1.0	0	0.0	45.7	0.20	37.0
22	AMAQ22	0.01	0.00	1.2	0	0.0	48.4	0.21	36.8
23	AMAQ23	0,01	0.00	0.5	0	0.0	54.8	0.21	36.6
24	AMAQ24	0.01	0.01	1.1	0	0.0	50.4	0.21	37.6
25	AMAQ25	0.01	0.00	1.1	0	0.0	48.6	0.21	37.4
26	AMAQ26	0.02	0.00	1.1	0	0.0	52.6	0.21	37.6
27	AMAQ27	0.01	0.00	1.0	0	0.0	48.5	0.21	37.5
28	AMAQ28	0.01	0.01	1.0	0	0.0	47.9	0.21	37.6
29	AMAQ29	0.01	0.00	1.1	0	0.0	50.1	0.20	37.5
30	AMAQ30	0.01	0.00	0.8	0	0.0	46.8	0.20	37.4
31	AMAQ31	0.01	0.00	1.2	0	0.0	48.4	0.20	37.4
32	AMAQ32	0.01	0.00	1.0	0	0.0	50.8	0.20	37.2
33	AMAQ33	0.01	0.00	1.0	0	0.0	54.8	0.20	37.3
34	AMAQ34	0.01	0.01	0.2	0	0.0	40.4	0.20	37.2
35	AMAQ35	0.01	0.00	0.2	0	0.0	42.6	0.20	37.6
36	AMAQ36	0.01	0.01	1.0	0	0.0	44.8	0.20	37.6
37	AMAQ37	0.01	0.00	0.1	0	0.0	40.4	0.22	37.6
38	AMAQ38	0.01	0.00	0.2	0	0.0	52.4	0.21	37.5
39	AMAQ39	0.01	0.00	1.0	0	0.0	50.0	0.20	37.4
40	AMAQ40	0.01	0.00	0.3	0	0,0	47.8	0.21	37.4
41	AMAQ41	0.01	0.00	0.5	0	0.0	46.2	0.21	37.4
42	AMAQ42	0.02	0.00	1.0	0	0.0	48.6	0.22	37.3
43	AMAQ43	0.01	0.00	1.0	0	0.0	56.4	0.22	37.0
44	AMAQ44	0.01	0.00	1.0	0	0.0	58.2	0.21	37.0
45	AMAQ45	0.02	0.00	1.0	0	0.0	60.1	0.21	37.0
46	AMAQ46	0.01	0.00	0.3	0	0.0	45.6	0.21	37.0
47	AMAQ47	0.01	0.00	0.1	0	0.0	47.8	0.20	36.8

48	AMAQ48	0.01	0.00	0.1	0	0.0	50.8	0.21	36.5
49	AMAQ49	0.01	0.01	0.1	0	0.0	50.0	0.21	36.6
50	AMAQ50	0.01	0.00	0.2	0	0.0	48.4	0.20	36.7
51	AMAQ51 (Control)- after Guwana Community	0.01	0.00	0.1	0	0.0	58.8	0.11	**36.8**
	FMEnv. Limit	**0.04-0.06**	**0.01**	**10**	**3-160**	**3-160**	**90**	**0.25**	**NS**

Table 4.4: Air Quality/Noise Level Measurement (Dry Season)

ID	Sample Points	NO_2 Ppm	SO_2 Ppm	CO Ppm	H2S Ppm	VOCs	Noise dB(A)	SPM mg/m^3	Temp. 0C
1	AMAQ 1	0.01	0.00	0.0	0.0	0.0	43.5	0.43	33.2
2	AMAQ 2	0.01	0.00	0.0	0.0	0.0	45.0	0.44	32.5
3	AMAQ 3	0.01	0.00	0.0	0.0	0.0	42.3	0.43	32.0
4	AMAQ 4	0.01	0.00	0.0	0.0	0.0	46.1	0.48	31.1
5	AMAQ 5	0.01	0.00	0.0	0.0	0.0	45.0	0.47	32.5
6	AMAQ 6	0.008	0.00	0.0	0.0	0.0	42.6	0.69	32.1
7	AMAQ 7	0.01	0.00	0.0	0.0	0.0	41.5	0.54	33.2
8	AMAQ 8	0.03	0.00	0.0	0.0	0.0	46.0	0.49	34.6
9	AMAQ 9	0.01	0.00	0.0	0.0	0.0	45.3	0.55	33.4
10	AMAQ 10	0.01	0.00	0.0	0.0	0.0	43.2	0.50	33.0
11	AMAQ 11	0.01	0.00	0.0	0.0	0.0	46.5	0.50	35.2
12	AMAQ 12	0.01	0.00	0.0	0.0	0.0	42.5	0.52	35.9
13	AMAQ 13	0.03	0.00	0.0	0.0	0.0	43.5	0.50	36.0
14	AMAQ 14	0.02	0.00`	0.0	0.0	0.0	46.0	0.50	36.1
15	AMAQ 15	0.01	0.00	0.0	0.0	0.0	48.5	0.51	36.0
16	AMAQ 16	0.01	0.00	0.0	0.0	0.0	40.9	0.55	36.4
17	AMAQ 17	0.05	0.00	0.0	0.0	0.0	40.5	0.53	35.8
18	AMAQ18	0.07	0.00	0.0	0.0	0.0	40.6	0.53	34.7
19	AMAQ19	0.008	0.00	0.0	0.0	0.0	44.9	0.50	34.7
20	AMAQ20	0.01	0.00	0.0	0.0	0.0	45.8	0.50	34.3
21	AMAQ21	0.01	0.00	0.0	0.0	0.0	45.5	0.53	34.0
22	AMAQ22	0.01	0.00	0.0	0.0	0.0	45.6	0.56	34.8
23	AMAQ23	0,01	0.00	0.0	0.0	0.0	42.8	0.65	34.6

24	AMAQ24	0.01	0.00	0.0	0.0	0.0	40.4	0.60	34.6
25	AMAQ25	0.01	0.00	0.0	0.0	0.0	41.5	0.41	35.0
26	AMAQ26	0.02	0.00	0.0	0.0	0.0	42.3	0.45	34.6
27	AMAQ27	0.01	0.00	0.0	0.0	0.0	44.5	0.48	35.2
28	AMAQ28	0.009	0.00	0.0	0.0	0.0	42.9	0.49	33.6
29	AMAQ29	0.02	0.00	0.0	0.0	0.0	49.0	0.50	33.8
30	AMAQ30	0.01	0.00	0.0	0.0	0.0	45.2	0.56	33.2
31	AMAQ31	0.01	0.00	0.0	0.0	0.0	46.5	0.49	33.6
32	AMAQ32	0.01	0.00	0.0	0.0	0.0	47.8	0.46	33.5
33	AMAQ33	0.01	0.00	0.0	0.0	0.0	50.3	0.48	33.3
34	AMAQ34	0.01	0.00	0.0	0.0	0.0	40.4	0.45	33.1
35	AMAQ35	0.008	0.00	0.0	0.0	0.0	42.6	0.50	34.0
36	AMAQ36	0.01	0.00	0.0	0.0	0.0	44.8	0.49	33.5
37	AMAQ37	0.01	0.00	0.0	0.0	0.0	40.4	0.55	33.2
38	AMAQ38	0.01	0.00	0.0	0.0	0.0	42.4	0.55	33.3
39	AMAQ39	0.005	0.00	0.0	0.0	0.0	50.0	0.52	32.3
40	AMAQ40	0.01	0.00	0.0	0.0	0.0	47.8	0.51	33.4
41	AMAQ41	0.01	0.00	0.0	0.0	0.0	46.2	0.48	34.8
42	AMAQ42	0.002	0.00	0.0	0.0	0.0	48.6	0.52	33.5
43	AMAQ43	0.009	0.00	0.0	0.0	0.0	50.2	0.50	32.0
44	AMAQ44	0.01	0.00	0.0	0.0	0.0	50.3	0.44	32.3
45	AMAQ45	0.043	0.00	0.0	0.0	0.0	49.1	0.45	32.0
46	AMAQ46	0.01	0.00	0.0	0.0	0.0	45.2	0.53	32.0
47	AMAQ47	0.007	0.00	0.0	0.0	0.0	47.2	0.50	33.8
48	AMAQ48	0.01	0.00	0.0	0.0	0.0	50.8	0.51	33.5
49	AMAQ49	0.01	0.00	0.0	0.0	0.0	50.0	0.51	33.6
50	AMAQ50	0.046	0.00	0.0	0.0	0.0	48.4	0.60	33.7
51	AMAQ51 (Control)- after Guwana Community	0.033	0.00	1.3	0	0.0	58.8	0.81	33.5
	FMEnv. Limit	**0.04-0.06**	**0.01**	**10**	**3-160**	**3-160**	**90**	**0.25**	**NS**

The above air quality result shows that the concentration of key contaminants (SOx, NOx, CO, N_2S, VOC_S and SPM Temp, Noise) fall below the Federal Ministry of Environment's regulatory limits. Except for NO_2 on sample point 18 during the dry season.

Nitrogen Dioxide (NO2)

Breathing air with a high concentration of NO_2 can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms. Longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of NO_2. Recorded NO_2 values over the course of this AQ assessment shows that the area is void of NO_2 pollution as they were all below FMEnv limit of 0.04- 0.06 ppm except for sample point 18 of dry season.

Noise level

Digital sound level meter was used to measure the noise level at all the sampling locations. The equipment measures noise level via a microphone probe that generates signals approximately proportional to located sound waves. Measurements were done by directing the probe towards the direction of the prevailing sound and the reading recorded from the digital meter in decibels dB (A).

4.6 SURFACE/GROUND WATER ASSESSMENT

Surface water samples were taken from Kainji lake bordering the project site and a stream within the project site, while ground water samples were taken from the project area. Tables 4.5 and 4.6 respectively below presents the results of the surface water parameters recorded for dry and wet seasons respectively. Results of groundwater are presented in Tables 4.7 and 4.8 for wet and dry seasons respectively.

Table 4.5: Physical Parameters of Surface Water Sample (Dry Season)

PARAMETER	UNIT OF MEASUREMENT	AMSW1	AMSW2	AMSW3	AMSW4	AMSW5	AMSW6	AMSW7	AMSW8
Temperature	°C	30.00	29.20	29.14	29.40	29.60	29.80	29.60	29.50
Conductivity	µS/cm	81.00	86.30	48.00	45.26	180.24	50.27	74.28	140.79
Ph		5.60	5.14	5.80	5.54	6.40	5.66	6.40	5.39
Colour	Pt-Co	300.12	274.12	321.28	330.80	361.41	241.22	311.30	247.44
Total Dissolved Solids	mg/L	39.53	42.11	23.42	22.09	87.96	24.53	36.25	68.71
Turbidity	FNU	6.54	13.27	24.25	21.28	78.65	61.44	28.56	7.69
Dissolved Oxygen	mg/L	6.40	6.60	6.20	6.00	6.20	6.50	6.40	6.70
Total Suspended Solids	mg/L	2.01	2.70	1.82	2.44	2.97	2.80	3.01	0.99
Total Solids	mg/L	41.54	44.81	25.24	24.53	90.93	27.33	39.26	69.70
Total Hardness	mg/L	62.45	63.15	63.02	95.32	126.28	77.13	65.93	54.23
Oil and Grease	mg/L	1.03	1.24	3.60	2.45	2.89	1.86	3.00	0.30
Phosphate	mg/L	0.83	0.45	0.21	0.07	1.22	0.95	1.05	0.17
Nitrate	mg/L	2.80	3.26	4.01	3.08	8.11	2.40	4.26	1.47
Nitrite	mg/L	0.10	0.21	0.06	0.20	0.71	0.50	0.14	0.20
Ammonia	mg/L	0.20	0.50	0.41	0.35	2.16	0.92	0.64	0.50
Sulphate	mg/L	0.30	0.70	5.60	6.11	18.95	17.25	11.28	0.62
Chloride	Ppt	69.25	36.25	68.47	100.28	120.45	61.11	68.33	60.08
Salinity	Ppt	0.01	0.02	0.01	0.03	0.61	0.02	0.03	0.04

Calcium Hardness	mg/L	40.58	50.53	45.60	62.65	80.95	47.93	45.68	37.48
Magnesium Hardness	mg/L	21.88	12.63	17.42	32.67	45.33	29.21	20.25	16.75
Potassium	mg/L	1.50	1.40	1.24	2.80	2.44	2.05	1.68	1.36
Sodium	mg/L	1.74	1.48	1.09	1.55	1.39	2.00	2.11	1.71
Calcium	mg/L	16.23	20.21	18.24	25.06	32.38	19.17	18.27	14.99
Magnesium	mg/L	5.25	3.03	4.18	7.84	10.88	7.01	4.86	4.02
Chromium	mg/L	0.20	0.05	0.04	0.10	0.02	0.03	0.01	0.01
Copper	mg/L	ND	ND	ND	ND	0.04	ND	ND	ND
Iron	mg/L	0.30	0.31	0.34	0.17	0.10	0.09	0.38	0.62
Zinc	mg/L	ND	0.02	0.03	ND	0.01	ND	0.02	ND
Lead	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.02	0.10	0.05	0.20	0.04	0.02	0.07	0.10
Cadmium	mg/L	0.07	0.03	ND	ND	ND	ND	ND	ND
Mercury	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	ND	ND	0.03	0.07	ND	0.02	ND
	Microbial Properties								
Total Heterotrophic Bacteria Count	CFU/Ml	1.00 x10^1	2.00 x10^1	1.00 x10^1	4.00 x10^1	2.00 x10^1	3.00 x10^1	3.00 x10^1	2.00 x10^1
Total Heterotrophic Fungi	CFU/Ml	1.60	0.80	1.80	2.00	1.60	2.10	2.20	3.00

Hydrocarbon Utilizing Bacteria	CFU/Ml	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Hydrocarbon Utilizing Fungi	CFU/Ml	3.00	3.00	4.00	2.00	3.00	4.00	2.00	3.00

Table 4.5: Physical Parameters of Surface Water Sample (Dry Season) Continues

PARAMETER	UNIT OF MEASUREMENT	AMSW9	AMSW10	AMSW11	AMSW12	AMSW13	AMSW14	AMSW15	AMSWC1
Temperature	°C	30.10	29.80	29.50	29.40	29.60	29.10	29.20	29.40
Conductivity	µS/cm	94.28	60.75	70.14	160.23	67.30	90.27	87.29	56.33
Ph		6.10	6.30	5.90	6.20	6.40	7.60	7.80	7.56
Colour	Pt-Co	142.15	71.25	95.68	102.47	80.24	96.36	87.45	45.51
Total Dissolved Solids	mg/L	46.01	29.65	34.23	78.19	32.84	44.05	42.60	27.49
Turbidity	FNU	10.24	17.17	19.23	21.17	7.63	8.21	23.33	2.15
Dissolved Oxygen	mg/L	6.30	6.70	6.60	6.20	6.50	6.80	6.40	6.30
Total Suspended Solids	mg/L	1.55	1.42	2.87	4.00	4.11	5.20	1.56	0.41
Total Solids	mg/L	47.56	31.07	37.10	82.19	36.95	49.25	44.16	27.90
Total Hardness	mg/L	64.44	60.86	90.02	115.14	75.38	74.56	62.73	34.08
Oil and Grease	mg/L	60.86	0.14	0.03	0.84	0.01	0.04	0.01	ND

Phosphate	mg/L	90.02	0.50	0.04	1.02	0.22	0.09	0.02	0.01
Nitrate	mg/L	115.14	2.63	1.24	4.13	3.68	4.25	5.02	2.54
Nitrite	mg/L	75.38	0.02	0.05	0.44	0.08	0.90	0.07	0.03
Ammonia	mg/L	74.56	0.01	0.03	0.07	0.04	0.08	0.02	0.02
Sulphate	mg/L	62.73	5.12	7.18	4.03	3.56	4.00	3.12	1.22
Chloride	Ppt	34.08	54.40	66.06	54.40	62.18	42.75	46.63	38.86
Salinity	Ppt	0.03	0.01	0.01	0.03	0.02	0.03	0.03	0.01
Calcium Hardness	mg/L	50.90	45.65	65.98	68.10	48.80	43.10	48.40	28.25
Magnesium Hardness	mg/L	13.54	15.21	24.04	47.04	26.58	31.46	14.33	5.83
Potassium	mg/L	1.03	1.70	1.52	2.11	1.74	1.22	2.60	0.60
Sodium	mg/L	1.04	0.92	1.47	1.56	1.80	1.24	1.72	1.00
Calcium	mg/L	20.36	18.26	26.39	27.24	19.52	17.24	19.36	11.30
Magnesium	mg/L	3.25	3.65	5.77	11.29	6.38	7.55	3.44	1.40
Chromium	mg/L	ND	0.03	0.04	0.02	0.06	0.09	0.05	0.01
Copper	mg/L	ND	ND	ND	0.02	ND	ND	ND	ND
Iron	mg/L	1.24	1.02	0.84	0.23	0.11	0.51	0.64	0.02
Zinc	mg/L	ND	0.05	ND	ND	0.01	ND	ND	ND
Lead	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.01	0.02	0.20	0.03	0.11	0.20	0.12	ND
Cadmium	mg/L	ND	ND	0.03	ND	0.04	ND	0.03	ND
Mercury	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	mg/L	ND	ND	ND	ND	ND	ND	ND	ND

Manganese	mg/L	0.04	ND	0.01	0.06	0.03	0.01	ND	0.02
	Microbial Properties								
Total Heterotrophic Bacteria Count	CFU/Ml	3.00 x10^{1}	4.00 x10^{1}	2.00 x10^{1}	1.00 x10^{1}	4.00 x10^{1}	3.00 x10^{1}	1.00 x 10^{1}	1.00 x 10^{1}
Total Heterotrophic Fungi	CFU/Ml	21.30	2.40	2.80	3.10	1.70	1.60	2.00	1.00
Hydrocarbon Utilizing Bacteria	CFU/Ml	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Hydrocarbon Utilizing Fungi	CFU/Ml	3.00	2.00	3.00	1.00	4.00	5.00	3.00	1.00

Table 4.6: Physical Parameters of Surface Water Sample (Wet Season)

PARAMETER	UNIT OF MEASUREMENT	AMSW1	AMSW2	AMSW3	AMSW4	AMSW5	AMSW6	AMSW7	AMSW8
Temperature	Oc	29.50	29.30	30.00	29.70	30.10	29.60	29.40	28.95
Conductivity	µS/cm	79.00	81.20	44.20	43.60	172.10	45.63	65.41	123.40
Ph		5.38	5.36	5.41	5.45	6.00	5.56	6.00	5.22
Colour	Pt-Co	340.00	305.00	350.00	350.00	2250.00	257.00	326.00	251.20
Total Dissolved Solids	mg/L	36.00	37.50	20.00	20.00	92.70	21.30	30.48	57.50

Turbidity	FNU	9.60	12.80	20.20	20.10	89.00	65.30	30.40	8.15
Dissolved Oxygen	mg/L	6.10	6.20	6.00	6.10	7.00	6.20	6.20	6.40
Total Suspended Solids	mg/L	2.35	3.41	2.58	3.62	4.15	3.54	4.55	1.45
Total Solids	mg/L	38.35	40.91	22.58	23.62	96.85	24.84	35.03	58.95
Total Hardness	mg/L	56.80	60.20	60.40	88.20	120.00	71.50	62.60	52.90
Oil and Grease	mg/L	2.98	1.63	5.82	3.11	3.97	2.45	3.14	0.50
Phosphate	mg/L	0.15	0.27	0.10	0.21	1.64	1.24	1.60	0.14
Nitrate	mg/L	2.72	3.11	3.82	2.96	7.99	2.35	4.15	1.28
Nitrite	mg/L	0.04	0.05	0.04	0.03	1.02	0.04	0.06	0.10
Ammonia	mg/L	0.17	0.4	0.25	0.21	3.15	0.12	0.16	0.01
Sulphate	mg/L	0.00	0.00	4.70	5.40	20.40	15.20	10.11	0.10
Chloride	Ppt	64.39	34.86	64.22	98.01	116.30	58.97	65.40	58.29
Salinity	Ppt	0.03	0.03	0.02	0.02	0.55	0.06	0.04	0.02
Calcium Hardness	mg/L	38.80	49.20	44.00	60.20	76.20	45.20	43.70	36.70
Magnesium Hardness	mg/L	18.00	11.00	16.40	28.00	43.80	26.30	18.90	16.20
Potassium	mg/L	1.22	1.11	1.25	2.12	2.33	1.87	1.27	1.20
Sodium	mg/L	1.60	1.20	0.89	1.34	1.24	1.56	1.81	1.40
Calcium	mg/L	15.52	19.68	17.60	24.08	30.48	18.08	17.48	14.68
Magnesium	mg/L	4.32	2.64	3.94	6.72	10.51	6.31	4.54	3.89
Chromium	mg/L	0.10	0.03	0.07	0.09	0.02	0.04	0.03	0.02
Copper	mg/L	ND	ND	ND	ND	0.02	0.01	ND	ND

Iron	mg/L	0.41	0.25	0.32	0.14	0.08	0.06	0.33	0.51
Zinc	mg/L	ND	0.01	0.02	0.03	ND	ND	0.02	ND
Lead	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.01	0.01	0.03	0.10	0.04	0.03	0.05	0.01
Cadmium	mg/L	0.02	0.01	ND	ND	0.01	ND	ND	0.02
Mercury	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Vanaduim	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.02	ND	0.10	0.04	0.12	ND	0.01	0.02
	Microbial Properties								
Total Heterotrophic Bacteria Count	CFU/Ml	2.00 $\times10^1$	4.00 $\times10^1$	2.00 $\times10^1$	6.00 $\times10^1$	3.00 $\times10^1$	5.00 $\times10^1$	4.00 $\times10^1$	4.00 $\times10^1$
Total Heterotrophic Fungi	CFU/Ml	2.10	1.10	2.10	2.20	3.00	2.50	2.60	3.20
Hydrocarbon Utilizing Bacteria	CFU/Ml	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Hydrocarbon Utilizing Fungi	CFU/Ml	4.00	2.00	5.00	3.00	3.00	6.00	4.00	4.00

PARAMETER	UNIT OF MEASUREMENT	AMSW 9	AMSW10	AMSW11	AMSW12	AMSW13	AMSW14	AMSW15	AMSWC1
Temperature	oC	29.10	28.70	29.60	29.30	29.40	29.14	28.77	29.21
Conductivity	µS/cm	90.10	56.80	68.70	157.25	65.38	89.80	84.24	54.26

Ph		5.50	5.80	5.60	6.40	5.80	7.20	7.32	7.45
Colour	Pt-Co	154.01	87.60	124.60	228.20	147.00	130.40	120.46	64.30
Total Dissolved Solids	mg/L	41.99	26.47	32.01	73.28	30.47	41.85	39.26	25.29
Turbidity	FNU	14.21	22.14	24.28	26.41	12.40	10.25	25.24	4.25
Dissolved Oxygen	mg/L	6.20	6.70	6.80	6.40	6.60	6.50	7.00	6.40
Total Suspended Solids	mg/L	2.87	1.69	3.14	4.25	5.80	6.21	2.22	1.01
Total Solids	mg/L	44.86	28.16	35.15	77.53	36.27	48.06	41.48	26.30
Total Hardness	mg/L	59.20	55.10	82.50	109.30	68.70	67.40	62.12	31.14
Oil and Grease	mg/L	0.60	0.21	0.06	1.20	0.03	0.30	0.04	0.01
Phosphate	mg/L	0.07	0.06	0.03	0.09	0.12	0.07	0.06	0.03
Nitrate	mg/L	1.60	2.80	1.11	4.25	3.56	4.70	5.21	2.45
Nitrite	mg/L	0.10	0.04	0.08	1.55	0.40	0.61	0.14	0.02
Ammonia	mg/L	0.02	0.02	0.05	0.04	0.06	0.07	0.03	0.01
Sulphate	mg/L	0.00	4.50	6.20	4.10	3.27	3.44	2.96	1.55
Chloride	Ppt	46.63	69.95	50.52	69.95	34.97	38.86	54.40	31.09
Salinity	Ppt	0.03	0.02	0.03	0.04	0.01	0.02	0.02	0.01
Calcium Hardness	mg/L	46.80	40.60	62.30	66.60	44.10	40.80	50.22	25.60
Magnesium Hardness	mg/L	12.40	14.50	20.20	42.70	24.60	26.60	11.90	5.54
Potassium	mg/L	0.94	1.52	1.39	1.87	1.44	1.02	2.00	0.45
Sodium	mg/L	1.01	0.62	1.28	1.10	1.23	1.04	1.55	0.96

Calcium	mg/L	18.72	16.24	24.92	26.64	17.64	16.32	20.09	10.24
Magnesium	mg/L	2.98	3.48	4.85	10.25	5.90	6.38	2.86	1.33
Chromium	mg/L	0.01	0.01	0.03	0.04	0.05	0.07	0.04	ND
Copper	mg/L	ND	ND	ND	ND	0.01	ND	ND	ND
Iron	mg/L	0.39	0.47	0.52	0.09	0.14	0.10	0.15	0.03
Zinc	mg/L	0.01	0.02	ND	ND	ND	0.02	ND	ND
Lead	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.20	0.10	0.03	0.05	0.04	0.02	0.01	ND
Cadmium	mg/L	ND	0.01	ND	ND	0.01	ND	0.02	ND
Mercury	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Vanaduim	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	ND	0.02	0.05	0.02	0.01	ND	0.01
	Microbial Properties								
Total Heterotrophic Bacteria Count	CFU/Ml	2.00 x10^{1}	5.00 x10^{1}	3.00 x10^{1}	2.00 x10^{1}	6.00 x10^{1}	4.00 x10^{1}	3.00 x 10^{1}	1.00 x 10^{1}
Total Heterotrophic Fungi	CFU/Ml	2.40	3.60	2.10	4.50	1.30	2.80	3.00	1.00 x 10^{1}
Hydrocarbon Utilizing Bacteria	CFU/Ml	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Hydrocarbon Utilizing Fungi	CFU/Ml	2.00	4.00	5.00	2.00	6.00	7.00	8.00	2.00

Table 4.7: Ground Water Measurement (Wet Season)

PARAMETER	UNIT OF MEASUREMENT	AMGW1	AMGW2	AMGW3	AMGW4	AMGW5	AMGW6	AMGW7	AMGWC1
Temperature	oC	29.40	29.20	29.20	29.30	28.90	28.30	29.40	28.54
Conductivity	µS/cm	516.00	590.00	621.00	589.00	624.00	611.00	625.00	541.20
Ph		6.38	6.38	5.40	6.38	6.47	6.39	6.38	7.20
Colour	Pt-Co	3.00	4.00	5.00	4.00	4.00	5.00	5.00	2.00
Total Dissolved Solids	mg/L	240.46	274.94	289.39	274.47	290.78	284.73	291.25	252.20
Turbidity	FNU	1.00	0.80	3.00	1.20	2.00	1.00	1.40	0.70
Dissolved Oxygen	mg/L	6.20	6.40	6.50	6.40	6.20	6.80	6.30	6.80
BOD	mg/L	20.00	22.00	21.00	18.00	20.00	16.00	14.00	10.20
COD	mg/L	50.00	55.00	52.50	45.00	50.00	40.00	35.00	25.50
Total Suspended Solids	mg/L	39.80	12.10	16.10	152.00	14.60	13.40	12.70	2.45
Total Solids	mg/L	280.26	287.04	305.49	426.47	305.38	298.13	303.95	254.65
Total Hardness	mg/L	27.20	19.40	44.40	27.10	20.40	28.20	36.80	29.22
Oil and Grease	mg/L	0.09	0.00	0.02	0.01	ND	0.02	0.01	ND
Phosphate	mg/L	0.31	0.12	0.40	0.64	0.28	0.71	0.52	0.20
Nitrate	mg/L	0.92	2.97	1.26	1.20	0.80	0.67	1.40	0.41
Nitrite	mg/L	0.01	0.92	0.02	0.01	0.02	ND	0.01	0.03
Ammonia	mg/L	0	0.11	0.04	0.01	0.01	0.01	0.02	0.01

Sulphate	mg/L	0.00	0.00	5.00	6.15	4.50	6.70	4.80	4.77
Chloride	Ppt	16.32	14.69	24.69	31.09	34.97	38.86	46.63	27.20
Salinity	Ppt	0.23	0.26	0.27	0.24	0.35	0.42	0.39	0.35
Calcium Hardness	mg/L	24.00	17.00	32.00	24.00	18.00	22.00	32.00	24.05
Magnesium Hardness	mg/L	3.20	2.40	12.40	3.10	2.40	6.20	4.80	5.17
Potassium	mg/L	0.23	0.10	0.04	0.30	0.06	0.09	0.07	0.05
Sodium	mg/L	1.20	0.56	0.40	1.30	1.40	0.80	1.60	
Calcium	mg/L	9.60	6.80	12.80	9.60	7.20	8.80	12.80	9.62
Magnesium	mg/L	0.77	0.58	2.98	0.74	0.58	1.49	1.15	1.24
Chromium	mg/L	ND	0.01	ND	ND	ND	0.0.2	ND	ND
Copper	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Iron	mg/L	0.10	0.40	0.30	0.22	0.14	0.33	0.15	0.12
Zinc	mg/L	ND	ND	ND	0.01	ND	ND	0.02	ND
Lead	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.03	0.01	0.02	0.01	0.10	0.02	0.05	0.01
Cadmium	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Vanaduim	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	0.03	ND	ND	0.01	ND	0.01	0.02

Table 4.8: Ground Water Measurement (Dry Season)

PARAMETER	UNIT OF MEASUREMENT	AMGW1	AMGW2	AMGW3	AMGW4	AMGW5	AMGW6	AMGW7	AMGWC1
Temperature	oC	29.30	29.10	2.9.4	29.20	29.30	29.70	29.60	29.40
Conductivity	µS/cm	620.10	640.00	652.07	620.00	648.00	660.00	670.00	620.00
Ph		7.00	7.03	7.12	6.84	6.90	6.85	7.02	7.12
Colour	Pt-Co	1.20	2.00	2.14	3.20	1.80	2.60	2.70	1.05
Total Dissolved Solids	mg/L	297.65	307.20	312.99	297.60	311.04	316.80	321.60	297.60
Turbidity	FNU	0.65	0.40	1.20	0.80	1.40	0.50	1.00	0.90
Dissolved Oxygen	mg/L	6.40	6.30	6.50	6.40	6.60	6.70	6.20	6.40
BOD	mg/L	9.40	12.00	14.00	10.20	11.00	10.60	12.80	9.40
COD	mg/L	23.50	30.00	35.00	25.50	27.50	26.50	32.00	23.50
Total Suspended Solids	mg/L	2.60	2.80	1.50	2.40	3.40	1.90	4.10	3.20
Total Solids	mg/L	300.25	310.00	314.49	300.00	314.44	318.70	325.70	300.80
Total Hardness	mg/L	62.22	22.00	46.13	29.43	24.11	29.78	38.62	32.72
Oil and Grease	mg/L	ND	ND	0.01	ND	ND	ND	ND	ND
Phosphate	mg/L	0.03	0.01	0.02	0.10	0.20	0.04	0.17	0.06
Nitrate	mg/L	1.00	0.12	0.91	0.80	0.41	0.30	0.78	0.36
Nitrite	mg/L	ND	ND	ND	0.01	ND	ND	ND	0.01
Ammonia	mg/L	ND	ND	ND	ND	ND	ND	0.01	ND
Sulphate	mg/L	0.10	0.01	6.20	5.28	3.70	5.69	4.85	5.00
Chloride	Ppt	38.86	27.20	31.09	46.63	42.75	38.86	50.52	23.32

Salinity	Ppt	0.31	0.24	0.27	0.41	0.42	0.30	0.48	0.19
Calcium Hardness	mg/L	25.55	18.00	34.05	26.05	21.40	23.03	33.20	26.18
Magnesium Hardness	mg/L	36.67	4.00	12.08	3.38	2.71	6.75	5.42	6.54
Potassium	mg/L	0.30	0.12	0.06	0.27	0.12	0.11	0.10	0.40
Sodium	mg/L	1.40	1.00	0.90	1.40	1.60	1.08	2.00	0.12
Calcium	mg/L	10.22	7.20	13.62	10.42	8.56	9.21	13.28	10.47
Magnesium	mg/L	8.80	0.96	2.90	0.81	0.65	1.62	1.30	1.57
Chromium	mg/L	ND	0.01	ND	ND	ND	ND	ND	ND
Copper	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Iron	mg/L	0.20	0.60	0.10	0.80	0.16	0.41	0.21	0.50
Zinc	mg/L	ND	ND	ND	0.01	ND	ND	ND	ND
Lead	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.04	0.02	0.02	0.03	0.05	0.02	0.03	ND
Cadmium	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	mg/L	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.02	0.01	ND	ND	ND	0.03	ND	0.01

Summary results of water column measurements taken during the wet and dry season marine surveys are discussed below.

pH:

pH values were all in the slightly acidic for both surface and ground water, the range across the study area during both the rainy and dry seasons, with mean values ranging between 5.22 and 7.45 in the rainy season and 5.14 and 7.80 in the dry season for surface water while it ranges between 6.84 and 7.14 for dry season and 5.40 and 7.20 during the rainy season. pH values generally increased down through the water column.

Conductivity

Specific conductivity values observed were relatively high in the project area. Specific conductivity values ranged from 43.60 to 172.10 micro Siemens per centimetre (mS/cm) in the rainy season and 48.00 to 180.24 mS/cm in the dry season while for groundwater the values ranges from 620.00 to 670.00 mS/cm in the dry season and 516.00 and 625 mS/cm in the rainy season. The lower values for the rainy season are not surprising since these would be expected due to a lowering in values through dilution by freshwater sources and rainfall.

Total Dissolved Solids

TDS for surface water ranged between 20.00mg/l and 92.70mg/l during the wet season and 22.09 mg/l and 87.96mg/l during the dry season, while for groundwater the value ranges between 240.46mg/l and 291.25mg/l during the wet season and 297.60 mg/l and 321.67mg/l during the dry season.

Salinity

Average surface water salinity ranged between 0.001 and 0.55 parts per thousand (ppt) for the wet season and 0.01 and 0.61ppt for the dry season, for ground water salinity ranged between 0.23 and 0.42 parts per thousand (ppt) for the wet season and 0.19 and 0.48ppt for the dry season.

Dissolved Oxygen

DO was generally high across the study area. The mean values for surface water ranging from 6.0 to 7.0 mg/l in the rainy season and 6.00 to 6.70 mg/l in the dry season, while the mean value for ground water ranges from 6.2 to 6.80mg/l in the rainy season and 6.20 to 6.70 mg/l in the dry season. This indicates that the study area is very productive since none of the values dropped below 3.80 mg/l. During both seasons these values are indicative of a sunny and nutrient rich environment. DO availability is influenced by a number of factors such as temperature, salinity, turbulence, and primary productivity. During the rainy season an extensive increase of organic material is to be expected from this source in this near shore location thus explaining the rather large difference in DO levels between the two seasons.

Nitrate

Nitrate of surface water ranger between 1.11 to 7.99mg/l in the rainy season and 1.24 to 115.14mg/l for the dry season, the ground water range between 0.41 and 2.97mg/l for rainy season and 0.12 and 1.0 mg/l during the dry season. Nitrate is the most oxidized form of nitrogen compounds commonly present in streams. It is the end product of the aerobic decomposition of organic nitrogenous matter. Nitrate in surface water is nutrient taken up by plants and converted into cell proteins. The highest concentration of nitrate in the water sampled was 115.14mg/l which is above the FMEnv threshold of 20mg/l, every other measurement is within the threshold.

Metals and Heavy Metals

Metals are naturally present in water in dissolved state. The contact between water and rocks or soil is usually the principal source of metal ions both in surface and groundwater. Metals can also enter through discharges from sewage treatment plants, industrial plants, and other sources. The levels of metals in water or aquatic environment must be right in order not to induce adverse effect on plants and animals, and even humans who depend on such water. This is because certain metals, especially some trace and heavy metals such as alkylated mercury, lead, cadmium, arsenic have been reported to show high human and environmental toxicity even at very low concentrations. Generally, there are low concentration of heavy metal in the project area, among which are chromium, manganese, nickel, iron few point where zinc and cadmium are detected while vanadium, mercury and lead are not detected at the project site.

Surface Water Microbiology

Microbial analysis of the water sampled showed the presence of Total Heterotrophic Bacteria Count, Total Heterotrophic Fungi and Hydrocarbon Utilizing Fungi in the analysed sample indicating faecal contamination of surface water in the study area. Fungi and, Enterobacter were all found to be present in this sample. This may be attributed to human actions including grazing, washing and defecating near the Streams.

4.7 SEDIMENTS ASSESSMENTS

The sediments samples were taken from the stream within the project site and the Kainji Lake bordering the project site (from the same point in which surface water samples were collected). The dry and wet season parameter measurements for sediments are presented in tables 4.9 and 4.10 respectively below.

Table 4.9: Sediment Parameter Measurement (Dry Season)

PARAMETER	UNIT OF MEASUREMENT	AMSD1	AMSD2	AMSD3	AMSD4	AMSD5	AMSD6	AMSD7	AMSC1
pH		7.10	7.30	7.00	7.20	6.80	6.10	6.50	7.40
Nitrate	Ppm	33.28	48.10	51.24	56.39	62.37	46.31	62.33	32.24
Nitrite	Ppm	0.20	0.04	1.20	0.70	0.41	0.31	0.73	0.26
Phosphate	Ppm	31.47	75.69	46.35	38.99	56.34	40.87	71.58	12.66
Sulphate	Ppm	57.12	40.55	52.70	45.23	50.00	35.30	51.39	15.45
CEC	(meq/100g)	4.37	4.63	4.85	3.59	3.74	3.19	2.43	1.32
THC	Ppm	3.56	2.40	3.61	3.45	3.41	4.70	5.06	1.34
TPH	Ppm	1.20	0.70	1.00	0.30	0.70	1.00	1.01	0.40
BTEX	Ppm	0.20	ND	ND	0.01	0.50	0.90	ND	ND
Sodium	(meq/100g)	1.02	0.88	1.42	1.03	0.30	1.48	0.22	0.14
Potassium	(meq/100g)	0.31	0.25	0.29	0.17	0.17	0.46	0.06	0.08
Calcium	(meq/100g)	1.72	2.00	1.34	0.74	1.80	1.04	0.70	0.15
Magnesium	(meq/100g)	1.32	1.50	1.80	1.65	1.47	0.21	1.45	0.95
Manganese	(meq/100g)	2.01	1.03	3.11	1.50	2.68	4.21	4.18	2.36
Iron	mg/kg	35.29	34.34	55.04	61.11	87.39	81.49	46.34	8.77
Nickel	mg/kg	2.10	12.27	0.90	2.63	12.47	2.62	0.94	0.52
Vanadium	mg/kg	0.03	ND	ND	0.01	0.40	0.02	0.04	0.40
Cadmium	mg/kg	2.68	3.64	3.45	4.91	4.01	3.72	4.09	1.70
Chromium	mg/kg	7.28	7.21	12.00	9.35	10.47	7.65	9.24	1.56
Lead	mg/kg	ND	ND	ND	0.02	ND	0.04	ND	ND
Zinc	mg/kg	65.32	59.90	35.20	63.22	50.14	50.48	35.11	12.08

Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND

Table 4.10: Sediment Parameter Measurement (Wet Season)

PARAMETER	UNIT OF MEASUREMENT	AMSD1	AMSD2	AMSD3	AMSD4	AMSD5	AMSD6	AMSD7	AMSC1
pH		7.40	7.40	6.90	6.80	6.60	5.60	6.30	7.1
Nitrate	Ppm	32.65	47.40	52.14	57.36	60.24	47.50	60.20	30.28
Nitrite	Ppm	0.01	ND	1.02	0.03	0.10	0.20	0.50	0.14
Phosphate	Ppm	33.07	74.61	45.56	37.33	58.33	41.91	69.37	12.23
Sulphate	Ppm	56.23	42.81	53.87	46.48	51.40	34.60	53.11	16.7
CEC	(meq/100g)	4.21	4.64	4.74	3.54	4.86	3.08	2.22	1.19
THC	Ppm	3.24	2.38	3.24	3.30	3.24	4.10	4.96	1.23
TPH	Ppm	1.25	2.70	1.02	0.06	0.40	0.90	1.04	0.2
BTEX	Ppm	0.00	0.01	0.01	0.03	0.20	0.80	0.00	ND
Sodium	(meq/100g)	0.89	0.94	1.43	0.94	0.20	1.53	0.11	0.12
Potasium	(meq/100g)	0.28	0.21	0.27	0.14	0.14	0.44	0.12	0.06
Calcium	(meq/100g)	1.80	1.92	1.29	0.68	2.80	0.92	0.68	0.14
Magnesium	(meq/100g)	1.23	1.57	1.75	1.78	1.71	0.19	1.30	0.87
Maganese	(meq/100g)	2.04	1.01	3.89	1.47	2.80	5.70	4.10	2.31
Iron	mg/kg	34.12	31.04	54.68	59.16	86.34	78.88	44.76	8.36
Nickel	mg/kg	2.52	13.42	0.85	2.52	13.42	2.52	0.83	0.47
Vanadium	mg/kg	0.01	ND	ND	0.20	0.10	0.05	0.03	0.1
Cadmium	mg/kg	2.58	3.50	3.44	.4.7	3.60	3.59	4.05	1.65

Chromium	mg/kg	6.86	7.48	11.59	10.22	11.59	7.49	8.49	1.42
Lead	mg/kg	ND	ND	ND	0.01	ND	0.02	ND	ND
Zinc	mg/kg	64.64	57.63	34.59	64.64	49.58	49.61	34.59	11.41
Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND

4.8 SOIL SAMPLES ANALYTICAL RESULT

The result of the soil samples analysis for both dry and wet seasons are presented in table 4.11 and 4.12 respectively.

Table 4.11: SOIL SAMPLE MEASUREMENT (DRY SEASON)

PARAMETER		UNIT OF MEASUREMENT	AMSS1	AMSS2	AMSS3	AMSS4	AMSS5	AMSS6	AMSS7
pH	Top		7.59	7.88	6.54	6.10	6.32	8.00	8.30
	Sub		6.49	6.78	6.45	6.02`	6.24	7.06	7.10
Nitrate	Top	Ppm	91.21	88.47	45.63	46.21	54.01	220.00	331.00
	Sub	ppm	80.22	80.43	36.84	38.20	40.00	210.00	313.00
Nitrite	Top	Ppm	5.60	21.01	22.08	22.97	16.25	33.10	26.55
	Sub	Ppm	5.46	20.98	22.06	21.99	16.12	33.08	25.95
Phosphate	Top	Ppm	215.21	71.45	110.25	109.25	108.61	106.33	36.41
	Sub	Ppm	210.23	62. 65	100.27	100.25	106.34	104.42	31.34
Sulphate	Top	Ppm	112.00	78.66	33.22	54.77	51.02	74.96	45.77
	Sub	Ppm	111..46	68.54	30.23	48.86	50.05	70.91	41.32
CEC	Top	(meq/100g)	4.39	4.70	2.03	2.63	3.21	2.15	2.18
	Sub	(meq/100g)	2.46	2,48	1.02	1.13	1.87	1.10	1.12
THC	Top	Ppm	2.00	1.22	1.54	1.00	0.65	1.21	1.07
	Sub	Ppm	0.89	0.86	0.94	0.58	0.39	1.00	0.68
TPH	Top	Ppm	0.03	0.02	0.03	0.21	0.05	0.84	0.80
	Sub	Ppm	2.55	2.46	2.58	3.29	1.90	3.06	3.05
BTEX	Top	Ppm	ND	ND	ND	ND	0.02	0.01	0.03
	Sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium	Top	(meq/100g)	2.21	1.54	0.69	0.61	0.31	0.40	0.47
	Sub	(meq/100g)	1.37	0.89	0.57	0.58	0.30	0.38	0.45
Potassium	Top	(meq/100g)	0.58	1.30	0.17	0.79	0.10	0.11	0.54
	Sub	(meq/100g)	1.57	2.03	0.58	1.23	0.78	0.89	1.32
Calcium	Top	(meq/100g)	1.24	1.34	0.61	0.82	1.45	1.36	0.90
	Sub	(meq/100g)	1.12	1.13	0.45	0.66	1.23	0.98	O.86
Magnesium	Top	(meq/100g)	0.36	0.52	0.56	0.41	1.35	0.28	0.27
	Sub	(meq/100g)	0.28	0.46	0.45	0.34	1.23	0.21	0.14
Manganese	Top	(meq/100g)	2.33	1.35	2.90	1.71	2.34	2.00	3.88
	Sub	(meq/100g)	2.89	1.36	3.00	1.73	2.32	2.31	3.57
Iron	Top	mg/kg	330.00	348.23	238.11	372.22	320.00	271.55	329.50
	Sub	mg/kg	300.00	40.23	230.32	367.12	300.00	265.67	32.76
Nickel	Top	mg/kg	2.57	4.60	3.67	4.35	3.12	1.84	2.94
	Sub	mg/kg	1.57	3.65	3.01	3.34	2.47	0.96	2.02
Vanadium	Top	mg/kg	1.00	1.52	0.32	2.61	0.24	1.63	1.85

	Sub	mg/kg	0.23	0.25	0.06	0.57	0.11	0.48	0.35
Cadmium	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Chromium	Top	mg/kg	15.20	20.36	10.65	47.01	8.00	7.93	24.02
	Sub	mg/kg	13.20	18.64	9.34	45.22	6.00	6.88	22.23
Lead	Top	mg/kg	1.26	1.53	0.24	1.26	0.38	0.03	0.48
	Sub	mg/kg	2.46	2.97	1.34	2.65	1.34	0.67	1.98
Zinc	Top	mg/kg	15.66	30.21	2.35	28.77	2.66	12.69	30.78
	Sub	mg/kg	12.43	20.55	0.67	20.46	1.23	8.89	25.43
Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

Table 4.11: SOIL SAMPLE MEASUREMENT (DRY SEASON) CONTINUES

PARAMETER		UNIT OF MEASUREMENT	AMSS8	AMSS9	AMSS10	AMSS11	AMSS12	AMSS13	AMSS14
Ph	Top		7.55	7.68	6.20	6.30	6.55	7.48	8.23
	Sub		6.55	6.66	6.00	6.08	6.15	6.58	7.10
Nitrate	Top	Ppm	65.32	60.10	52.21	41.99	57.28	225.00	240.24
	Sub	Ppm	43.27	40.47	38.96	31.68	40.23	200.02	218.39
Nitrite	Top	Ppm	5.66	22.34	18.99	20.11	16.38	29.96	25.14
	Sub	Ppm	3.57	21.57	15.79	15.51	16.25	19.72	22.91
Phosphate	Top	Ppm	236.31	74.15	112.54	115.47	123.06	98.47	43.33
	Sub	Ppm	224.05	68.34	100.32	100.37	121.67	90.54	38.82
Sulphate	Top	Ppm	163.23	87.45	57.58	53.29	51.48	65.36	39.88
	Sub	Ppm	161.21	77.58	57.68	51.30	48.27	63.31	37.66
CEC	Top	(meq/100g)	2.85	2.32	3.30	3.00	2.35	1.21	4.13
	Sub	(meq/100g)	1.67	2.30	3.26	2.78	2.25	1.79	4.12
THC	Top	Ppm	1.54	1.65	1.30	0.55	0.67	1.45	1.69
	sub	Ppm	1.58	1.71	1.31	0.65	0.67	1.46	1.72
TPH	Top	Ppm	0.29	0.46	0.37	0.06	0.03	0.61	0.53
	sub	Ppm	0.30	0.49	0.48	0.02	0.04	0.86	0.78
BTEX	Top	Ppm	ND	ND	ND	ND	ND	ND	ND
	sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium	Top	(meq/100g)	0.22	0.74	0.64	0.45	0.39	0.34	0.52
	sub	(meq/100g)	0.18	0.67	0.59	0.37	0.28	0.30	038
Potassium	Top	(meq/100g)	0.19	0.23	0.61	0.68	0.59	0.35	0.68
	sub	(meq/100g)	0.14	0.21	0.38	0.58	0.42	031	0.59
Calcium	Top	(meq/100g)	1.22	0.17	1.66	0.85	1.12	0.15	1.90
	sub	(meq/100g)	1.20	0.03	1.46	0.75	1.04	0.09	1.65

	Top	(meq/100g)	1.22	1.18	0.39	1.02	0.25	0.37	1.03
	sub	(meq/100g)	0.56	0.46	0.25	0.79	0.12	0.20	0.87
Magnesium									
Manganese	Top	(meq/100g)	2.10	1.02	3.87	1.52	3.34	2.67	4.44
	sub	(meq/100g)	2.18	1.54	3.99	2.02	3.87	3.01	4.88
Iron	Top	mg/kg	241.33	241.36	236.21	290.22	219.36	252.37	219.68
	Sub	mg/kg	215.78	216.73	204.23	275.90	200.12	231.73	203.59
Nickel	Top	mg/kg	3.65	6.35	3.11	6.99	3.47	1.62	3.79
	sub	mg/kg	2.65	4.68	2.02	4.58	2.23	1.22	2.58
Vanadium	Top	mg/kg	1.02	1.11	0.31	1.82	ND	ND	1.58
	sub		0.89	0.97	ND	.1.13	ND	ND	0.23
Cadmium	Top	mg/kg	ND	ND	ND	ND	0.02	ND	ND
	sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Chromium	Top	mg/kg	16.32	33.27	11.11	39.26	10.28	8.05	27.33
	sub	mg/kg	13.42	30.74	10.21	30.45	8.22	6.01	23.24
Lead	Top	mg/kg	1.03	1.23	ND	1.02	ND	ND	0.84
	Sub	mg/kg	5.30	5.89	ND	3.85	ND	ND	1.34
Zinc	Top	mg/kg	19.25	34.26	1.35	38.14	2.41	13.02	37.58
	sub	mg/kg	16.67	30.53	1.17	32.89	2.12	10.02	31.34
Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

Table 4.11: SOIL SAMPLE MEASUREMENT (DRY SEASON) CONTINUES

PARAMETER		UNIT OF MEASUREMENT	AMSS15	AMSS16	AMSS17	AMSS18	AMSS19	AMSS20	AMSS21
pH	Top		7.41	7.33	6.39	7.90	7.54	7.61	7.72
	sub		6.41	6,32	6.03	6.70	6.54	6.61	6.70
Nitrate	Top	Ppm	60.23	59.26	57.24	41.28	74.99	107.88	184.25
	Sub	Ppm	58.32	53.78	52.36	40.48	71.82	103.37	182.72
Nitrite	Top	Ppm	4.56	30.25	15.69	14.87	13.26	30.98	23.41
	Sub	Ppm	2.62	27.90	11.47	10.90	11.23	30.41	21.03
Phosphate	Top	Ppm	241.03	85.47	98.36	101.36	102.45	105.77	46.29
	Sub	Ppm	193.26	70.32	90.00	100.45	98.59	100.41	43.82
Sulphate	Top	Ppm	152.24	96.35	48.29	63.35	51.26	75.69	42.24
	Sub	Ppm	142.34	94.38	45.52	60.28	48.49	70.78	39.41
CEC	Top	(meq/100g)	2.67	2.43	3.34	3.95	2.83	1.92	3.61
	Sub	(meq/100g)	1.36	1.92	1.53	1.98	1.84	1.28	2.13
THC	Top	Ppm	0.78	0.91	0.82	0.38	0.74	0.36	0.52
	Sub	Ppm	0.64	0.76	0.80	0.33	0.71	0.30	0.46
TPH	Top	Ppm	0.23	0.30	0.56	0.05	0.19	0.12	0.06
	Sub	Ppm	0.26	0.34	0.60	0.15	0.20	0.18	0.09
BTEX	Top	Ppm	0.02	0.06	ND	ND	0.01	0.02	ND
	Sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium		(meq/100g)	0.23	0.69	0.84	1.56	0.52	0.41	0.36

	Top								
	Sub	(meq/100g)	0.21	0.65	0.82	1.42	0.49	0.380.35	
Potassium	Top	(meq/100g)	0.21	0.39	0.78	0.75	0.71	0.52	1.02
	Sub	(meq/100g)	0.20	0.36	0.77	0.76	0.68	0.50	0.98
Calcium	Top	(meq/100g)	1.32	0.32	1.31	0.82	1.24	0.53	1.30
	Sub	(meq/100g)	1.31	0.34	1.30	0.86	1.25	0.56	1.28
Magnesium	Top	(meq/100g)	0.91	1.03	0.41	0.82	0.36	0.46	0.93
	Sub	(meq/100g)	0.48	0.92	0.28	0.59	0.22	0.28	0.51
Manganese	Top	(meq/100g)	1.25	1.02	2.31	1.27	2.08	2.32	3.68
	Sub	(meq/100g)	1.46	1.13	2.36	1.42	2.24	2.78	3.66
Iron	Top	mg/kg	55.62	62.01	59.24	60.14	57.02	60.23	48.25
	Sub	mg/kg	46.72	60.54	52.71	57.16	52.29	56.32	40.81
Nickel	Top	mg/kg	1.26	2.90	3.21	2.84	2.51	2.90	1.64
	Sub	mg/kg	1.15	2.36	3.10	2.61	2.14	2.23	1.25
Vanadium	Top	mg/kg	0.10	0.62	0.75	ND	ND	0.20	1.35
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Cadmium	Top	mg/kg	ND	ND	0.08	0.06	ND	ND	0.10
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Chromium	Top	mg/kg	6.32	11.25	9.54	15.58	5.47	3.59	16.95
	Sub	mg/kg	4.23	9.35	7.56	12.89	3.37	2.60	16.16
Lead	Top	mg/kg	2.31	1.20	0.17	0.60	0.07	ND	0.65
	Sub	mg/kg	4.76	3.82	1.23	1.72	0.86	ND	1.99
Zinc	Top	mg/kg	9.56	21.01	2.32	13.21	2.78	9.99	18.20
	Sub	mg/kg	8.55	20.02	1.92	11.43	1.89	7.88	
Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

Table 4.11: SOIL SAMPLE MEASUREMENT (DRY SEASON) CONTINUES

PARAMETER	UNIT OF MEASUREMENT		AMSS22	AMSS23	AMSS24	AMSS25	AMSS26	AMSS27	AMSS28
pH	Top		7.12	7.60	7.56	7.00	7.12	7.56	7.45
	sub		6.12	6.60	6.55	6.08	6.16	6.58	6.45
Nitrate	Top	Ppm	60.12	49.58	50.28	54.18	70.69	90.26	79.58
	sub	Ppm	57.27	43.91	45.82	50.18	62.90	87.30	70.42
Nitrite	Top	Ppm	13.26	35.20	36.87	41.25	42.23	35.69	40.78
	sub	Ppm	11.23	30.09	31.86	37.76	41.08	30.17	36.53
Phosphate	Top	Ppm	212.11	85.24	81.27	98.00	94.17	100.58	51.29
	sub	Ppm	202.34	80.43	79.75	90.35	92.51	94.79	49.27
Sulphate	Top	Ppm	104.77	98.25	48.97	64.22	51.22	71.84	43.21

	sub	Ppm	100.68	92.73	45.89	60.81	47.66	66.51	40.62
CEC	Top	Ppm	3.65	3.00	3.78	3.78	3.30	1.92	4.29
	sub	Ppm	1.62	1.83	1.49	1.63	1.44	1.22	1.32
THC	Top	(meq/100g)	1.25	1.67	1.90	1.42	1.03	2.56	1.18
	sub	(meq/100g)	1.26	1.64	1.83	1.43	1.00	2.52	1.15
TPH	Top	Ppm	0.36	0.27	0.19	0.28	0.19	1.22	0.65
	Top	Ppm	0.48	0.29	0.21	0.32	0.24	1.26	0.68
BTEX	Top	Ppm	0.06	0.54	ND	ND	ND	0.05	0.03
	sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium	Top	Ppm	1.40	0.64	1.02	1.42	0.70	0.62	0.66
	sub	Ppm	1.18	0.23	0.88	1.27	0.43	0.38	0.33
Potassium	Top	(meq/100g)	0.14	0.45	0.98	0.71	0.58	0.54	1.03
	sub	(meq/100g)	0.11	0.21	0.65	0.52	0.24	0.34	0.79
Calcium	Top	(meq/100g)	1.33	0.38	1.47	0.66	1.60	0.41	1.78
	sub	(meq/100g)	1.23	0.30	1.36	0.42	1.28	0.31	1.39
Magnesium	Top	(meq/100g)	0.78	1.53	0.31	0.99	0.42	0.35	0.82
	sub	(meq/100g)	0.67	1.21	0.21	0.37	0.25	0.18	0.42
Manganese	Top	(meq/100g)	2.50	2.06	20.90	0.88	3.25	1.37	2.99
	sub	(meq/100g)	2.62	2.10	21.86	1.78	3.28	1.42	3.01
Iron	Top	(meq/100g)	64.25	60.25	65.28	67.28	60.23	70.14	54.00
	sub	(meq/100g)	60.12	58.43	60.31	62.89	57.31	69.00	48.26
Nickel	Top	mg/kg	1.70	1.90	2.50	284.00	1.53	1.73	1.05
	sub	mg/kg	1.48	1.59	2.23	282.49	1.22	1.40	0.31
Vanadium	Top	mg/kg	ND	0.02	0.03	ND	ND	ND	ND
	sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Cadmium	Top	mg/kg	0.23	0.05	0.08	0.31	ND	0.01	0.10
	sub	mg/kg	0.19	ND	ND	0.11	ND	ND	ND
Chromium	Top	mg/kg	5.62	12.01	10.25	13.45	6.02	7.41	5.36
	sub	mg/kg	4.72	10.32	9.39	10.52	3.99	5.72	2.11
Lead	Top	mg/kg	3.12	1.42	0.31	0.45	ND	0.24	0.32
	sub	mg/kg	9.34	6.23	2.88	2.39	ND	2.67	1.89
Zinc	Top	mg/kg	7.32	15.02	2.65	12.22	3.09	8.21	13.96
	sub	mg/kg	5.68	10.73	1.95	9.72	2.00	6.21	10.87
Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

Table 4.11: SOIL SAMPLE MEASUREMENT (DRY SEASON) CONTINUES

PARAMETER		UNIT OF MEASUREMENT	AMSS29	AMSS30	AMSS31	AMSS32	AMSS33	AMSS34	AMSS35
pH	Top		7.00	7.20	6.28	7.00	7.00	7.50	7.60
	Sub		6.04	6.25	5.89	6.00	6.01	6.48	6.68
Nitrate	Top	Ppm	72.10	80.26	80.64	68.25	64.66	80.04	120.31
	Sub	Ppm	71.05	76.48	76.84	64.34	60.57	73.25	118.86
Nitrite	Top	Ppm	7.12	9.25	14.78	16.22	13.25	13.69	10.57
	Sub	Ppm	7.11	9.12	12.90	12.31	10.72	11.39	8.43
Phosphate	Top	Ppm	125.34	81.45	46.25	70.14	64.65	89.84	70.10

	Sub	Ppm	120.23	65.09	43.05	78.1	60.48	82.24	67.08
Sulphate	Top	Ppm	110.23	79.89	35.28	56.23	51.42	74.88	52.39
	Sub	Ppm	100.34	71.47	32.39	51.19	49.32	70.28	42.91
CEC	Top	(meq/100g)	3.20	3.85	1.31	2.56	3.38	2.16	1.46
	Sub	(meq/100g)	1.48	1.82	0.82	1.73	1.90	1.62	0.98
THC	Top	Ppm	1.41	2.21	0.84	1.11	0.65	2.56	2.54
	Sub	Ppm	140	2.13	0.80	1.00	0.45	2.51	2.49
TPH	Top	Ppm	0.71	0.62	0.47	0.63	0.07	0.22	0.21
	Sub	Ppm	0.61	0.52	0.37	0.53	0.01	0.18	0.11
BTEX	Top	Ppm	0.03	ND	ND	0.05	ND	ND	0.06
	Sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium	Top	(meq/100g)	1.36	1.05	0.28	0.51	0.35	0.14	0.29
	Sub	(meq/100g)	1.26	0.21	0.16	0.26	0.26	0.07	0.22
Potassium	Top	(meq/100g)	0.40	1.08	0.31	1.02	0.37	0.14	0.56
	Sub	(meq/100g)	0.32	0.78	0.21	0.76	0.12	0.05	0.25
Calcium	Top	(meq/100g)	1.22	1.24	0.25	0.68	1.40	1.55	0.32
	Sub	(meq/100g)	0.59	0.83	0.18	0.38	1.07	1.24	0.22
Magnesium	Top	(meq/100g)	0.22	0.48	0.47	0.35	1.26	0.33	0.29
	Sub	(meq/100g)	0.18	0.29	0.31	0.29	1.07	0.12	0.15
Manganese	Top	(meq/100g)	2.01	1.64	1.75	1.51	2.06	2.11	2.99
	Sub	(meq/100g)	2.25	1.82	1.90	1.62	2.18	2.43	3.62
Iron	Top	mg/kg	219.25	217.20	249.25	208.33	214.17	260.28	260.23
	Sub	mg/kg	200.21	200.17	226.23	199.38	201.36	242.22	224.71
Nickel	Top	mg/kg	1.11	5.24	3.58	3.69	3.14	2.45	2.66
	Sub	mg/kg	0.09	4.24	2.65	2.84	2.10	1.59	1.88
Vanadium	Top	mg/kg	0.51	0.41	0.52	1.67	2.33	1.87	2.24
	Sub	mg/kg	0.01	0.01	0.02	0.11	0.67	0.88	1.66
Cadmium	Top	mg/kg	ND	0.24	ND	ND	ND	1.05	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Chromium	Top	mg/kg	10.47	12.58	10.44	29.65	8.70	6.89	19.06
	Sub	mg/kg	8.23	10.37	9.22	27.88	6.80	4.67	16.01
Lead	Top	mg/kg	2.30	1.41	0.79	0.93	0.31	0.04	0.48
	Sub	mg/kg	6.80	7.72	2.89	2.91	1.77	0.98	1.52
Zinc	Top	mg/kg	12.56	24.74	4.58	20.10	2.45	9.55	27.98
	Sub	mg/kg	10.23	23.12	2.78	18.50	1.34	7.33	21.87
Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

Table 4.11: SOIL SAMPLE MEAUREMENT (DRY SEASON) CONTINUES

PARAMETER		UNIT OF MEASUREMENT	AMSS36	AMSS37	AMSS38	AMSS39	AMSS40	AMSS41	AMSS42
pH	Top		7.50	6.55	7.20	7.60	5.66	7.10	6.60
	Sub		6.50	6.53	6.20	6.48	6.69	6.02	6.01
Nitrate	Top	Ppm	121.20	130.20	132.00	128.65	175.24	112.01	112.30
	Sub	Ppm	119.67	122.32	130.28	122.81	171.03	100.45	100.32
Nitrite	Top	Ppm	15.26	12.58	14.20	8.22	16.55	20.14	13.65

	Sub	Ppm	13.58	10.29	10.43	6.78	14.72	17.93	11.70
Phosphate	Top	Ppm	35.58	37.84	37.62	40.12	54.23	30.99	45.78
	Sub	Ppm	33.98	36..86	37.68	39.24	52.25	29..42	44.62
Sulphate	Top	Ppm	121.25	64.96	66.28	76.89	90.26	105.14	89.76
	Sub	Ppm	120.42	63.71	65.89	76.35	87.12	100/62	88.03
CEC	Top	(meq/100g)	3.25	4.63	1.79	2.69	2.63	2.31	2.19
	Sub	(meq/100g)	1.03	2.03	0.92	1.34	1.21	1.13	1.12
THC	Top	Ppm	1.75	1.06	1.02	0.90	0.68	1.74	1.22
	Sub	Ppm	1.25	0.97	0.98	0.86	0.58	1.23	1.11
TPH	Top	Ppm	0.25	0.62	0.32	0.14	0.20	0.57	0.80
	Sub	Ppm	0.28	0.69	0.35	0.21	0.22	0.66	0.81
BTEX	Top	Ppm	ND	ND	ND	ND	ND	0.03	0.04
	Sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium	Top	(meq/100g)	1.23	1.30	0.42	0.68	0.41	0.39	0.46
	Sub	(meq/100g)	1.13	1.18	0.32	0.58	0.31	0.27	0.36
Potassium	Top	(meq/100g)	0.27	1.42	0.19	0.95	0.15	0.12	0.60
	Sub	(meq/100g)	0.24	1.42	0.14	0.73	0.08	0.09	0.42
Calcium	Top	(meq/100g)	1.33	1.29	0.52	0.71	1.02	1.46	0.68
	Sub	(meq/100g)	1.09	1.07	0.34	0.51	0.82	1.27	0,25
Magnesium	Top	(meq/100g)	0.42	0.62	0.66	0.35	1.05	0.34	0.45
	Sub	(meq/100g)	0.25	0.43	0.58	0.24	1.59	0.21	0.26
Manganese	Top	(meq/100g)	1.74	1.30	2.05	1.62	1.99	1.95	2.67
	Sub	(meq/100g)	1.76	1.36	2.05	1.68	2.00	1.96	2.68
Iron	Top	mg/kg	50.12	56.03	37.52	80.22	120.23	71.21	43.44
	Sub	mg/kg	40.21	52.34	31.85	76.87	118.86	68.23	40.34
Nickel	Top	mg/kg	1.57	3.30	2.80	3.11	3.14	1.60	2.01
	Sub	mg/kg	0.67	1.98	1.23	1.97	1.94	1.48	1.27
Vanadium	Top	mg/kg	ND	1.30	0.75	1.44	0.10	130.20	1.35
	Sub	mg/kg	ND	1.19	0.58	1.24	ND	127.48	1.15
Cadmium	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Chromium	Top	mg/kg	11.24	15.24	10.11	16.32	7.22	7.20	12.36
	Sub	mg/kg	10.39	13.56	8.91	14.37	5.81	5.29	11.02
Lead	Top	mg/kg	1.24	2.35	0.81	2.14	3.42	1.22	0.80
	Sub	mg/kg	6.72	7.90	4.21	4.70	9.14	6.86	4.32
Zinc	Top	mg/kg	5.66	9.01	3.22	18.69	12.01	12.35	13.88
	Sub	mg/kg	4.66	6.38	2.97	16.23	11.74	10.67	12.66
Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

Table 4.11 : SOIL SAMPLE MEASUREMENT (DRY SEASON) CONTINUES

PARAMETER		UNIT OF MEASUREMENT	AMSS43	AMSS44	AMSS45	AMSS46	AMSS47	AMSS48	AMSS49
pH	Top		7.60	6.85	7.10	7.36	6.80	6.90	7.40
	Sub		6.60	6.15	6.01	6.26	6.08	6.10	6.04
Nitrate	Top	Ppm	41.25	25.26	41.55	26.45	72.15	29.11	34.15
	Sub	Ppm	38.25	22.72	37.89	22.21	70.56	24.98	30.40
Nitrite	Top	Ppm	5.02	3.11	3.61	8.14	10.99	14.05	11.87
	Sub	Ppm	3.72	2.31	2.48	6.24	8.82	12.09	10.35
Phosphate	Top	Ppm	127.23	85.41	69.32	44.11	43.26	40.54	58.60
	Sub	Ppm	120.54	80.48	62.83	39.17	42,39	38.51	56.08
Sulphate	Top	Ppm	112.00	81.27	58.29	66.33	74.18	86.52	95.12
	Sub	Ppm	90.34	67.24	40.78	48.69	53.80	64.78	88.46
CEC	Top	(meq/100g)	4.09	3.83	2.34	2.19	3.13	2.32	2.18
	Sub	(meq/100g)	2.03	1.58	1.23	1.21	1.79	1.22	1.09
THC	Top	Ppm	3.00	1.57	2.00	1.55	0.90	1.33	1.47
	Sub	Ppm	2.00	1.03	1.01	0.98	0.78	0.96	1.03
TPH	Top	Ppm	0.80	0.30	0.27	0.30	0.50	0.70	0.73
	Sub	Ppm	0.90	0.31	0.29	0.34	0.50	0.80	0.76
BTEX	Top	Ppm	0.01	ND	ND	ND	ND	0.03	0.01
	Sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium	Top	(meq/100g)	1.25	1.08	0.41	0.72	0.44	0.32	0.60
	Sub	(meq/100g)	1.05	0.68	0.06	0.09	0.05	0.14	0.48
Potassium	Top	(meq/100g)	0.69	1.33	0.36	0.65	0.31	0.24	0.55
	Sub	(meq/100g)	0.60	1.05	o.22	0.43	0.18	0.12	0.55
Calcium	Top	(meq/100g)	1.74	1.03	1.20	0.28	1.06	1.42	0.63
	Sub	(meq/100g)	1.09	0.63	0.85	0.08	0.59	1.02	0.21
Magnesium	Top	(meq/100g)	0.41	0.39	0.37	0.54	1.32	0.34	0.40
	Sub	(meq/100g)	0.31	0.29	0.27	0.43	0.88	0.29	0.24
Manganese	Top	(meq/100g)	1.71	1.45	3.50	1.90	3.00	3.04	3.44
	Sub	(meq/100g)	2.78	2.89	3.57	2.03	3.01	3.26	3.45
Iron	Top	mg/kg	57.21	67.00	66.32	76.46	77.25	70.11	66.16
	Sub	mg/kg	3-.34	40.29	40.37	50.28	50.41	50.04	50.01
Nickel	Top	mg/kg	2.00	3.20	4.01	4.05	3.68	3.87	3.03
	Sub	mg/kg	1.06	2.41	2.99	2.99	2.33	2.49	2.05
Vanadium	Top	mg/kg	0.31	0.24	0.38	2.29	0.40	1.11	1.42
	Sub	mg/kg	0.21	0.16	0.19	1.28	0.24	0.87	0.94
Cadmium	Top	mg/kg	1.01	ND	ND	0.02	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Chromium	Top	mg/kg	9.66	5.24	52.28	9.54	1.62	8.05	8.61
	Sub	mg/kg	7.34	3.33	40.89	6.29	0.88	6.63	6.57
Lead	Top	mg/kg	2.40	2.50	3.22	3.70	4.37	4.58	3.72
	sub	mg/kg	5,39	6.03	7.42	8.01	**9.80**	8.05	2.54
Zinc	Top	mg/kg	7.00	10.05	5.60	7.81	6.50	12.12	14.00
	Sub	mg/kg	4.00	6.90	3.22	4.71	3.56	9.08	12.35

Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

Table 4.11: SOIL SAMPLE MEASUREMENT (DRY SEASON) CONTINUES

PARAMETER		UNIT OF MEASUREMENT	AMSS50	AMSS51	AMSS52	AMSS53	AMSS54	AMSS55	AMSS56
pH	Top		7.33	7.60	7.00	6.89	7.00	7.54	7.61
	Sub		6.32	6.62	6.02	6.71	6.01	6.53	6.61
Nitrate	Top	Ppm	77.11	96.21	80.54	78.38	76.44	83.06	97.08
	Sub	Ppm	59.70	88.38	68.42	59.20	57.93	60.48	79.87
Nitrite	Top	Ppm	4.25	9.21	13.00	8.26	11.24	10.29	11.25
	Sub	Ppm	2.34	6.82	10.87	5.79	7.65	5.24	7.88
Phosphate	Top	Ppm	98.18	100.27	100.33	75.48	76.38	84.34	78.00
	Sub	Ppm	90.75	96.39	97.05	70.63	73.92	80.89	68.00
Sulphate	Top	Ppm	122.37	105.81	108.27	124.39	152.04	99.25	80.20
	Sub	Ppm	100.76	90.72	91.68	120.39	148.27	78.50	78.22
CEC	Top	(meq/100g)	3.51	3.31	1.55	1.91	3.42	2.80	1.47
	Sub	(meq/100g)	1.38	1.36	0.69	0.78.	1.40	1.22	1.08
THC	Top	Ppm	1.02	1.80	2.45	2.06	1.52	2.61	2.33
	Sub	Ppm	1.00	1.80	2.44	2.02	1.50	2.48	2.23
TPH	Top	Ppm	0.92	0.03	0.78	0.62	0.41	0.15	0.36
	Sub	Ppm	0.97	0.06	0.79	0.65	0.45	0.18	0.39
BTEX	Top	Ppm	ND	0.02	ND	ND	ND	0.12	ND
	Sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium	Top	(meq/100g)	1.25	0.33	0.29	0.47	0.33	0.29	0.38
	Sub	(meq/100g)	1.20	0.13	0.12	0.29	0.13	0.12	0.13
Potassium	Top	(meq/100g)	0.44	1.29	0.31	0.48	0.45	0.41	0.45
	Sub	(meq/100g)	0.22	1.08	0.19	0.24	0.26	0.20	0.26
Calcium	Top	(meq/100g)	1.34	1.37	0.56	0.69	1.30	1.48	0.33
	Sub	(meq/100g)	1.30	1.32	0.52	0.601	1.26	1.43	0.30
Magnesium	Top	(meq/100g)	0.48	0.32	0.39	0.27	1.34	0.62	0.31
	Sub	(meq/100g)	0.39	0.28	0.29	0.18	1.17	0.52	0.16
Manganese	Top	(meq/100g)	3.38	4.88	2.51	3.05	4.03	3.75	3.06
	Sub	(meq/100g)	4.02	5.03	3.01	3.86	4.12	3.97	3.18
Iron	Top	mg/kg	153.28	133.20	147.25	203.69	124.27	98.54	66.31
	Sub	mg/kg	130.79	111.30	128.09	178.32	113.68	83.23	57.25
Nickel	Top	mg/kg	2.70	8.01	5.63	3.71	5.02	2.47	3.50
	Sub	mg/kg	1.35	3.49	2.13	1.89	3.40	1.05	2.63
Vanadium	Top	mg/kg	0.13	0.11	0.51	1.12	2.75	1.62	2.90
	Sub	mg/kg	0.09	0.09	0.12	0.89	1.42	1.24	1.59
Cadmium	Top	mg/kg	0.03	0.04	ND	0.01	ND	0.05	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Chromium	Top	mg/kg	9.10	6.34	8.06	11.78	7.60	5.42	12.88
	Sub	mg/kg	7.36	4.23	6.89	9.34	5.39	3.28	10.44
Lead	Top	mg/kg	1.91	1.06	0.45	0.82	0.10	0.03	0.34
	Sub	mg/kg	3.78	5.20	2.33	2.49	2.00	1.87	2.22

Zinc	Top	mg/kg	11.64	20.39	6.52	7.18	2.64	5.77	21.15
	Sub	mg/kg	7.34	16.89	4.23	5.02	1.32	2.55	19.28
Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

Table 4.11: SOIL SAMPLE MEASUREMENT (DRY SEASON) CONTINUES

PARAMETER		UNIT OF MEASUREMENT	AMSS57	AMSS58	AMSS59	AMSS60	AMSS61	AMSS62	AMSS63
pH	Top		7.00	6.88	7.28	6.80	7.10	7.22	7.34
	sub		6.04	6.84	6.28	6.84	6.08	6.24	6.30
Nitrate	Top	Ppm	78.25	60.29	58.55	70.14	51.24	71.54	70.42
	Sub	Ppm	69.70	48.38	48.42	59.20	37.93	60.48	49.87
Nitrite	Top	Ppm	4.10	4.25	3.21	3.60	5.47	7.09	36.84
	Sub	Ppm	2.18	2.39	1.48	1.32	3.63	4.74	26;39
Phosphate	Top	Ppm	87.47	90.25	77.58	70.09	46.11	80.99	64.31
	Sub	Ppm	67.78	70.34	56.72	58.38	30.17	64.47	55.79
Sulphate	Top	Ppm	105.14	46.25	84.17	93.28	110.74	68.06	71.18
	Sub	Ppm	100.72	40.72	71.63	80.29	104.27	48.90	48.24
CEC	Top	(meq/100g)	3.22	2.65	1.33	1.59	3.04	2.87	2.18
	Sub	(meq/100g)	1.38	1.36	0.69	0.78.	1.40	1.22	1.08
THC	Top	Ppm	0.52	1.45	1.52	1.40	1.30	2.65	2.04
	Sub	Ppm	0.36	1.00	1.44	1.42	0.50	2.03	1.23
TPH	Top	Ppm	0.31	0.24	0.45	1.12	0.70	0.17	0.80
	Sub	Ppm	1.43	1.36	1.78	2.78	1.78	1.05	1.89
BTEX	Top	Ppm	ND	ND	ND	ND	ND	ND	ND
	Sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium	Top	(meq/100g)	1.13	0.51	0.32	0.14	0.32	0.27	0.65
	Sub	(meq/100g)	1.03	0.18	0.28	0.09	0.13	0.12	0.20
Potassium	Top	(meq/100g)	0.35	1.42	0.31	0.51	0.41	0.47	0.68
	Sub	(meq/100g)	0.25	1.28	0.21	0.41	0.31	0.37	0.58
Calcium	Top	(meq/100g)	1.30	0.34	0.28	0.62	1.32	1.56	0.45
	Sub	(meq/100g)	1.10	0.19	0.11	0.32	1.12	1.29	0.30
Magnesium	Top	(meq/100g)	0.44	0.38	0.42	0.32	0.99	0.57	0.40
	Sub	(meq/100g)	0.22	0.28	0.29	0.18	0.37	0.52	0.26
Manganese	Top	(meq/100g)	2.84	6.22	4.51	3.05	3.21	1.42	3.16
	Sub	(meq/100g)	3.02	5.03	5.41	3.86	4.12	3.97	5.18
Iron	Top	mg/kg	168.44	129.02	13.26	25.39	102.31	91.24	98.32
	Sub	mg/kg	105.84	123.68	9.42	20.69	99.77	84.27	91.32
Nickel	Top	mg/kg	2.34	4.21	4.10	3.44	3.82	4.52	0.32
	Sub	mg/kg	2.20	4.00	3.98	1.23	2.12	2.85	0.13
Vanadium	Top	mg/kg	0.45	0.31	0.58	2.09	3.45	3.20	1.09
	Sub	mg/kg	0.35	0.21	0.48	1.05	2.47	2.20	0.54
Cadmium	Top	mg/kg	ND	0.12	ND	0.04	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Chromium	Top	mg/kg	7.08	6.05	8.25	10.88	6.17	6.52	9.00
	Sub	mg/kg	5.61	4.89	6.27	8.13	4.87	4.52	6.00

Lead	Top	mg/kg	2.40	2.09	1.00	0.90	2.09	0.65	2.77
	Sub	mg/kg	8.49	8.00	7.01	4.68	8.35	3.56	9.04
Zinc	Top	mg/kg	12.75	14.99	6.45	7.98	2.59	7.10	5.03
	Sub	mg/kg	10.47	10.39	3.60	4.39	1.30	5.82	3.06
Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

TABLE 4.11: SOIL SAMPLE MEASUREMENT (DRY SEASON) CONTINUES

PARAMETER		UNIT OF MEASUREMENT	AMSS64	AMSS65	AMSS66	AMSS67	AMSS68	AMSS69	AMSS70
pH	Top		7.00	7.20	7.30	7.30	7.40	7.70	7.40
	Sub		6.00	6.25	6.35	6.34	6.45	6.75	6.43
Nitrate	Top	Ppm	87.56	91.24	77.21	80.09	96.54	87.29	100.27
	Sub	Ppm	69.67	72.32	130.28	62.81	81.03	60.45	87.32
Nitrite	Top	Ppm	12.00	11.03	9.28	9.40	5.23	6.07	10.52
	Sub	Ppm	11.23	30.09	31.86	37.76	41.08	30.17	36.53
Phosphate	Top	Ppm	57.21	73.29	84.47	67.00	93.60	87.14	78.09
	Sub	Ppm	50.54	60.48	52.83	39.17	62,39	58.51	56.68
Sulphate	Top	Ppm	110.33	101.71	96.33	95.28	74.54	106.28	95.27
	Sub	Ppm	90.34	67.24	60.78	58.69	43.80	64.78	58.46
CEC	Top	(meq/100g)	2.93	4.14	3.34	3.74	4.54	1.71	2.11
	Sub	(meq/100g)	1.48	2.07	1,17	1.56	2.39	0.98	1.07
THC	Top	Ppm	0.27	0.70	1.02	1.50	1.39	2.41	1.69
	Sub	Ppm	0.20	0.65	0.97	1.50	1.30	2.24	1.50
TPH	Top	Ppm	0.03	0.21	0.30	0.17	0.14	0.56	0.83
	Sub	Ppm	0.09	0.27	0.93	0.34	o.37	1.24	1.67
BTEX	Top	Ppm	0.02	0.01	ND	0.01	ND	0.28	0.07
	Sub	Ppm	ND	ND	ND	ND	ND	ND	ND
Sodium	Top	(meq/100g)	0.50	0.58	1.32	0.90	1.37	0.41	0.50
	Sub	(meq/100g)	0.40	0.46	0.97	0.63	0.99	0.22	0.25
Potassium	Top	(meq/100g)	0.25	0.80	0.30	0.77	1.06	0.45	0.30
	Sub	(meq/100g)	0.15	1.65	0.19	0.34	0.99	0.28	0.18
Calcium	Top	(meq/100g)	1.12	1.32	1.40	1.36	1.60	0.49	1.00
	Sub	(meq/100g)	0.78	0.83	0.90	0.45	0.30	0.23	0.08
Magnesium	Top	(meq/100g)	1.06	1.44	0.32	0.71	0.51	0.36	0.31
	Sub	(meq/100g)	0.83	1.00	0.18	0.14	0.14	0.16	0.19
Manganese	Top	(meq/100g)	0.70	1.38	1.36	1.78	2.48	2.51	3.22
	Sub	Ppm	0.90	1.42	1.69	1.98	3.06	2.83	3.88
Iron	Top	mg/kg	59.00	67.28	74.69	87.25	71.99	84.18	97.00
	Sub	mg/kg	40.00	60.28	67.36	70.25	60.22	74	
Nickel	Top	mg/kg	2.45	2.60	2.68	2.41	3.58	3.64	3.44
	Sub	mg/kg	2.47	2.80	2.85	2.47	3.65	3.71	4.77
Vanadium	Top	mg/kg	ND	0.30	0.14	0.41	1.03	1.47	1.71
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Cadmium	Top	mg/kg	0.06	0.25	ND	0.70	ND	ND	0.19
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND
Chromium	Top	mg/kg	10.34	11.29	15.00	2.92	8.74	4.65	8.73

	Sub	mg/kg	10.04	11.01	14.84	2.30	8.65	4.60	8.73
Lead	Top	mg/kg	0.63	1.08	3.70	4.26	3.47	2.86	1.05
	Sub	mg/kg	4.54	5.82	9.72	10.40	9.04	7.38	5.88
Zinc	Top	mg/kg	6.66	7.35	4.81	13.02	5.68	10.08	12.98
	Sub	mg/kg	3.33	4.29	2.20	7.31	3.79	5.00	6.53
Mercury	Top	mg/kg	ND	ND	ND	ND	ND	ND	ND
	Sub	mg/kg	ND	ND	ND	ND	ND	ND	ND

Table 4.11: SOIL SAMPLE MEASUREMENT (DRY SEASON) CONTINUES

PARAMETER		UNIT OF MEASUREMENT	AMSS71	AMSS72	AMSS73	AMSS74	AMSS75	AMSSC1
pH	Top		7.00	7.40	7.50	7.10	8.00	7.60
	Sub		6.04	6.38	6.48	6.10	7.00	6.58
Nitrate	Top	Ppm	103.20	97.36	124.28	120.59	84.56	63.25
	Sub	Ppm	89.22	80.43	116.84	108.20	60.00	50.00
Nitrite	Top	Ppm	22.11	12.44	20.58	19.63	14.00	4.39
	Sub	Ppm	3.72	2.31	2.48	6.24	8.82	12.09
Phosphate	Top	Ppm	192.01	202.06	148.69	210.88	111.80	79.36
	Sub	Ppm	150.54	190.48	122.83	189.17	92,39	48.51
Sulphate	Top	Ppm	145.40	179.97	106.25	97.51	100.24	95.63
	Sub	Ppm	98.34	171.47	92.39	71.19	84.32	78.28
CEC	Top	(meq/100g)	3.09	3.44	2.08	2.83	2.71	1.77
	Sub	(meq/100g)	1.03	2.03	0.92	1.34	1.21	1.13
THC	Top	Ppm	1.30	1.72	1.30	1.40	2.05	0.36
	Sub	Ppm	1.26	1.64	1.83	1.43	1.00	0.22
TPH	Top	Ppm	0.26	0.54	0.17	0.16	0.29	0.06
	Sub	Ppm	0.28	0.69	0.35	0.21	0.22	0.66
BTEX	Top	Ppm	ND	ND	ND	0.01	0.29	ND
	Sub	Ppm	ND	ND	ND	ND	ND	ND
Sodium	Top	(meq/100g)	1.10	1.30	0.35	0.42	0.31	0.32
	Sub	(meq/100g)	101	1.21	0.16	0.26	0.26	0.17
Potassium	Top	(meq/100g)	0.32	0.12	0.34	0.48	0.61	0.12
	Sub	(meq/100g)	0.12	0.14	0.25	0.22	0.44	0.08
Calcium	Top	(meq/100g)	1.30	1.51	1.39	1.24	1.61	1.10
	Sub	(meq/100g)	1.01	1.20	1.09	1.02	1.24	0,83
Magnesium	Top	(meq/100g)	0.37	0.51	0.00	0.69	0.18	0.23
	Sub	(meq/100g)	0.18	0.24	0.01	0.38	0.09	0.13
Manganese	Top	(meq/100g)	3.11	3.50	2.41	1.70	1.45	1.60
	Sub	(meq/100g)	3.22	2.56	2.47	1.78	1.46	1.62
Iron	Top	mg/kg	100.20	81.24	80.23	81.62	102.20	43.66
	Sub	mg/kg	80.00	64.88	61.58	60.41	98.28	28.33
Nickel	Top	mg/kg	2.60	3.50	2.41	2.32	2.15	1.60
	Sub	mg/kg	1.06	2.41	2.24	2.33	2.33	1.86
Vanadium	Top	mg/kg	ND	0.12	0.09	0.23	0.71	0.06
	Sub	mg/kg	ND	ND	ND	ND	ND	ND
	Top	mg/kg	ND	0.03	ND	0.21	ND	ND

TABLE 4.12:SOIL SAMPLE MEASUREMENT (WET SEASON)

PARAMETER	UNIT OF MEASUREMENT		AMSS1	AMSS2	AMSS3	AMSS4	AMSS5	AMSS6	AMSS7
Ph		Top	7.41	7.44	5.99	5.71	5.69	7.98	8.25
		Sub	6.40	6.70	5.22	5.11	5.19	6.80	7.50
Nitrate	Ppm	Top	84.00	85.00	42.00	42.00	52.00	210.00	326.00
		Sub	86.22	88.45	53.64	48.20	60.05	218.00	343.08
Nitrite	Ppm	Top	4.00	23.00	20.00	22.00	14.00	32.01	26.00
		Sub	5.46	25.58	23.16	24.09	16.52	36.08	28.05
Phosphate	Ppm	Top	212.00	70.89	106.33	70.89	106.33	106.33	35.45
		Sub	220.23	86. 68	110.27	90.35	116.35	110.42	39.44
Sulphate	Ppm	Top	106.34	78.23	32.54	54.44	50.11	74.63	48.67
		Sub	111.46	88.56	35.23	68.86	55.15	80.91	51.34
CEC	(meq/100g)	Top	3.27	4.44	1.37	2.45	3.01	1.87	2.09
		Sub	2.46	2.48	1.32	1.45	2.87	1.30	1.12
THC	Ppm	Top	1.58	1.04	0.82	0.78	0.41	1.54	1.46
		Sub	1.55	0.83	0.58	0.29	0.30	0.26	0.25
TPH	Ppm	Top	0.02	0.01	0.01	0.10	0.01	0.64	0.79
		Sub	2.55	2.46	2.58	3.29	1.90	3.06	3.05
BTEX	Ppm	Top	ND	ND	ND	0.01	0.01	0.02	0.02
		Sub	ND	ND	ND	ND	ND	ND	ND
Sodium	(meq/100g)	Top	1.15	1.43	0.20	0.54	0.25	0.20	0.42
		Sub	1.37	1.89	1.57	1.58	1.30	1.38	1.45
Potasium	(meq/100g)	Top	0.55	1.26	0.14	0.77	0.10	0.11	0.54
		Sub	0.57	1.20	0.98	0.23	0.08	0.08	0.32
Calcium	(meq/100g)	Top	1.24	1.30	0.56	0.78	1.42	1.33	0.85
		Sub	1.12	1.13	0.45	0.66	1.23	0.98	O.86
Magnesium	(meq/100g)	Top	0.32	0.45	0.47	0.36	1.24	0.23	0.28
		Sub	0.28	0.46	0.41	0.32	1.23	0.21	0.14
Maganese	(meq/100g)	Top	2.11	1.30	2.85	1.67	2.37	1.96	3.74
		Sub	2.22	1.39	2.90	1.78	2.64	2.01	3.89
Iron	mg/kg	Top	339.98	354.98	236.08	381.98	318.18	270.58	322.98
		sub	400.06	401.48	248.91	406.57	390.22	330.41	401.38

Nickel	mg/kg	Top	2.48	4.52	3.66	4.27	2.94	1.77	2.86
		Sub	4.78	7.92	5.88	6.21	4.59	3.33	4.27
Vanadium	mg/kg	Top	0.85	1.44	0.27	2.60	ND	1.53	1.79
		Sub	0.98	1.46	0.48	2.83	ND	1.77	2.00
Cadmium	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	Top	14.10	21.17	10.32	46.30	7.04	7.80	23.25
		Sub	12.00	19.05	8.24				
Lead	mg/kg	Top	1.22	1.41	0.06	1.02	0.03	ND	0.42
		Sub	6.89	6.98	3.24	5.77	3.11	ND	4.28
Zinc	mg/kg	Top	15.11	29.66	2.23	28.61	2.55	12.02	30.96
		Sub	17.65	31.47	5.88	30.63	5.33	13.79	32,12
Mercury	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND

PARAMETER	UNIT OF MEASUREMENT		AMSS8	AMSS9	AMSS10	AMSS11	AMSS12	AMSS13	AMSS14
pH		Top	7.32	7.57	6.00	5.92	5.82	7.33	8.10
		Sub	6.89	7.23	5.88	5.43	5.66	7.05	7.84
Nitrate	Ppm	Top	64.00	58.00	51.00	43.00	58.00	216.00	231.41
		Sub	64.28	58.38	52.00	43.76	58.99	217.02	231.44
Nitrite	Ppm	Top	5.12	21.06	18.25	19.99	15.27	28.74	24.36
		Sub	5.00	20.78	18.04	19.33	15.09	28.41	23.55
Phosphate	Ppm	Top	231.14	72.3	111.28	111.3	121.41	98.74	42.1
		Sub	234,27	78.12	113.58	113.55	124.87	100.03	43.90
Sulphate	Ppm	Top	161.34	88.43	56.54	54.88	50.42	64.63	38.69
		Sub	162.35	66.88	57.64	57.98		51.00	40.46
CEC	(meq/100g)	Top	2.50	2.11	3.24	2.90	2.18	1.09	3.64
		Sub	1.50	1.11	2.22	1.97	1.20	0.76	2.65
THC	Ppm	Top	1.46	1.57	1.20	0.44	0.59	1.35	1.76
		Sub	1.3	1.50	1.00	0.38	0.48	1.03	1.48
TPH	Ppm		0.30	0.41	0.32	0.06	0.02	0.50	0.48

		Top							
		Sub	0.36	0.45	0.36	0.02	ND	0.38	0.37
BTEX	Ppm	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
Sodium	(meq/100g)	Top	0.17	0.68	0.66	0.41	0.36	0.26	0.41
		Sub	0.38	0.46	0.42	0.22	00.22.	0.23	0.31
Potasium	(meq/100g)	Top	0.12	0.21	0.55	0.66	0.57	0.32	0.65
		Sub	0.10	0.18	0.42	0.44	0.47	0.12	0.53
Calcium	(meq/100g)	Top	1.26	0.14	1.67	0.84	1.06	0.14	1.61
		Sub	1.20	0.08	1.60	0.65	0.69	0.07	1.53
Magnesium	(meq/100g)	Top	0.95	1.07	0.36	0.99	0.20	0.36	0.96
		Sub	1.05	1.87	1.96	2.01	1.13	1.77	2.00
Maganese	(meq/100g)	Top	2.04	1.01	3.89	1.47	3.21	2.56	4.78
		Sub	2.99	1.57	4.03	1.88	3.45	2.89	4.92
Iron	mg/kg	Top	232.98	234.98	232.01	281.18	228.18	250.54	222.98
		Sub	245.12	246.88	238.02	287.33	230.20	251.60	224.7
Nickel	mg/kg	Top	3.48	6.54	3.03	6.87	3.94	1.52	3.86
		Sub	3.50	5.60	3.28	6.71	4.02	1.56	3.97
Vanadium	mg/kg	Top	0.85	1.23	0.29	1.60	ND	1.22	1.47
		Sub	0..75	1.07	0.18	1.33	ND	1.09	1.35
Cadmium	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	Top	15.13	31.46	10.68	36.41	9.04	7.83	26.15
		Sub							
Lead	mg/kg	Top	1.07	1.11	ND	0.87	ND	ND	0.82
		Sub	5,23	2.99	ND	ND	ND	ND	ND
Zinc	mg/kg	Top	18.15	33.64	1.23	37.61	2.14	13.02	36.66
		Sub	18.23	33.84	2.02	37.72	2.44	13.78	38.66
Mercury	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND

PARAMETER	UNIT OF MEASUREMENT		AMSS15	AMSS16	AMSS17	AMSS18	AMSS19	AMSS20	AMSS21
pH		Top	Top	7.24	6.28	7.86	7.23	7.25	7.60
		Sub	Sub	7.12	6.20	7.25	7.11	7.11	7.29
Nitrate	Ppm	Top	Top	61.20	55.30	40.20	74.01	108.24	178.25
		Sub	Sub	62.79	56.33	40.88	75.36	106.28	180.00
Nitrite	Ppm	Top	Top	30.20	15.65	14.75	12.60	31.05	22.38
		Sub	Sub	31.20	16.66	15.65	13.40	30.23	20.78
Phosphate	Ppm	Top	Top	84.21	98.73	100.25	99.36	104.28	45.64
		Sub	Sub	83.25	96.25	98.36	98.27	102.79	43.55
Sulphate	Ppm	Top	Top	95.32	47.80	62.11	49.28	71.60	41.30
		Sub	Sub	94.24	45.80	61.24	47.24	70.01	40.26
CEC	(meq/100g)	Top	Top	2.57	3.00	3.72	2.64	1.68	3.29
		Sub	Sub	1.57	2.01	2.76	1.63	1.22	2.28
THC	Ppm	Top	Top	0.89	0.78	0.33	0.65	0.28	0.49
		Sub	Sub	90.03	08.06	0.33	0.67	0.29	0.51
TPH	Ppm	Top	Top	0.10	0.40	0.03	0.14	0.06	0.02
		Sub	Sub	0.08	0.37	ND	0.10	ND	ND
BTEX	Ppm	Top	Top	C	ND	ND	0.01	ND	ND
		Sub	Sub	ND	ND	ND	ND	ND	ND
Sodium	(meq/100g)	Top	Top	0.67	0.71	1.45	0.45	0.39	0.28
		Sub	Sub	0.65	0.68	1.42	0.42	0.35	0.25
Potasium	(meq/100g)	Top	Top	0.32	0.61	0.74	0.66	0.42	0.84
		Sub	Sub	0.32	0.58	0.67	0.64	0.39	0.80
Calcium	(meq/100g)	Top	Top	0.25	1.29	0.75	1.22	0.41	1.29
		Sub	Sub	0.22	1.21	0.65	1.04	0.29	1.24
Magnesium	(meq/100g)	Top	Top	1.33	0.39	0.78	0.31	0.46	0.88
		Sub	Sub	1.31	0.37	0.75	0.46	0.38	0.66
Maganese	(meq/100g)	Top	Top	0.94	2.17	1.20	2.14	2.20	3.56
		Sub	Sub	0.83	2.11	1.00	2.03	1.88	3.50
Iron	mg/kg	Top	54.36	58.32	56.78	59.64	55.40	57.58	45.39
		Sub	52.38	56.31	54.70	57.63	53.10	55.88	43.49

Nickel	mg/kg	Top	1.24	2.88	2.99	2.71	2.41	2.70	1.58
		Sub	1.20	2.60	2.77	2.65	2.31	2.50	1.50
Vanadium	mg/kg	Top	0.08	0.50	0.70	ND	ND	ND	1.33
		Sub	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/kg	Top	ND	ND	0.07	0.03	ND	ND	0.01
		Sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	Top	5.89	10.21	8.29	14.78	4.54	3.33	17.8
		Sub	2.89	10.01	8.22	12.78	4.52	3.11	15.90
Lead	mg/kg	Top	2.10	0.98	0.01	0.39	0.01	ND	0.54
		Sub	4.00	2.00	1.00	1.03	ND	ND	Nd
Zinc	mg/kg	Top	8.16	20.56	2.22	12.63	2.54	8.88	16.69
		Sub	8.00	18.49	2.00	10.61	2.39	7.99	16.26
Mercury	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND

PARAMETER	UNIT OF MEASUREMENT		AMSS22	AMSS23	AMSS24	AMSS25	AMSS26	AMSS27	AMSS28
pH		Top	7.11	7.52	7.63	7.21	7.44	7.84	8.00
		Sub	6.59	7.08	7.12	6.69	6.23	7.24	7.00
Nitrate		Top	58.66	50.20	51.36	53.30	71.20	89.30	78.60
		Sub	58.22	50.02	51.14	53.09	70.20	89.13	78.21
Nitrite	Ppm	Top	12.35	36.90	47.80	58.21	45.87	32.65	41.77
		Sub	11.35	35.80	45.80	48.20	44.83	30.75	40.66
Phosphate	Ppm	Top	120.30	84.10	80.25	95.65	90.99	101.24	48.70
		Sub	119.30	8063.10	79.26	94.66	89.77	100.24	47.
Sulphate	Ppm	Top	105.40	92.10	48.30	63.20	49.30	70.22	43.30
		Sub	100.02	90.19	47.28	60.39	47.12	70.02	42.18
CEC	Ppm	Top	3.20	2.68	3.38	3.44	2.92	1.72	3.78
		Sub	1.23	1.17	1.38	1.45	1.22	0.98	1.46
THC	(meq/100g)	Top	1.20	1.60	1.77	1.24	0.98	2.56	1.03
		Sub	1.04	1.08	1.07	1.03	0.87	2.27	0.43
TPH	Ppm	Top	0.30	0.20	0.14	0.15	0.14	0.88	0.10

		Sub	0.35	0.25	0.18	0.20	0.18	1.00	0.20
BTEX	Ppm	Top	0.02	0.01	ND	ND	ND	0.02	0.03
		Sub	ND	ND	ND	ND	ND	ND	ND
Sodium	Ppm	Top	1.11	0.45	0.90	1.33	0.57	0.54	0.56
		Sub	1.22	0.57	1.02	1.55	0.95	0.87	0.87
Potasium	(meq/100g)	Top	0.12	0.35	0.76	0.65	0.54	0.48	0.92
		Sub	0.15	0.40	0.84	0.74	0.68	0.67	1.21
Calcium	(meq/100g)	Top	1.23	0.36	1.44	0.64	1.45	0.39	1.55
		Sub	1.03	0.16	0.22	0.39	1.35	0.29	1.35
Magnesium	(meq/100g)	Top	0.74	1.52	0.28	0.82	0.36	0.31	0.75
		Sub	0.84	1.67	0.38	0.97	0.46	0.51	0.89
Maganese	(meq/100g)	Top	2.36	2.14	2.01	0.85	3.10	1.22	2.86
		Sub	2.40	2.56	2.32	1.00	3.32	1.44	3.00
Iron	(meq/100g)	Top	63.01	61.02	64.12	66.23	58.2	67.1	51.41
		Sub	4.53	66.05	67.23	69.42	61.39	70.03	55.58
Nickel	mg/kg	Top	1.66	1.87	2.45	2.63	1.48	1.66	0.98
		Sub	1.77	1.97	2.65	2.86	1.56	1.77	1.22
Vanadium	mg/kg	Top	ND	ND	0.01	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/kg	Top	0.12	0.03	0.04	0.26	ND	ND	0.33
		Sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	Top	6.54	11.20	9.56	13.47	5.12	6.45	5.14
		Sub	6.75	11.46	10.24	13.78	5.88	6.75	5.49
Lead	mg/kg	Top	3.02	1.24	0.28	0.41	ND	0.12	0.11
		Sub	6.90	4.02	2.88	2.98	1.03	1.99	1.99
Zinc	mg/kg	Top	7.19	14.12	2.54	11.39	3.01	7.78	13.69
		Sub	7.33	14.56	2.92	11.87	3.68	7.88	13,72
Mercury	mg/kg	Top	C	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
PARAMETER	UNIT OF MEASUREMENT		AMSS29	AMSS30	AMSS31	AMSS32	AMSS33	AMSS34	AMSS35
pH		Top	7.20	7.00	5.69	6.87	6.98	7.52	7.41

		Sub	6.58	6.47	5.33	6.28	6.32	7.15	7.09
Nitrate	Ppm	Top	71.02	78.26	79.35	68.20	64.29	78.50	124.05
		Sub	74.58	80.26	81.34	7o.78	66.42	80.50	126.10
Nitrite	Ppm	Top	6.30	8.64	14.25	15.67	12.58	13.47	10.25
		Sub	6.20	8.24	14.08	15.27	12.28	13.17	10.05
Phosphate	Ppm	Top	124.20	80.54	45.63	68.54	63.60	87.44	69.28
		Sub	126.30	83.60	47.63	69.59	63.90	89.22	7030
Sulphate	Ppm	Top	106.34	78.23	32.54	54.44	50.11	74.63	48.67
		Sub	105.34	78.33	31.58	53.66	48.10	73.53	47.68
CEC	(meq/100g)	Top	3.21	3.65	1.56	2.26	3.24	2.00	1.29
		Sub	2.31	3.46	1.32	2.00	3.14	1.50	0.88
THC	Ppm	Top	1.44	1.28	0.67	1.03	0.45	2.40	2.30
		Sub	1.33	1.12	0.55	0.89	0.31	2.05	2.15
TPH	Ppm	Top	0.60	0.50	0.44	0.62	0.03	0.12	0.21
		Sub	0.65	0.55	0.48	0.69	0.09	0.48	0.49
BTEX	Ppm	Top.15	0.01	<0.001	<0.001	0.02	<0.001	<0.001	0.03
		Sub	ND	ND	ND	ND	ND	ND	ND
Sodium	(meq/100g)	Top	1.28	1.11	0.32	0.46	0.33	0.12	0.27
		Sub	1.08	1.09	0.35	0.38	0.33	00.08	0.12
Potasium	(meq/100g)	Top	0.39	1.02	0.28	0.88	0.31	0.12	0.52
		Sub	0.46	1.50	0.47	1.02	0.75	0.73	1.23
Calcium	(meq/100g)	Top	1.21	1.11	0.54	0.63	1.29	1.44	0.25
		Sub	1.18	1.00	0.50	0.59	1.17	1.22	0.21
Magnesium	(meq/100g)	Top	0.33	0.41	0.42	0.29	1.31	0.32	0.25
		Sub	0.40	0.55	0.58	0.39	1.66	0.54	0.45
Maganese	(meq/100g)	Top	2.00	1.50	1.87	1.45	2.15	2.01	3.03
		Sub	2.34	1.89	2.07	1.65	2.35	2.33	3.49
Iron	mg/kg	Top	220.00	224.00	250.10	202.20	215.08	261.14	265.01
		Sub	222.00	225.00	252.00	205.20	220.10	265.20	267.29
Nickel	mg/kg	Top	1.25	6.20	3.90	3.55	2.78	2.02	2.56
		Sub	1.56	6.87	4/22	3.88	2.90	2.43	2.96
Vanadium	mg/kg		0.52	1.54	0.65	1.58	2.22	1.47	2.06

		Top							
		Sub	0/82	1/84	0.78	1.93	2.56	1.73	2.74
Cadmium	mg/kg	Top	ND	0.01	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	Top	10.20	12.40	9.58	36.02	8.04	6.66	18.18
		Sub	12.20	14.40	10.68	37.23	9.06	7.88	20.18
Lead	mg/kg	Top	2.01	1.20	0.80	0.87	0.20	0.01	0.30
		Sub	4.00	3,20	1.24	1.21	0.76	0,34	o.44
Zinc	mg/kg	Top	12.10	24.15	4.14	19.99	2.41	9.25	28.23
		Sub	11.93	22.15	3.14	17.59	4.31	10.85	29.23
Mercury	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND

PARAMETER	UNIT OF MEASUREMENT		AMSS36	AMSS37	AMSS38	AMSS39	AMSS40	AMSS41	AMSS42
pH		Top	7.30	6.05	7.18	7.40	5.24	6.90	6.26
		Sub	7.03	5.89	6.88	7.20	5.14	6.35	1.06
Nitrate	Ppm	Top	114.00	124.00	124.00	127.00	173.00	101.00	115.00
		Sub	115.00	125.00	126.00	129.00	175.00	103.00	117.00
Nitrite	Ppm	Top	14.00	12.00	13.20	7.69	16.22	19.36	13.28
		Sub	14.38	12,49	13,88	7.89	1.55	19.82	
Phosphate	Ppm	Top	35.00	38.00	38.00	39.00	53.00	31.00	46.00
		Sub	37.00	40.00	40.00	41.00	54.00	33.00	47.00
Sulphate	Ppm	Top	120.36	68.31	65.08	75.42	85.06	107.78	90.5
		Sub	118.35	66.32	63.05	72.89	84.05	105.68	89.01
CEC	(meq/100g)	Top	3.490.88	4.59	1.47	2.41	2.62	2.27	2.05
		Sub	2.49	3.59	1.27	1.43	1.67	1.30	1.07
THC	Ppm	Top	1.59	1.14	0.92	0.83	0.61	1.64	1.17
		Sub	1.50	1.00	0.72	0.64	0.43	1.28	1.00
TPH	Ppm	Top	0.20	0.60	0.23	0.10	0.09	0.51	0.78
		Sub	0.25	0.65	0.33	0.25	0.10	0.65	
BTEX	Ppm	Top	ND	ND	ND	ND	ND	ND	0.02
		Sub	ND	ND	ND	ND	ND	ND	ND

Sodium	(meq/100g)	Top	1.25	1.30	0.40	0.64	0.35	0.36	0.42
		Sub	1,23	1,14	0.20	0.42	0.15	0.23	0/32
Potasium	(meq/100g)	Top	0.56	1.36	0.16	0.72	0.13	0.14	0.54
		Sub	0.60	1.46	0.32	0.94	0.26	0.48	0.93
Calcium	(meq/100g)	Top	1.26	1.37	0.46	0.68	1.12	1.43	0.65
		Sub	1.3	1.30	0.28	0.42	0.89	1.27	0.36
Magnesium	(meq/100g)	Top	0.41	0.56	0.45	0.37	1.02	0.34	0.44
		Sub	0.69	0.85	0.68	0.57	1.64	0.59	0.99
Maganese	(meq/100g)	Top	1.68	1.27	2.02	1.54	2.01	2.00	2.68
		Sub	1.78	1.37	2.24	1.63	2.18	2.17	2.97
Iron	mg/kg	Top	49.92	54.08	36.48	81.18	118.10	70.22	42.91
		Sub	50.92	55.07	37.58	82.44	200.21	72.94	44.92
Nickel	mg/kg	Top	1.54	3.21	2.77	3.03	3.30	1.58	2.02
		Sub	1.58	3.41	2.99	3.30	3.73	1.98	2.34
Vanadium	mg/kg	Top	ND	1.28	0.68	1.42	0.09	129	1.33
		Sub	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	Top	12.21	14.02	9.28	16.81	7.04	6.66	13.36
		Sub							
Lead	mg/kg	Top	1.33	2.24	0.74	2.01	3.27	1.11	0.78
		Sub	5.43	6.22	3.90	6.42	7.58	3.44	1.80
Zinc	mg/kg	Top	5.11	8.92	3.14	18.71	3.54	12.01	14.26
		Sub	6.11	9.90	4.14	19.18	4.54	13.03	15.43
Mercury	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND

PARAMETER	UNIT OF MEASUREMENT		AMSS43	AMSS44	AMSS45	AMSS46	AMSS47	AMSS48	AMSS49
pH		Top	7.70	6.66	7.20	7.43	6.24	6.83	7.26
		Sub	7.10	6.22	7.00	7.13	6.01	6.23	7.12
Nitrate	Ppm	Top	40.65	24.74	42.01	27.32	73.11	28.55	35.00

		Sub	45.55	28.74	45..02	30.42	76.11	32.56	37.02
Nitrite	Ppm	Top	4.22	2.87	3.20	7.69	11.22	13.36	11.18
		Sub	4.00	2.35	3.00	7.27	11.00	13.04	11.00
Phosphate	Ppm	Top	135.00	81.14	68.61	43.37	43.55	39.20	56.77
		Sub	136.00	81.25	68.84	44.40	44.66	40.25	56.88
Sulphate	Ppm	Top	110.11	80.31	55.28	65.49	75.16	87.78	92.15
		Sub	100.33	75.32	50.87	63.29	73.25	85.78	90.23
CEC	(meq/100g)	Top	3.69	3.58	2.10	1.90	2.78	2.10	1.98
		Sub	2.68	2.57	1.87	1.30	1.52	1.89	1.21
THC	Ppm	Top	2.51	1.41	1.11	1.25	0.87	1.22	1.47
		Sub	2.15	1.21	1.00	1.12	0.77	1.11	1.25
TPH	Ppm	Top	0.74	0.25	0.22	0.24	0.26	0.06	0.69
		Sub	0.97	0.30	0.33	0.28	0.29	0.10	0.99
BTEX	Ppm	Top	0.01	ND	ND	ND	ND	ND	0.02
		Sub	ND	ND	ND	ND	ND	ND	ND
Sodium	(meq/100g)	Top	1.14	1.03	0.39	0.66	0.41	0.25	0.50
		Sub	1.12	0.91	0.32	0.55	0.32	0.21	0.45
Potasium	(meq/100g)	Top	0.61	1.22	0.34	0.54	0.23	0.21	0.60
		Sub	0.65	1.27	0.39	0.75	0.36	0.32	0.95
Calcium	(meq/100g)	Top	1.55	1.02	1.04	0.25	1.03	1.35	0.51
		Sub	1.45	0.85	0.84	0.15	0.76	1.15	0.36
Magnesium	(meq/100g)	Top	0.39	0.31	0.33	0.45	1.11	0.29	0.37
		Sub	0.42	0.40	0.40	0.55	1.35	0.38	0.52
Maganese	(meq/100g)	Top	1.68	1.35	3.20	1.70	2.55	2.98	3.31
		Sub	1.98	1.67	3.43	1.90	2.88	3.00	3.65
Iron	mg/kg	Top	56.57	65.23	65.89	74.12	75.26	69.87	65.23
		Sub	60.60	68.23	67.90	77.14	77.89	76.02	68.22
Nickel	mg/kg	Top	2.15	2.69	3.66	3.88	3.45	3.21	2.78
		Sub	2.20	2.30	3,40	3,42	3,41	3,30	2,31
Vanadium	mg/kg	Top	0.35	0.21	0.41	2.14	0.03	1.23	1.33
		Sub	0.25	0.11	0.31	1.14	ND	1.13	1.22
Cadmium	mg/kg		1.01	ND	ND	0.02	ND	ND	ND

		Top							
		Sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	Top	10.20	6.98	5.64	9.17	1.58	7.14	8.22
		Sub	12.29	8.89	6.66	10.27	2.59	8.22	9.34
Lead	mg/kg	Top	2.22	2.36	3.01	2.78	4.15	4.12	3.64
		Sub	5.22	5.36	6.33	25.27	8.12	8.12	5.23
Zinc	mg/kg	Top	6.66	9.88	5.41	7.56	65.04	11.25	13.25
		Sub	6.88	9.99	5,67	7.89	65.21	11.34	13.30
Mercury	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND

PARAMETER	UNIT OF MEASUREMENT		AMSS50	AMSS51	AMSS52	AMSS53	AMSS54	AMSS55	AMSS56
pH		Top	7.54	7.05	6.99	6.45	6.77	7.33	7.72
		Sub	7.14	6.67	6.22	6.15	6.22	6.99	7.25
Nitrate	Ppm	Top	76.30	95.04	81.12	76.25	74.15	80.22	94.23
		Sub	79.00	98.06	84.33	78.30	76.30	83.33	96.25
Nitrite	Ppm	Top	3.21	8.74	12.14	7.74	10.39	9.68	9.88
		Sub	3.00	8.54	11.23	7.23	9.88	9.23	9.22
Phosphate	Ppm	Top	94.14	98.25	101.35	74.25	75.65	86.35	77.77
		Sub	96.23	100.30	103.40	75.15	76.78	88.03	76.88
Sulphate	Ppm	Top	120.32	112.74	102.35	116.35	145.25	98.87	78.56
		Sub	118.32	110.84	100.38	114.25	143.28	96.88	76.49
CEC	(meq/100g)	Top	3.15	2.88	1.47	1.89	3.18	2.56	1.33
		Sub	2.15	1.88	0.47	0.89	2.18	1.56	0.33
THC	Ppm	Top	0.98	1.28	2.10	1.78	1.45	2.41	2.01
		Sub	0.78	1.00	2.00	1.28	1.27	2.11	1.89
TPH	Ppm	Top	0.81	0.05	0.74	0.52	0.35	0.11	0.30
		Sub	0.91	0.10	0.94	0.72	0.53	0.33	0.60
BTEX	Ppm	Top	ND	ND	ND	ND	ND	0.12	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
Sodium	(meq/100g)	Top	1.11	0.31	0.27	0.41	0.26	0.24	0.34
		Sub	1.22	0.78	0.48	0.77	0.48	0.43	0.79

Potasium	(meq/100g)	Top	0.42	1.21	0.31	0.47	0.42	0.36	0.39
		Sub	1.42	1.87	1.31	0.98	0.84	0.68	0.41
Calcium	(meq/100g)	Top	1.21	1.11	0.54	0.63	1.29	1.44	0.25
		Sub	0.32	1.04	0.13	0.27	0.22	0.16	0.19
Magnesium	(meq/100g)	Top	0.41	0.25	0.35	0.38	1.21	0.52	0.35
		Sub	1.41	1.29	1.36	1.36	1.32	1.57	1.35
Maganese	(meq/100g)	Top	3.21	5.12	2.48	2.88	3.66	3.45	2.59
		Sub	3.48	5.64	2.89	3.02	3.99	3.90	2.97
Iron	(meq/100g)	Top	152.22	124.00	142.10	202.40	115.22	96.16	65.01
		Sub	150.00	120.00	140.00	200.20	113.11	96.00	64.88
Nickel	mg/kg	Top	2.65	8.33	5.41	3.64	4.78	2.65	3.66
		Sub	2.78	8.99	5.82	3.93	4.92	2.91	3.96
Vanadium	mg/kg	Top	0.12	0.36	0.45	1.20	2.88	1.56	2.84
		Sub	0.03	0.04	0.35	1.20	2.33	1.24	1.47
Cadmium	mg/kg	Top	0.00	0.01	ND	0.04	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	Top	8.74	6.55	7.92	12.32	7.44	5.48	13.25
		Sub	10.74	8.66	994	13.38	8.55	5.99	14.23
Lead	mg/kg	Top	2.01	1.20	0.80	0.87	0.20	0.01	0.32
		Sub	4.20	3.28	2.80	2.77	1.34	0.36	1.60
Zinc	mg/kg	Top	11.45	21.01	6.35	7.11	2.41	5.21	23.12
		Sub	12.45	23.03	7.67	8.01	3.56	6.22	24.14
Mercury	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND

PARAMETER	UNIT OF MEASUREMENT		AMSS57	AMSS58	AMSS59	AMSS60	AMSS61	AMSS62	AMSS63
pH		Top	7.10	7.00	7.41	6.66	7.14	7.05	7.16z
		Sub	6.89	6.48	7.11	6.22	6.79	6.88	6.86
Nitrate	Ppm	Top	77.21	62.21	55.23	68.95	47.58	70.10	68.99
		Sub	79.21	64.22	57.25	70.96	49.68	72.23	70.23
Nitrite	Ppm		3.60	4.12	2.15	2.00	5.14	6.22	47.80

		Top							
		Sub	3.20	4.00	2.00	1.0	5.00	6.00	47.20
Phosphate	Ppm	Top	84.14	87.00	75.52	66.53	45.27	81.49	63.45
		Sub	85.24	88.00	77.54	67.55	46.34	83.50	65.45
Sulphate	Ppm	Top	102.07	45.36	85.26	90.25	112.28	67.55	70.49
		Sub	101.07	46.26	84.23	89.32	111.28	66.54	69.50
CEC	ppm	top		2.55	1.26	1.86	2.94	2.71	2.00
		sub		1.55	0.26	0.86	1.94	1.71	1.00
THC	Ppm	TOP	1.48	2.23	2.57	2.63	2.22	4.10	3.14
		sub	0.48	1.23	1.56	1.48	1.22	3.10	2.14
TPH	Ppm	Top	0.30	0.10	0.50	1.06	0.66	0.12	0.60
		Sub							
BTEX	Ppm		ND	ND	ND	ND	ND	ND	ND
		top	ND	ND	ND	ND	ND	ND	ND
Sodium	(meq/100g)	sub	1.04	0.56	0.22	0.41	0.21	0.24	0.61
		top							
Potasium	(meq/100g)	top	0.33	1.31	0.28	0.47	0.39	0.43	0.56
		sub							
Calcium	(meq/100g)	top	1.27	0.32	0.24	0.67	1.33	1.52	0.42
		sub							
Magnesium	(meq/100g)	top	0.45	0.36	0.52	0.31	1.01	0.52	0.41
		Sub							
Maganese	(meq/100g)	Top	2.65	6.32	4.25	3.16	3.28	1.47	3.25
		Sub							
Iron	mg/kg	Top	166.20	130.20	13.24	25.12	102.25	90.56	98.45
		Sub							
Nickel	mg/kg	Top	2.30	4.12	4.22	3.56	3.74	4.60	0.35
		Sub							
Vanadium	mg/kg	Top	0.50	0.30	0.55	2.17	3.58	3.25	1.18
		Sub	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/kg	Top	ND	0.03	ND	0.02	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	Top	6.89	5.55	8.10	11.02	6.22	6.45	8.77
		Sub	7.00	6.00	8.25	11.48	6.88	6.99	9.01
Lead	mg/kg	Top	2.60	2.14	0.90	0.88	2.14	0.63	2.35
		Sub	4.60	4.24	1.9001.88	1.88	4.14	1.64	3.44
Zinc	mg/kg	Top	12.25	15.24	6.32	8.24	2.45	7.14	4.69
		Sub							
Mercury	mg/kg	Top	ND	ND	ND	ND	ND	ND	ND
		Sub	ND	ND	ND	ND	ND	ND	ND

PARAMETER	UNIT OF MEASUREMENT		AMSS64	AMSS65	AMSS66	AMSS67	AMSS68	AMSS69	AMSS70
pH		Top	7.11	6.78	7.24	7.29	7.35	7.64	7.37
		Sub							
Nitrate	Ppm	Top	87.36	90.14	76.77	80.20	97.36	88.54	102.84
		Sub	89.46	92.34	78.99	82.40	99.46	89.65	103.45
Nitrite	Ppm	Top	12.31	10.42	8.74	9.35	5.47	6.66	11.52
		Sub	11.32	10.21	6.34	8.99	5.04	6.11	11.14
Phosphate	Ppm	Top	56.54	74.51	85.63	67.25	94.15	86.69	77.41
		Sub	57.57	75.58	86.73	67.89	95.23	88.70	78.51
Sulphate	Ppm	Top	102.4	111.84	97.88	84.58	75.26	105.65	104.98
		Sub	101.30	110.12	96.78	83.68	74.28	104.75	103.09
CEC	(meq/100g)	Top	2.84	3.78	3.12	3.66	4.65	1.54	2.13
		Sub	1.86	2,78	2.12	2.66	3.65	0.54	2.01
THC	Ppm	Top	0.25	0.69	1.08	1.47	1.35	2.54	1.78
		Sub	0.21	0.54	0.89	1.24	1.15	1.58	1.38
TPH	Ppm	top	0.20	0.60	0.23	0.10	0.09	0.51	0.78
		sub	0.45	0.90	0.58	0.40	0.12	0.76	0.94
BTEX	Ppm	top	0.01	0.02	ND	ND	ND	0.31	0.05
		sub	ND	ND	ND	ND	ND	ND	ND
Sodium	(meq/100g)	top	0.47	0.56	1.25	0.87	1.41	0.37	0.47
		Sub	0.78	0.86	1.59	1.23	1.84	0.88	0.96
Potasium	(meq/100g)	sub	0.24	0.88	0.27	0.90	1.20	0.42	0.34
		top	0.22	0.55	0.21	0.70	1.00	0.32	0.23
Calcium	(meq/100g)	sub	1.11	1.21	1.35	1.24	1.62	0.47	0.99
		top	1.36	1.42	1.55	1.46	1.88	0.87	1.32
Magnesium	(meq/100g)	sub	1.02	1.13	0.25	0.65	0.42	0.28	0.33
		top	0.98	1.00	0.15	0.55	0.38	0.24	0.11
Maganese	(meq/100g)	sub	0.69	1.40	1.23	1.69	2.54	2.48	3.47
		top	0.64	1.38	1.18	1.47	212	2.12	3.18
Iron	mg/kg	sub	58.66	68.99	74.12	85.64	72.36	83.21	96.65
		top	59.67	67.88	73.90	86.45	73.39	84.22	97.54
Nickel	mg/kg	top	2.55	2.47	2.64	2.39	3.69	3.48	2.66
		sub	2.45	2.35	2.36	2.13	3.23	3.24	2.22
Vanadium	mg/kg	top	ND	0.27	0.12	0.34	1.02	1.34	1.81
		sub	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/kg	top	0.03	0.10	ND	0.50	ND	ND	0.11
		sub	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	top	10.24	11.28	14.60	2.86	8.65	4.75	8.63
		sub	11.56	12.37	15.90	2.89	8/84	4.90	8.88
Lead	mg/kg	top	0.58	1.02	3.65	4.89	3.42	2.74	0.98
		sub	2.50	3..20	5.76	6.48	5.43	4.78	1.98
Zinc	mg/kg	top	6.35	7.24	4.59	12.34	5.55	9.66	13.47
		sub	6.70	7.68	5.60	13.44	6.66	10.34	14.87

Mercury	mg/kg	top	ND	ND	ND	ND	ND	ND	ND
		sub	ND	ND	ND	ND	ND	ND	ND

PARAMETER	UNIT OF MEASUREMENT		AMSS71	AMSS72	AMSS73	AMSS74	AMSS75	AMSSC1
Ph		top	7.03	7.11	7.56	6.89	8.24	7.10
		sub	6.70	6.90	6.45	6.23	7.44	6.79
Nitrate	Ppm	top	104.25	98.74	123.46	115.75	85.51	60.25
		sub	105.56	99.45	135.67	116.85	86.53	60.90
Nitrite	Ppm	top	23.14	12.65	21.59	18.74	13.33	4.15
		sub	22.4	11.66	20.49	17.75	12.23	3.15
Phosphate	sub	top	189.69	200.35	147.25	214.62	109.37	80.21
		sub	190.70	202.37	148.34	216.88	111.43	82.34
Sulphate	Ppm	top	100.25	100.78	107.25	96.35	97.55	94.01
		sub	99.47	98.22	106.48	95.47	96.66	93.20
CEC	(meq/100g)	top	3.14	3.32	2.38	2.90	2.66	1.64
		sub	2.14	2.32	1.35	1.90	1.66	0.64
THC	Ppm	top	1.24	1.84	1.26	1.35	2.48	0.25
		sub	1.12	1.37	1.16	1.21	2.18	0.15
TPH	Ppm	top	0.31	0.42	0.21	0.11	0.28	0.02
		sub	0.37	0.58	0.36	0.22	0.47	0.13
BTEX	Ppm	top	ND	ND	ND	0.02	ND	ND
		sub	ND	ND	ND	ND	ND	ND
Sodium	(meq/100g)	top	1.02	1.25	0.36	0.48	0.33	0.27
		sub	0.08	0.28	0.31	0.42	0.22	0.21
Potasium	(meq/100g)	top	0.28	0.14	0.29	0.46	0.57	0.14
		sub	0.26	0.07	0.27	0.40	0.45	0.29
Calcium	(meq/100g)	top	1.28	1.45	1.36	1.27	1.58	1.00
		sub	1.26	1.43	1.33	1.20	1.53	1.00
Magnesium	(meq/100g)	top	0.56	0.48	0.37	0.69	0.18	0.23
		sub	0.52	0.43	0.34	0.23	0.09	0.13
Maganese	(meq/100g)	top	3.21	3.45	2.47	1.69	1.48	1.44
		sub	3.41	3,70	2.67	1.90	1.88	1.78
Iron	mg/kg	top	98.36	78.45	82.36	81.29	100.95	42.56
		sub	99.57	79.50	63.42	83.58	98.92	44.89
Nickel	mg/kg	top	2.55	3.47	2.66	2.45	2.33	1.55
		sub	2.66	3.87	2.99	279	266	.188
Vanadium	mg/kg	top	ND	0.23	0.08	0.24	0.66	0.01
		sub	ND	ND	ND	ND	ND	ND
Cadmium	mg/kg	top	ND	0.02	ND	0.10	ND	ND
		sub	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	top	8.54	7.65	9.65	1.25	4.44	2.17
		sub	10.33	9.76	10.96	2.38	5.55	3.26
Lead	mg/kg	top	0.44	1.25	3.65	3.75	6.25	0.87

		sub	3.42	5.45	6.78	6.85	8.50	3.49
Zinc	mg/kg	top	6.56	7.48	9.36	14.25	12.37	6.52
		sub	6.70	7-80	9.56	15.00	12.89	7.02
Mercury	mg/kg	top	ND	ND	ND	ND	ND	ND
		sub	ND	ND	ND	ND	ND	ND

4.8.1 Soil Chemical Properties

Soil pH

Soil pH for the project area ranged between 5 to 8 for both the rainy and dry season. Soil pH value is a measure of the free hydrogen ion (H+) and hydroxyl ion (OH-) concentration of soil solutions. The pH provides a variety of useful information about soil including the relative availability of plant nutrients amongst others. The pH of the project area is slightly acidic and slightly alkaline. The average pH value of soil samples from the study area was 6.9 which is within the FMEnv limit of 6-9.

Soil Nutrients (Nitrate Nitrite, phosphate and Sulphate)

The average concentration of Nitrate in the soil samples for wet season was 88.08ppm which is above control sample of 63.25ppm, for nitrite the average concentration is 15.88ppm also above the control point of 4.39ppm, for phosphate the average concentration is 91.89ppm above the control point of 79.36, For Sulphate, average concentration was 82.52ppm below the control point of 95.63ppm. For the wet season the average concentration of Nitrate in the soil samples was 86.42ppm which is above control sample of 60.25ppm, for nitrite the average concentration is 15.96ppm also above the control point of 4.15ppm, for phosphate the average concentration is 89.15ppm above the control point of 80.25, For Sulphate, average concentration was 81.40ppm below the control point of 94.01ppm. Although, the general concentrations of anions in soil samples from the study area were high except for the sulphate, however they were found to be within the acceptable range for good agricultural performance (Sobulo and Adepetu, 1987).

Exchangeable Cations (Magnesium (Mg2+), Calcium (Ca2+), Potassium (K+) and Sodium (Na2+)

The exchangeable cations in the soil are easily dissolved into solution making them readily available for uptake by the roots of plants. Their presence in soils is therefore directly related to the nutrient levels and hence, fertility of the soil. Cation nutrients such as, Magnesium (Mg2+), Calcium (Ca2+), Potassium (K+) and Sodium (Na2+), also help in cleansing the soil by providing adsorption/exchange sites for potential soil and groundwater pollutants e.g. Lead (Pb2+), Cadmium (Cd2+), etc. First, the pollutants are immobilised and finally form insoluble hydroxides, carbonates, etc, thus, becoming unavailable for plants use.

For dry season the average Magnesium concentration was 0.588mg/kg which is below the FMEnv limit 50mg/kg. Calcium in the soil samples has an average concentration of 1.04mg/kg which is below the FMEnv limit of 150mg/kg. Potassium has an average data of 0.54mg/kg and sodium has an average data of 0.67mg/kg. For wet season the average Magnesium concentration was 0.56mg/kg which is below the FMEnv limit 50mg/kg, Calcium in the soil samples has an average concentration of 1.01mg/kg which is below the FMEnv limit of 150mg/kg, potassium has an average data of 0.51mg/kg and sodium has an average data of 0.59mg/kg.

Heavy Metals

These are metals with mass number greater than 20 and specific gravity greater than 5.0g/cm3. They usually occur naturally in the environment at low concentrations; however heavy metal pollution may occur when concentration becomes higher than recommended threshold. Elevated concentrations may be due to anthropogenic activities especially the discharge of heavy metal laden waste into the environment. When this occurs, plant and animals may absorb these toxic elements which can impair proper growth and physiological development. The following heavy metals were analyzed in soil samples from the project site: Manganese (Mn), Iron (Fe), Vanadium, Nickel (Ni), Cadmium, Chromium, Lead (Pb), Zinc (Zn) and Mercury. While mercury is not detected, vanadium and cadmium is not detected on some sampling points.

Iron (Fe): The average concentration of iron measured from the analysis of soil samples collected from the study area for dry season is 131.51mg/kg and wet season is130.57mg/kg which is above the FMEnv limit of <1mg/kg.

Manganese (Mn): The average concentration of manganese in the soils of the study area during the dry season was 2.71mg/kg and the wet season was 2.41mg/kg. The concentration levels are well above the FMEnv recommended threshold of 0.20 mg/kg in all soil samples. Elevated levels may not be unrelated to the nature of minerals in the soil, use of agrochemicals and other anthropogenic activities in the study area.

Lead (Pb): The average lead concentration in soil samples from the study area for the dry season is 1.61mg/kg and the wet season is 1.54mg/kg. The values of Pb recorded at the study area were above the FMEnv limit of <1mg/kg prescribed for fairly unpolluted soils. This shows evidence of human activities, has the project area been formerly a settlement before the resettlement of the resident to another land.

Nickel (Ni): The average concentration of Nickel in soil samples for the dry season was 9.29 mg/kg and wet season was 3.07mg/kg. The Nickel concentration values obtained for all the soil samples were above the limit of <1mg/kg prescribed for unpolluted soil samples by the FMEnv. This shows evidence of human activities, has the project area was formerly a settlement before the resettlement of the resident to another land.

Zinc (Zn): The average concentrations of Zinc obtained in the soil samples from the study area for the dry season was 11.92mg/kg and the wet season was 12.30mg/kg. The values of Zn recorded at the study area were above the limit of <1mg/kg prescribed for unpolluted soil by the FMEnv.

The slightly elevated levels of heavy metals in the soil of the project area may not be unrelated to the nature and availability of solid minerals underneath the soil as well as anthropogenic activities including the use of hydrocarbon products and agro-chemicals which may have contaminated the soils in the area. It is instructive to note that the levels recorded were fairly above those prescribed for unpolluted soil by Allen et al (1974).

4. 9 VEGETATION AND WILDLIFE STUDIES

The synopsis of vegetation characteristics as well as wildlife studies carried out across the project area during the sampling exercise is presented in the subsections below.

4.9.1 Vegetation Study

Amfani Town falls within the southern guinea savannah zone. However, clearance of vegetation for farming, fuel wood extraction for domestic and cottage industrial uses and saw milling has led to the development of growth vegetation at various levels of development. Dense forests are few and far apart. Such forests are found in lowland areas, particularly where population pressure is less on the land. Gallery forests are common along major streams and pronounced depressions.

The vegetation is characterized with interspersions of thickets, grassland tree savannah, and fringing woodland or gallery forests along the valleys. The dominant woody species in the Amfani communities include Elaeis guinesis, (cashew)Anacardium occidentales, *Terminalia laxiflora*, *Albizia zygia*, *Ficus exasperate*, *Ficus syncomorous*, *Khaya senegalesis*, *Tarmarindus indica* (tsamiya), *Parkia biglobosa* (Doruwa), *Vitellaria pradoxa* "Kadanya" (Shear butter),*Vitex doniana* (dinya), *Annona sengalensis* , *Mangifera indica*, Citrus senensis, *Azadirachta indica* (Dongoyaro) etc. also grasses and isolated trees. Trees of economic value, including locust bean, shea-butter, mango and citrus were identified.

Aquatic Macrophytes

The Kainji lake inhabits a good percentage of aquatic macrophytes; predominatly water lettuce (*Pistia stratiotes*), water lily (*Nymphaea spp*), swamp potato (*Ipomoea aquatica*). Common plants found in the area is shown in the table below.

Table 4.13: Common Plants Encountered in the Area

	Common name	Botanical name	Structure	Local Uses
1.	Bitter leaf	*Vernonia amygdalina*	Herb	Edible leaf
2.	Baobab	*Adansonia digitata*	Tree	Edible leaf and fruits
3.	Acacia	*Acacia sengal*	Tree	Source of gum Arabica
4.	Maje (hausa)	*Daniellia oliveri*	Tree	Fuel wood
5.	Doka (hausa)	*Isoberlinia doka*	Tree	Fuel wood
6.	Locust bean	*Parkia biglobosa*	Tree	Edible
7.	Mahogany	*Khaya ivorensis*	Tree	Source of wood
8.	Mango	*Mangifera indica*	Tree	Edible fruit
9.	Isamiya (hause)	*Tamarindus indica*	Tree	Edible by cattle
10.	Neem plant	Azadirachta indica	Tree	Medicinal Plant
11.	Makerfo (Hausa)	*Afromosia laxiflora*	Tree	Fuel wood
12.	Shea butter	*Butryspermum spp. Vitellaria pradoxa*	Tree	Edible and use for skin application
13.	Oil palm	*Elaeis guinesis*	Tree	Edible fruit
14.	Cashew	*Anacardium occidentales*	Tree	Edible fruit cash crop

The species of grasses that are found includes *Penisetum setaceum*, *Andropogan citratus*, *Monocymbium ceressiforme*, *Hyparrhernia hirta*, *Brancharia decumbans* and *Aristida behriana* this has been confirmed by Aboki et al (2007). Among others.

Plate 4.10: A Typical Vegetation of The Project Site

4.9.2 Wildlife Study

Studies on the wildlife diversity occurring along the proposed line route were conducted between 7am and 4pm local time by a Zoologist. Thus, various conventional techniques; both direct and indirect methods (Moshby 1974; Sutherland 1997) were adopted. Principal objectives were to produce a comprehensive checklist of fauna, determine their distribution and conservation status (prior to commencement of the project), against which future changes and magnitude of change in wildlife populations would be detected. The footprints, trails, nests, faeces and shells of animals were observed for evidence of wildlife presence. Considering the dependence of wildlife on vegetation for shelter, food, perching, nesting site, etc. sampling stations were established along vegetation transects. Critical habitats and microhabitats such as, litter, forest undergrowth, crevices, termitaria and burrows were ransacked with the aid of 1m long probe to dislodge any hiding herpetofauna and mammals. To increase the chances of sighting wild animals or their evidence of presence, the search was carried out radially, along the northern, southern, eastern and western axis of each transect. With respect to amphibians, Visual Encounter surveys (VES), Dip-netting (DN), Acoustic encounter surveys (AES), were applied, while Pitfall traps with drift fence were used for reptiles, and ground-running mammals such as rodents.

Each transect was sampled for about three hours, (once in two days) during the period, between 7am and 4pm local time. All dislodged and sighted animal were identified to possible taxonomic levels, using the exquisite field guides and Keys. When and wherever possible, photographs were taken to demonstrate field observations. Binoculars were used to observe birds in flight to aid identification. Droppings and tracks of animals were observed and identified.

Further information on diversity and conservation status of wildlife in the prospect area were acquired from (i) National Children Zoo and (ii) by interviewing farmers/ hunters concerning the variety of wildlife captured in the area, sites of high faunal density, seasonal abundance, hunting techniques and degrees of success.

The wildlife identified within the study area in which the proposed Amfani industrial park smart city will be located include the following as stated in Table 4.14 below.

Table 4.14: List of Common Vertebrate Animals Identified in the Study Area

Class	Scientific Name	Common Name
AVES (Bird)	Milvus migrans	Black kite
	Nectarinia spp	Yellowish nesting sunbird
	Pycnonotus barbatus	Common garden bulbul
	Gultera edourdi	Guinea fowl
	Urotriochis spp	Hawk
	Corvus albus	Pied Crow
	Euplectes progne	Long-tailed widow bird
	Plesionstigara cusullatus	Village weaver bird
	Coturnix spp	Quails
	Bubulcus ibis	Cattle egret
REPTILIA	Veranus niloticus	Forest monitor
	Agama agama	Rainbow Lizard
	Trachylepis spp	Grey Skink
	Kinixys erosa	Hinged land tortoise
	Dendroaspis viridis	Green mamba
	Naja melanoeuca	Black cobra
	Python reginis	Royal python
AMPHIBIANS	Bufo regularis	African toad
	Rana spp	Frog
MAMMALIA	Glaucomycyterus spp	Forest Bat
	Rattus spp	Bush rat
	Cricetaomys gambianus	Gambian giant rat
	Thryonomys swinderianus	Greater cane rat(Grass cutter)
	Xerus crythropus	Ground squirrel
	Neotragus batesi	Dwarf antelopes
	Autherurus africanus	Porcupine
	Nandima bunotata	Two spotted palm covet
	Genetta poe vnsis	Forest genet

Plate 4.11: Droppings and Tracks of Animals Observed and Identified

Plate 4.12: Rattus spp

Plate 4.13: Agama lizard


Plate 4.14: Morning Collared Dove **Plate 4.15: Cattle Egret**


Plate 4.16: House crow **Plate 4.17: Sparrow**

4.9.2.1 Fisheries

The data on the fisheries was brought and sampled from close water bodies and interactions with people living along the river bank communities and staff of fresh water research institute new bussa. Most of the fish species were identified at the landing sites using standard guides but the ones that could not be identified immediately had the samples taken for further identification. Secondary information was also obtained from existing literatures.

Table 4.15: Fishes Identified Within Project Area

Family	Species	Common Name	Local Name
Mormyridae	*Marcuseniusabadi i*	Elephant Fish	Miligi
	Mormyrushaselquisti	Elephant Snout	Miligi
	Mormyrusrume	Bottle Nose	Miligi
	Hyperopisusbebe	Ngai	Kuma
Cichlida e	*Tilapia zilli*	Red Belly Tilapia	Gargaza
	Oreochromisniloticus	Nle Tilapia	Gargaza
	Oreohromisaureus	Blue Tilapia	Gargaza
	Sarotherodongalilaeus	Mango Tilapia	Gargaza
Claroteidae	*Claroteslaticeps*	Wide Head Fish	Maigo
	Auchenoglanisoccidentalis	Bubu	Buro
Alestida e	*Brycinus nurse*	Nurse Tetra	Kawara
	Hydrocynusbrevis	Tiger Fish	Zawai
	Hydrocynusforskhalii	Elongated Tiger Fish	Zawai
Mochokidae	*SynodontisNigrita*	Squeaker	Kurungu
	Synodontisschall	Wahrindi	Kurungu
Bagridae	*Bagrusbayad*	Bayad	Dinko
	Bagrusdocmak	Semuntundu	Dinko
Latidae	*Latesniloticus*	Nile Perch	GiwanRuwa
Arapaimide	*Heterotisniloticus*	African Bony Tongue	Bali
Citharinidae	*Citharinuscitharius*	Moon Fish	Falia
Cyprinidae	*Labeocoubie*	African Carp	BarkinDumi
Scilbeidae	*Schilbemyustis*	African Butter Fish	Nalanga
Channidae	*Parachanaobscura*	Snake Head Fish	Tufi
Clariidae	*Clariasanguillaris*	Mudfish	Tarwada
Gymnarchidae	*Gymnarchusniloticus*	Aba	Dan Sarki
Hepsetidae	*Hepsetusodoe*	Kafue Pike	Zagundumi
Distichontidae	*Ichthyoborusbesse*	Grass Eater	Karen Ruwa

***Source: EAECL** Field Data 2019/2020*

Plate 4.18 : *Clarias anguillaris*

Plate 4.19: (Alestidea) Brycinus Nurse

Plate 4.20: Parachana Obscura (Snake Head Fish)

Plate 4.21: Auchenoglanis Occidentalis (Bubu)

Plate 4.22: ***Citharinus citharius***

Plate 4.23*: Tilapia zilli (Red Belly Tilapia)*

4.10 PLANKTON

4.10.1 Phytoplankton

Phytoplankton encompassed all microscopic algae which drift with currents or float on water surface of an ocean, rivers, lakes and other water bodies. Phytoplankton plays a major role as the basis of the aquatic food web, providing essential ecological function of all aquatic life. The many kind of phytoplankton are classified into many different classes, families, genera and species of both marine and freshwater. Phytoplankton has a rapid responds to environmental changes, and hence their occurrence, species composition and diversity are widely used as biological indicator of the quality of the water conditions.

A total of 24 taxa of phytoplankton belonging to four divisions namely Chlorophyta (green algae), Bacillariophyta (diatoms), Euglenophyta (euglenids) and Cyanophyta (blue-green algae) were recorded in the samples. The green algae dominated the phytoplankton community with 15 species. It also constituted 66% and 58% of the total phytoplankton population. The blue-green algae, euglenids and diatoms following in that order constituted the rest of the phytoplankton. The distribution of algae population was relatively even across the lake and there was no significant difference (P = 0.8572) amongst them. There was also no significant spatial variation in the number of taxa which range between 5 and 14 on the lake. Taxa richness, diversity and abundance across the sampling Kainji lake were relatively low, as the lake had an average of 10.8 and 11.6 taxa with abundance average of 44.4 and 50.2 cells/l/sampling point. The low to moderate diversity levels reported for the phytoplankton flora may be attributable to unfavorable environmental conditions such as low light intensity due to very high turbidity and nutrient status of the water body.

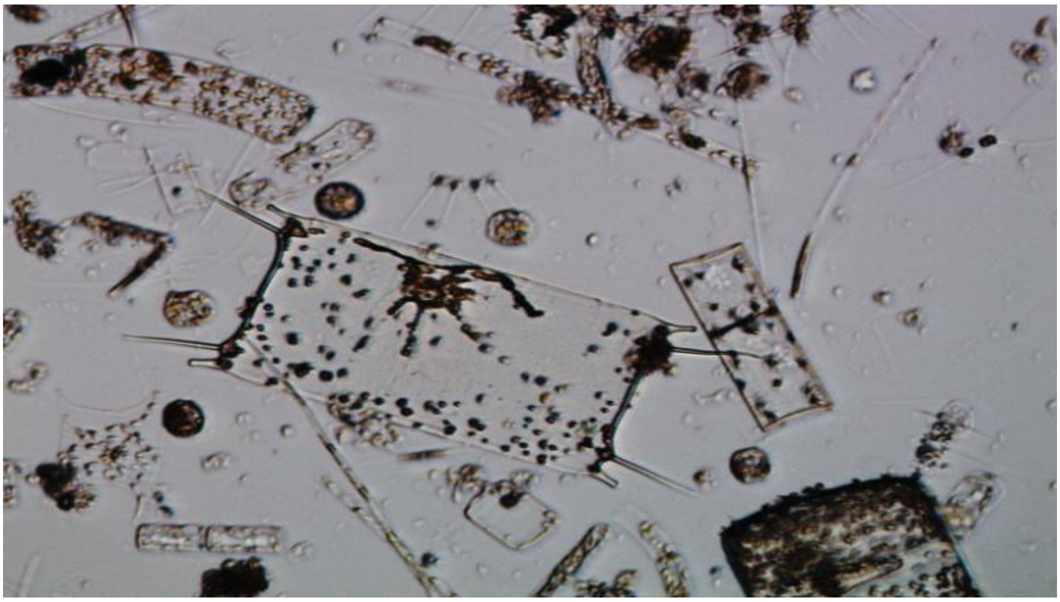


Plate 4.24: Phytoplankton Analysis

Each sample was concentrated to 20ml. Five drops of each were thoroughly investigated under a MI wild binocular microscope with calibrated eye piece. For each sample, five fields were investigated using the micro transect drop count method described by Lackey (1938). All organisms were identified using appropriated keys and illustration described in Hendey (1964), Winpenny (1966), Olaniyan (1975) and Nwankwo (2004). All organisms were recorded as number of organism per ml.

4.10.2 Zooplankton

Zooplankton are drifting organism living in the oceans, particularly the pelagic and littoral zones, as well as in rivers, lakes and ponds. Majority of them are microscopic, unicellular or multicellular forms with size ranging from a few microns to a millimeter or more. Zooplankton are the heterotrophic group of plankton as they feed on phytoplankton. Zooplankton can be subdivided into two groups; holoplankton (spend entire lifecycle as plankton) and meroplankton (spend part of lifecycle as plankton). The meroplankton group consist of larval and young stages of animals that will adopt a different lifestyle once they mature (e.g.larvae of fish, shrimp, crab).

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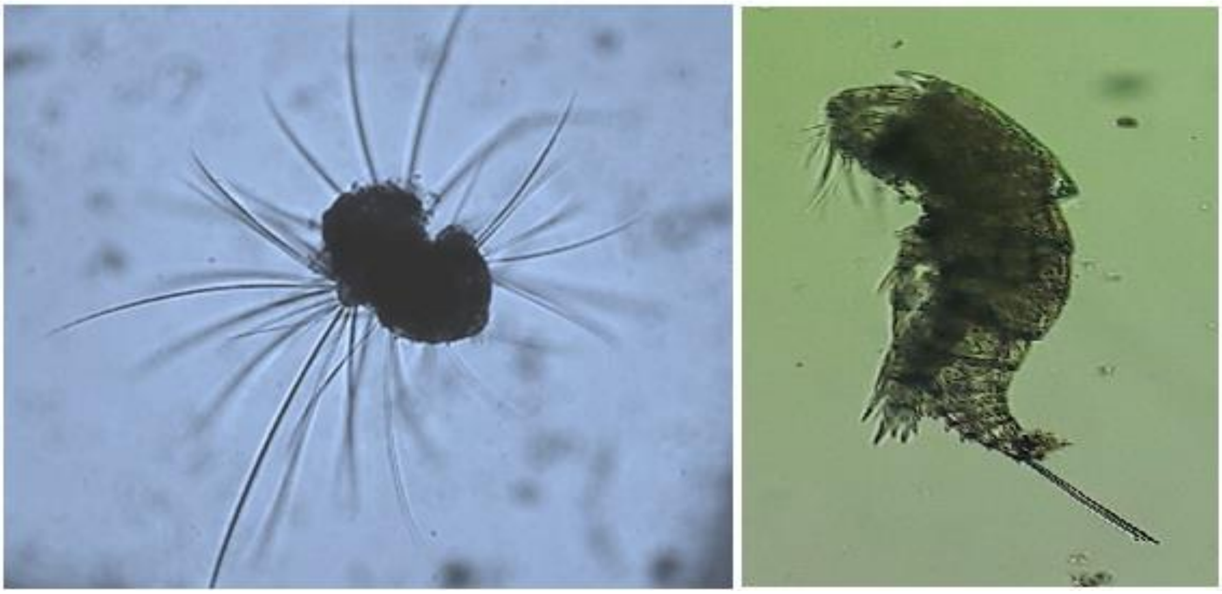


Plate 4.25: Zooplankton Analysis

Seventeen species of zooplankton were encountered in the plankton. The relative abundance and spatial distribution of the species are seen over the lake. The most frequently encountered and more diverse were the Crustaceans. The crustaceans consisting of 6 species each of copepods and cladocerans dominated the plankton in number of species and population during both the dry and wet seasons. Other zooplankton encountered included 3 species of rotifera, 2 protozoans and 1 ostracod. The population was generally more during the dry season than the wet season

4.11 BENTHIC COMMUNITIES

Riverbed sediments consist of rock particles and organic remain at varying composition depending on depth, distance from coastline and local variant (biological and geological activities). Organisms that live on the bottom of riverbed include some fish, clams, oysters, crustaceans, sponges, sea anemones etc. These organisms together with their surrounding water and sediment make up the benthic ecosystem. Sediment type of an area is very important in determining the kind of benthic community that develops, sediments tends to shift and move, making it difficult for large plants or algae to become established, clams, burrowing worms, and small crustaceans however, make use of sediments as suitable habitat (Sanders and Hessler, 1969).

Benthic macro-invertebrates or benthos are those organisms that lack vertebrae and occupy the bottom layer of water body for all or part of their life cycle (Roseenberg and Resh, 1993). Generally, they are visible to the naked eyes and play a variety of crucial roles in aquatic ecosystem. Benthic deposits are bottom sediments that originate from dead or decaying organic materials. They are biological indicators of water quality or habitat condition in aquatic environment since the bed collects the sediment from the water. Most macro-benthic communities are sedentary and reflect the quality of their immediate environment.

Community structure and distribution of macro-benthos in Kainji lake was evaluated and it revealed that annelids were the dominant benthos species recorded across sampling stations during both seasons under study with the occurrence of two mollusc species during the dry season.

4.12 SOCIO-ECONOMICS

4.12.1 Socio-Economic Baseline

Socio-economic and community health impact assessment tools are designed to integrate the desires and aspirations of the project host community with those of the project proponent. In line with the ESIA objectives, wide consultations were held, and community's aspirations were also recorded. This socio-economic baseline survey conducted in November 2019- January 2020 seeks to determine the socio-cultural, demographic and quality of life of the population around project site. Structured questionnaire interviews and group discussions were used primarily to obtain necessary information from households and other target groups. Other sources of information included similar studies, existing records in the local government and other public institutions.

4.12.2 Area of Influence

Communities identified as directly affected in this area are those who fall within 5km^2 radius of the proposed project site. The communities, together with the physical footprint of the project will hereafter be referred to as the "Area of Influence" for the project. The project is anticipated to impact particularly upon these communities. Most of the surrounding areas are farmlands. This baseline chapter therefore examines, briefly, the macro socio-economic environment, the regional and district context and then looks in more detail at the way in which communities, households, and individuals, directly affected by the project, currently exist.

4.12.3 Scope of Study

The study was conducted in 7 communities in Magama LGA of Niger State. The communities include; Tudun Faila, Tungan Gari, Gadan Zare, Yunawa, Amfani , Tunga Alhaji and Gungawa villages. Apart from Amfani and Gungawa communities, the rest of the communities are located within the same area called Sabongari. The study covered the socio-cultural resources of these communities, demographic issues including population and growth, age and sex distribution, and adult literacy. Others were such indicators of the quality of life of the residents as quality of housing, access to potable water, availability of functional infrastructural amenities, livelihood activities and patterns, and income levels. Health facilities and their patronage, disease prevalence and disease vectors, water and sanitation, and nutrition were also studied. Additionally, the study discusses the perceptions, concerns and expectations of members and residents of these communities.

4.12.4 Demographics

Niger State is a state in Centrajofl Nigeria and the largest state in the country. The state capital is Minna, and other major cities are Bida, Kontagora, and Suleja. It was formed in 1976 when the then North-Western State was bifurcated into Niger State and Sokoto State. It is home to Ibrahim Babangida and Abdulsalami Abubakar, two of Nigeria's former military rulers. The Nupe, Gbagyi, Kamuku, Kambari, Dukawa, Hausa and Koro form the majority of numerous indigenous tribes of Niger State. The state is named after the River Niger. Two of Nigeria's major hydroelectric power stations, the Kainji Dam and Shiroro Dam, are located in Niger State, and the newly Zungeru Dam is also located there, the Jebba Dam is half Niger state and Kwara Sharing bounderies. The famous Gurara Falls is in Niger State, and Gurara Local Government Area is named after the Gurara River, on whose course the fall is situated. Also situated there is Kainji National Park, the largest National Park of Nigeria, which contains Kainji Lake, the Borgu Game Reserve and the Zugurma Game Reserve.

4.12.5 Population Size and Growth

The population estimates for Niger State following the 2006 national census, as published by the National Population Commission (NPC), is 3,950,249 while that of Magama is 181,653. Over the years the population of the state and the Local Government Area would have grown, determined by interplay of the demographic processes of fertility, mortality and migration. Considering these population growth determining factors, NPC estimated that the population of Nigeria grows annually at 3.0% (NDHS, 2008). At this rate of growth (and using the exponential growth model), the projected population of the State and LGA from 2006 to 2020 is presented in Table 4.15.

Table 4.16: Projected Population of Niger State and the Project Affected LGA

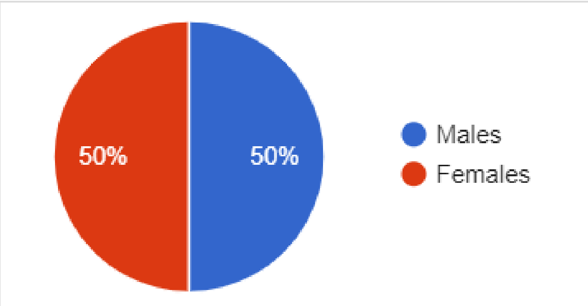
Year	Niger State	Magama LGA
2006	3,950,249.00	181,653.00
2007	4,068,756.47	187,102.59
2008	4,187,263.94	192,715.67
2009	4,305,771.41	198,497.14
2010	4,424,278.88	204,452.05
2011	4,542,786.35	210,585.61
2012	4,661,293.82	216,903.18
2013	4,779,801.29	223,410.28
2014	4,898,308.76	230,112.59
2015	5,016,816.23	237,015.96
2016	5,135,323.70	244,126.44
2017	5,253,831.17	251,450.24
2018	5,372,338.64	258,993.74
2019	5,490,846.11	266,763.55
2020	5,609,353.58	274,766.46

***Source: 2006 NPC Census Figure and Population Projection Using* 3.0% Nigeria Annual Population Growth**

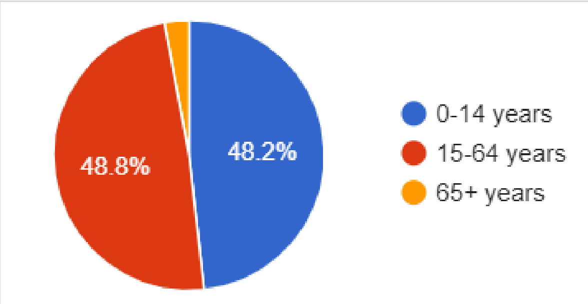
Altogether, 250 individual respondents were interviewed from communities in the study area; in addition, there were four (4) Focus Group Discussion (FGD) sessions (1 for in each of the study area).

Niger, state, west-central Nigeria, bounded to the south by the Niger River. It is also bounded by the states of Kebbi and Zamfara to the north, Kaduna to the north and northeast, Kogi to the southeast, and Kwara to the south. The Abuja Federal Capital Territory is on Niger state's eastern border, and the Republic of Benin is its western border. The landscape consists mostly of wooded savannas and includes the floodplains of the Kaduna River.

Niger state is populated mainly by the Nupe people in the south, the Gwari in the east, the Busa in the west, and Kamberi (Kambari), Hausa, Fulani, Kamuku, and Dakarki (Dakarawa) in the north. Islam is the predominant religion. Most of the inhabitants are engaged in farming. Cotton, shea nuts, yams, and peanuts (groundnuts) are cultivated both for export and for domestic consumption. Sorghum, millet, cowpeas, corn (maize), tobacco, palm oil and kernels, kola nuts, sugarcane, and fish are also important in local trade. Paddy rice is widely grown as a cash crop in the floodplains of the Niger and Kaduna rivers, especially in the area around Bida. Cattle, goats, sheep, chickens, and guinea fowl are raised for meat. Pigs are raised around Minna for sale to southern Nigeria.

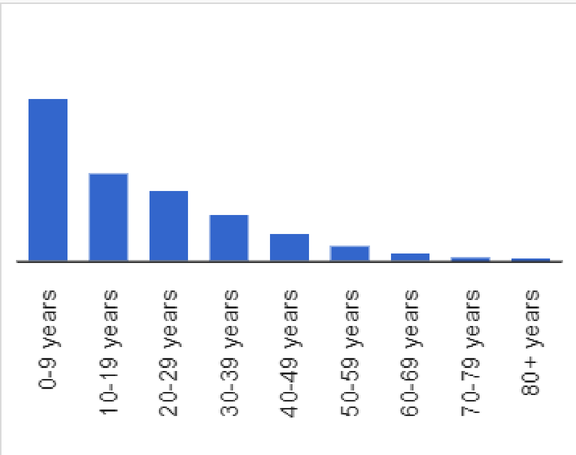


Gender (C 2006)	
Males	90,740
Females	90,730



Age Groups (C 2006)	
0-14 years	87,514
15-64 years	88,628
65+ years	5,328

Fig 4.10: Niger State Population structure (Source: NPC 2006)



Age Distribution (C 2006)	
0-9 years	67,767
10-19 years	36,756
20-29 years	30,180
30-39 years	19,835
40-49 years	11,929
50-59 years	6,766
60-69 years	3,954
70-79 years	2,367
80+ years	1,916

Fig 4.11: Age distribution Magama LGA (source: NPC 2006)

4.12.6 Demography of Respondents

4.12.6.1 Gender Distribution

Table 2 presents the gender distribution of respondents. Males constituted the bulk (76.4%) of the respondents, while females constituted 23.6%. The gender distribution is a reflection of the patriarchal nature of the study communities, which makes the males more likely to be identified as the heads of their households. It also reflects the socio-religious system which makes females less visible in interaction with strangers.

Table 4.17: Gender Distribution of Respondents

Gender	Number	%
Male	191	76.4
Female	51	23.6
Total	250	100

Plate 4.26: Consultation at Amfani Community

4.12.6.2 Marital Status

Majority (93.2%) of the individual respondents were married, while 3.8% were single, and 3% divorced or widowed.

Plate 4.27: Consultation with the Communities at Sabongari

4.12.6.3 Age Distribution

Respondents interviewed during the survey were within ages 10–75years. 27.6% were below 30 years, 27.2% were within 31–40 years, 20.8% were between 41 and 50 years, 13.2% were between 51 and 60 years, and 5.6% were above 60 years (see Table 4.16).

Table 4.18: Age Distribution of Respondents

Age	Number	%
20 years or less	15	6.0
21-30	54	21.6
31—40 years	68	27.2
41-50 years	52	20.8
51-60 years	33	13.2
61-70 years	8	3.2
71 years and above	6	2.4
No response	14	5.6
Total	250	100

Source: EAECL Fieldwork 2019

The ages of the female participants in the FGD ranged from 25 to 48, all of whom were married and were Muslims. They also described themselves as housewives and none had any formal education. Further analysis shows that 94.1% of the respondents were within the working age from under 20 years to 60 years, while 80.1% may be said to be in the active working age (under 20 years to 50 years).

4.12.7 Religious Background

Majority (92.7%) of the respondents were Muslims, while 6.9% said they were Christians, and 0.4% traditional worshippers in Sabon Gari, the situation is not different in Amfani where 86.2%, 12.7% and 1.3% are adherents to Islam, Christianity and traditional worship respectively. In Tunga Alhaji adherents to Islam accounts for 95% of the respondents, while 4% and 1% account for adherents to Christianity and African traditional religion same as Gungawa, where 97.2% respondents are Muslims, 1.2% said they are Christians and 1.6% are traditional worshipers (Fig 4.12).

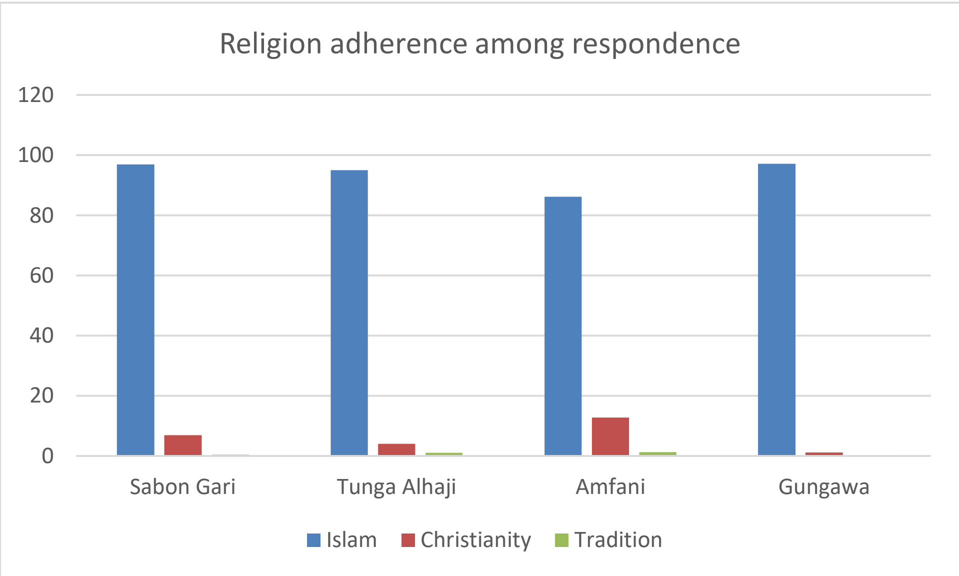


Fig 4.12: Religion Adherence among Respondents

4.12.8 Household Composition, Structure and Size

The typical household unit in the study area has a head and several members. In many cases the head is the father and members include his wife, children and wards. The wards are often children of relations and, in some cases, friends. These are usually fed and generally catered for from the resources of the household. Members of the household are not necessarily related biologically. The household could also be composed of members who are not related but have agreed to live together under a common household head. This latter type of household group is not common in the study area. From questionnaire responses, the mean household sizes obtained were 6.4 for the surveyed communities.

4.12.9 Family Size, Births and Deaths

10.4% of respondents had up to three persons in their families, 27.4% had between 4 and 6 persons, 23.9% had between 7 and 10 persons, 24.3% had 11 to15 persons, and 13.9% had a family size of 16 or more. The number of males per family ranged from 1 to 21 with a total average of 4.74. The number of females ranged from 1 to 30, with a total average of 5.04. This suggests that there are more females in the communities than males. An explanation for this is the tendency for adult males to leave the villages for the town in search of income-earning employment opportunities. The findings of the survey show that over the last 12 months, 11.8% of the respondents had 1 birth in their families, 3.9% had 2 births, another 3.9% had 3 births, and 19.7% had 4 or more births. On the other hand, 42 (17.9%) respondents reported 1 death, 4 (1.4%) had 2 deaths, 7 (2.9%) had 3 deaths, and 2 (0.7%) had 4 or more deaths. The population of the communities is increasing, as the number of births exceeds the number of deaths (Table 4.23).

Table 4.19: Number of Births and Deaths In the Families In the Last 12 Months

Family Member Birth/Death	Respondents (Birth)		Respondents (Death)	
None	46	60.5%	108	77.1%
1	9	11.8%	25	17.9
2	3	3.9%	2	1.4%
3	3	3.9%	4	2.9%
4 or more	15	19.7%	1	0.7%
Total	76		140	
No Response	174		110	

Source: EAECL Fieldwork 2019

4.12.10 Education

Educational level is one of the key determinants for measuring standard of living. About one-thirds (35.8%) of the respondents did not have any formal education, 49.2% had only primary level/Quoranic education; 10.6% had secondary level education, and only 4.4% had tertiary/post-secondary education (Figure 6.22)**.** This indicates a relatively high level of illiteracy in the study communities.

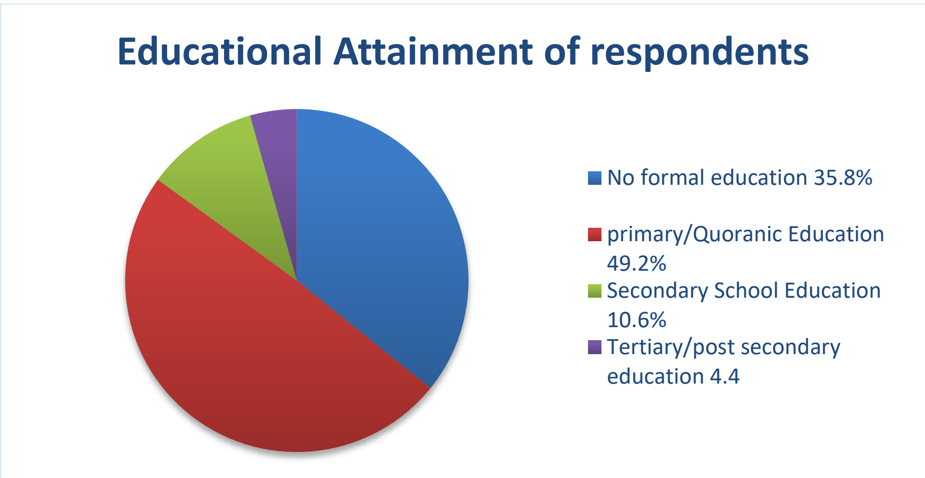


Fig 4.13: Educational Attainment of Respondents

Source: EAECL Filed Study

The project affected communities all have primary and secondary schools either within the community or within a 5km radius, this prevailing relatively low level of adult literacy in the area was attributed to inadequate staffing, lack of instructional materials and poor state of facilities in public schools. All of these factors were identified in both primary and secondary schools in all the study area.

Traditional Qur'anic schools exist in the study area just as they do in other parts of northern Nigeria. They are largely operated in the context of Makarantu Allo (Islamic schools for beginners in learning the Qur'an) and Tsangaya (schools for memorizing and learning to write the Qur'an). While Makarantu Allo are operated more as neighbourhood-based schools in the area under the supervision of a malam (teacher) and some auxiliary assistants, the Tsangayu (plural of Tsangaya) are operated mostly as independent settings within or outside communities under the supervision of a number of malams "in charge" of the upkeep of the setting and other dependants therein.

At interviews with primary and secondary school teachers in the area, school drop-out rate was said to be low and was estimated at between 3% and 3.5% per class. However, a number of the older children, between primary 6 and JSS 3, miss school daily especially during the farming season. Several of the children go to their parents' farm to assist with the farm work. A major reason for drop out among female students in JSS and SSS is early marriage. At the Government Girls Secondary School Amfani, it was estimated that about 2% of the female students are already mothers in the last 12 months. This school dropout situation could worsen across the study area with the proposed project if school boys are able to secure temporary employment as casual labour during the construction, and if school girls are lured into sex by construction workers.

4.12.11 Livelihood Activities

Livelihood activities across the surveyed communities are similar. The identified activities are mainly primary production activities like farming, animal rearing, hunting, fishing and timber works.

Commerce and provision of services like petty trading, artisanship practices and employment in the civil/public services were also identified. The largest proportions of household members in all the communities are engaged in farming. Next to these is the proportion of household members engaged in cattle rearing. Artisanship practices inclusive of electrical repairs, tailoring, etc are significant in the study area. Civil/public service employees in the communities are limited mostly to Local Government workers, teachers and health workers.

Farming is a major activity, and many residents are engaged in both crop farming and raising of some livestock (cattle, sheep and goats) for subsistence and commercial purposes. There are few large or modern farms; most of the crops are grown on farmlands owned by extended families in the communities. The usual crops are Maize, cassava, Groundnut, Guinea corn, sweet potato, Bambara nut, sugar cane and vegetables. Most crops are planted in the wet season, but a significant number of the people also involve in irrigation farming, while a few them are involved in illegal mining of mineral resources.

Farming equipment in use are still very rudimentary, comprising mainly of hoes and machetes and few cases tractors. While farming is done by both adult males and females, fetching of firewood is usually done by adult females. Although incomes from these farming and allied livelihood activities vary depending on the scale of operations, respondents estimate that an average farmer earns between N200, 000 and N300, 000 annually from an investment of between N30, 000 and N50, 000.

The markets apart, there is significant daily sales of goods in the communities. This type of selling is conducted from a variety of places. Some are petty traders who can only afford to sell a few things like sweets, biscuits, bread, fruits, etc, from table tops usually located in the front of their houses. Some others can afford to rent proper shops and sell from such places. This latter group usually have larger shop space and also stock more goods. There are also traders that tend to sell a wide variety of items like clothing, shoes and bags, electrical fittings, non-alcoholic beverages and stationery, among others. Many of the indigenous petty traders are men. Traders deal with a wide variety of goods and also operate on different scales and so their incomes are also very varied. The indications from their responses during interviews are that their monthly incomes vary between N10, 000 to N20, 000. Residents commonly engage in more than one livelihood activity. Engaging in multiple livelihood activities provides household members complementary sources of income. In many cases it is an indication that each of these activities only provides a subsistence income and may be seasonal.

Table 4.20: Occupation of the Respondents

Occupation	Sabon Gari	Amfani	Gungawa	Tunga Alhaji
Farming alone	22	27	22	25
Livestock rearing alone	11	10	11	9
Farming and Livestock rearing	16	12	13	11
Civil/Public service	6	7	8	9
Petty trading	3	4	5	4
Others	4	2	3	4

Plate 4.30: Active Illegal Mining Sites in Amfani

4.12.11.1 Income Distribution

Income distribution in any area is closely linked with inequality in the area. For this study, there is a wide variation in income distribution in the study area, depending on the economic activity involved in. FGD reveals that the highest incomes accrue to the very small number of contractors, while lowest incomes accrue to roadside mobile phone recharge cards sellers.

Table 4.21: Monthly Income Distribution of Respondents

Occupation	Annual income Range (N) %			
	<60,000	70-200,000	200-300,000	>300,000
Artisanship	16.0	27.0	13.0	44.0
Farming	-	34.0	45.0	21.0
Petty trading	29.0	27	23	21
Civil service	-	5.0	45.0	50
Transportation	9.0	42.0	9.0	45
Contracting	-	-	15.0	85
Road side mobile phone recharge card sellers	32.0	55.0	10.0	3

Source: EAECL Fieldwork, 2019

Plate 4.31: Plate 3: Agricultural activity in Gungawa Community

Plate 4.32: Fishing activity in Sabon Gari Community

4.12.12 Settlement Pattern and Housing Conditions

In general, communities in the study area are small to medium sized. Going by National Population Commission's definition of a town as a settlement with a population of 20,000 or more, only the LGA headquarter may qualify as town. All the project affected communities are quite rural.

All the communities have the characteristics of both linear and nuclear settlements. The linear characteristics derive from the concentration of houses along the main streets and lanes in the settlements. Their nuclear characteristics derive from the clustering of houses. Houses are built in clusters which in some cases may identify family lineages and kindred groups.

Spacing between houses is not definite and could range from three or four metres to about ten metres.

The houses are quite diverse in their design and construction materials. About 98% of houses in the study area lack modern designs and they are built without utilities like kitchen, toilet and bath, in-house. A majority of the houses in the communities are family bungalows and tenement (rooming) houses.

Plate 4.33: Housing Type in Sabon Gari

4.12.12.1 House Construction Materials

Across the study area, the materials used in constructing houses are mud (wattle and daub), thatch, corrugated iron sheets (zinc) and cement blocks. Most of the houses are poorly designed; they do not have toilets and bath rooms in-house. Bath rooms, in most cases are provided in a fenced area behind the house. The most common type of toilet in all the communities is the pit toilet. Another issue with the design of these houses is the provision of kitchens. Most houses have their kitchen outside the main building, in the backyard. Some of those where kitchens are provided in-house are poorly ventilated and smoke from cooking generally circulates the house and affects its occupants.

4.12.13 Life Style and Social Indulgent Practices

Life style and practices raised and discussed during FGDs and interviews included, drinking of alcohol, cigarette smoking and use of hard drugs, prostitution, teenage pregnancy and child labour. Residents confirmed that the use of spirits and alcoholic beverages is relatively rampant among them. Most residents, of both genders, had been drinking since their teenage and several since they were children. Though alcohol beverages are not commonly sold in these communities, but individuals who indulge in the consumption find way to buy them.

Cigarette smoking is also quite common among teenage and adult males. Most residents also believe that some of the youth smoke hemp, though no body admit to smoking Indian hemp maybe due to the implication of admitting same.

Child labour, another of the social vices, is not common. Children usually assist their parents in farming and running of their shops. The girl child in the study area is also made to go round the streets of their community to sell merchandises for the parents. This type of work does not attract any salaries or wages.
Residents expressed fears that the proposed project would further encourage some of these vices if itinerant workers and camp followers take up residence among them during construction. Drinking, smoking, use of hard drugs, teenage pregnancies and prostitution were particularly mentioned by the respondents.

4.12.14 Migration Trend Pattern

There were no existing records and actual figures on migration in the communities, however, it was possible to examine and determine the trend and pattern. Many residents indicated they were born in the communities of their residence or had lived in them for more than ten years. Those who were born in or had lived in the communities for more than ten years were considered non migrant while those who had lived for less than ten years were considered migrant. The result shows that between 65% and 80% of respondents were non migrant. This trend was not entirely unexpected given that all the communities are rural. However, there were also indications that some household members had relocated over the years for various reasons. The most common reasons for relocation were farming, fishing, marriage, school and work, and the most affected age groups were those between 10 and 44 years. Those who relocated went mostly to cities in Nigeria, like Minna, Kano, Port Harcourt, Abuja and Lagos.

4.12.15 Language, Marriage and Family

The major languages of communication in all the communities are the Hausa and English. English is spoken in both its formal and pidgin forms. The project affected communities are all multilingual as there many ethnic groups therein, however, Hausa language is considered as the indigenous language in all the surveyed communities.

The marriage institution is accepted and revered in all the communities. Marriages are contracted between adult males and adult females, though there are few cases of juvenile marriages, there are no accounts of either same sex. Monogamy and polygamy are practiced but local sources say that polygamy is on the decline. The marriage process involves two basic stages, the knocking stage and the traditional marriage proper. The stages involve the intending couple, their parents and relations, friends and well-wishers. Parents and relations, however, play more prominent roles in the first stage than other parties. Drinks and gifts are usually presented by the groom's family to the bride's family during these meetings (the stages). There are no known marriage restrictions on the basis of culture in any of the communities.
The family is recognized as a very important social unit and both nuclear and extended families exist in the communities. The typical nuclear family is headed by the father, with the mother and children. The extended family includes members who are not biological offspring of the same parents but relations. A nuclear family where the father was dead could be headed by the mother if the children are juveniles or by the eldest son if he is a grown man and able to bear the financial responsibility of taking care of the family. The extended family is always headed by a male member.

Considering that all the communities are used to non-indigenous residents, members can communicate in English and Hausa. The communities in some way have an accommodating social attitude, this attitude could be valuable for the proposed project, given that itinerant workers and camp followers would be attracted to the communities and this kind of social attitude would foster healthy cross-cultural exchanges. This can also help in some way to limit conflicts that arise when people of different cultural backgrounds live together, thereby reducing the potentials for tension and social upheavals during the project.

4.12.16 Social Structure and Organization

The studied communities share a lot in common with regards to social structures and organizations. Basically, membership of socio-cultural groups (women's groups, youth groups, CBOs, cultural groups and social welfare groups) by household members is quite common. The roles played by these groups are distinct and significant. A group like the Cooperative (Kungiya) is set up purely to perform local administrative roles and to liaise between the communities and all external bodies, and other communities. Similarly, a lot of the social clubs and CBOs actively participate in improving the welfare conditions of their members.

Apart from these socio-cultural groups, the communities are also made up of compounds. This structure that incorporates compounds allows the compounds some level of autonomy in their daily administration. The compounds are made up of extended families and their affairs are directly overseen by their appointed leaders who are mostly the eldest male in the family.

4.12.17 Governance and Hierarchical Structure

There are well-recognized leadership structures that oversee the political administration of the study area. Two (2) levels of political organization exist in the study area; the formal government and traditional administration. At the formal government level, the 4 communities are under Magama LGA of Niger State. The leadership organization is such that the executive, legislative and judiciary functions of the modern government are well integrated. Traditionally, the communities are distinct but similar traditional administrative structures. The structure comprises the Mai Angwan and traditional council members.

The traditional heads are elected from eligible males, candidate must come from particular families considered royal families to become Mai Angwan by the district head. Occupants hold office for life except where they are deposed by the community. They could be deposed by the community if they are believed to be working against the communities' interest, if they committed a heinous crime or became incapacitated by ill health. The village heads are appointed by their respective village with input from the district head or Emir. The village heads also have the role of advising the district heads.

Other groups that make up the traditional administrative structure include the women (Kungiya Mata) and youth (kungiya Matasa) and both report to the village head. Both groups are also headed by executive committees which include the President, Vice President, Secretary, among others. The executive committees are elected. Across the study area, while the youth executives serve for one or two years, the women leaders usually do not have a fixed term in office. All adult female members of each community are eligible for

membership of the women's group in their respective communities. Membership of the youth groups is similarly open to adult community members of both sexes who are between 18 and 40 years.
The roles of these organs of society are clearly defined and there were no indications of role conflicts. These organs could play significant roles in information dissemination and community mobilization before, during and after the proposed project.

4.12.18 Conflict Management

Living beings everywhere fight over scarce resources and means of existence. Such competitions are sometimes peaceful, but they turn out to be violent in most situations when rivals seek to hamper, disable, or destroy their competitors in pursuit of mutually desired goals. Deng captures this scenario when he observes that conflicts are proof of situations where interaction involving two or more parties in which actions in pursuit of incompatible objectives or interests result in varying degrees of discord between normally harmonious and cooperative relations and a disruptive adversarial confrontation that may culminate at its worst in high-intensity violence.

The surveyed communities like any other human community are not without human crisis, which may arise from time to time due to individual differences occasioned by different socialization and orientation. Reported sources of conflict in the study community are disputes over land, politics and grazing rights. The most frequent sources of these disputes as reported by the respondents are land ownership and boundary. The principal medium of conflict resolution in the community is the traditional leadership. There are unwritten rules that govern dispensation of justice in the area. Resort to formal judiciary (court) process is very rare in adjudicating civil disputes.

Family crises are first reported to the most elderly person in the family who settles them, but should he fail to achieve the needed peace, the case is referred to the Mai Angwan. The Mai Angwan invites all the parties involved, listens to them and passes judgment. People found guilty are punished with penalties ranging from payment of fine, public apology and expulsion from the community, depending on the gravity of the crime committed. Formal law enforcement agencies are rarely contacted to adjudicate on contentious communal issues. They are only called in when traditional conflict resolution mechanisms do not achieve desired effects. Law enforcement officials would rarely storm a community to arrest alleged offence perpetrators, without at least, informing the District head or Mai Angwan.

4.12.19 Roles of Women and Youth in Community Development

The women and youth groups play important roles in the communities, and serve to bring their members together as well as intervene in their welfare. During the survey it was noted that culturally women could not, lead the communities, head the key organs of traditional administration, seat or participate with the men in taking community decisions. This cultural inhibition is a clear indication of gender inequality in the communities.

The youth on the other hand, have become a strong force in the communities. Their roles basically include ensuring internal and external security, enforcing law and order and development planning. Youth leadership, especially the President and Secretary are regularly invited to community meetings with the traditional councils, where decisions about development and security are taken.

4.12.19.1 Gender Issues

It is imperative to note that while sex relates more to biological context and differences among the two dominant sexes, gender relates more affirmatively to the social meanings given to each of the sexes not without significant implications for social relations as social stratification confers honour on some and dishonour on others. In general, field observation from this study revealed that social relations in the area are based on patriarchal relationship in which authority is vested in the male head of the household.
Gender differences were found to manifest in the study area more clearly in terms of community and political participation, in that women are generally excluded from decision-making processes. Moreover, Nigerian women are frequently at a disadvantage in terms of inheritance and tenure rights.

Gender is a central organising principle of societies and often governs the processes of security. Nigeria ranks 118 of 134 countries in the Gender Equality Index, Nigeria has one of the lowest rates of female entrepreneurship in sub-Saharan Africa. The majority of women are concentrated in casual, low-skilled, low paid informal sector employment and women represent over 70% of the World's poor due to unequal access to economic opportunities. Increasing female participation in the workforce and the development of the female human capital will not only help to reduce poverty at the household level, it will also radically enhance national security. (British Council, 2012).Given the limited opportunities for local employment that will be created, it is not expected that the project will have a significant impact on the status quo of gender relations and gender equity in the project's social environment. However, gender mainstreaming remains a key principle that the project should apply when recruiting both temporary and permanent employment.

The socio-economic survey found that, in the local study area, gender differences in status manifest more clearly in terms of political participation than in socio-economic attributes. The interaction during the fieldwork revealed the dominant position of men. Fieldworkers found it hard to get women to participate in focus group discussions as permission is required from their husbands or male head of the household. During the Stakeholder Engagement process there was also little participation from women.

Women do not have same inheritance rights, nor could they directly access critical resources such as land or credit. Women are less mobile than men because of family responsibilities, and in particular, the need to care for children. Women hardly take part in decision making process at the community level. In fact, women are never recognized as part of the ruling council. They are often allowed to socialise by forming their own group, but could hardly influence decisions of men. Women are usually treated as 'children'. At best, women could become group leaders or *saruniya mata.*

The global gulf between job creation and the growth in the numbers of job seekers have worsened the employment situation for women and men alike in Niger State. But women face greater vulnerabilities in the labour market because of their relative lack of education, religious restrictions and training, the tendency to channel women into certain occupations, and the continuous heavy burdens of unpaid domestic work, childbearing and childcare, which restrict the time and energy available for income-earning activities. Nigeria like other countries in the world is responding to the clear request calls made variously by the United Nations societies of all forms of discriminations especially gender based discriminations. Nigeria indeed has tried to respond to this development from the international arena by articulating policies and programmes that seek to reduce gender in equalities in socio economic and political spheres, however, the success of bridging the gap between men and women is farfetched. (ILO info stories 2017)

Interactions in the study area revealed that women in the area are significant but undermined force. Economically, they constitute the majority of the peasant labour force in the agricultural sector, while most of the others occupy the bottom of occupational ladder and continue to be channelled into service and domestic occupations. The consequence of the unequal status between men and women is high level of economics and political powerlessness among women, and powerlessness in turn retards development of any level, politically, economically and socially. FGD revealed gender inequality existed from the dawn of civilization and has continued over centuries in the study area. Gender discrimination has created wide gender gaps in the project affected communities, with very devastating social, economic and, health consequences on the members of the female gender, who have been intensely marginalized, and subjugated to the background.

The culture of the people of the study area perceives and treats men as superior to women, this is well manifested in the "son preference syndrome" that is prevalent in Nigeria. Male children in Sabon Gari, Amfani, Gungawa and Tunga Alhaji communities often enjoy preferential treatment, like exemption from house chores; they enjoy unlimited right to education, while the girls are limited and often given out for marriage at earlier age by some parents for economic gains. The culture equally disinherits wives and daughters in all the surveyed communities. The culture of the area strictly restricts women to the stereotyped role of home keeping, childbearing and childrearing, in fact they are not allow to move freely without their husbands' permission. She is to be seen and not heard, she is kept in '*budah*' and their homes restricted and most cases cannot be entered by male visitors.

Finding in the study area is not different from that of British Council as recorded in gender report of Nigeria 2012, which states that over 80% of women are unable to read while more than two thirds of 15–19 year old girls in Northern Nigeria are unable to read a sentence compared to less than 10% in the South.

The negative outcomes outlined above are the result of systemic and deeply entrenched discrimination that not only undermines the life chances of millions of individual girls and women but adversely affects their future children and the whole community. Nigeria's 2006 National Gender Policy is consistent with the global consensus when it states that women's empowerment and gender equality underpin the achievement of all the other MDGs. A well-established link exists between maternal education and child survival, for example. Educated girls are more likely to avoid early marriage, plan their pregnancies and have better maternal and child health outcomes. Nigeria's progress and national development will be constrained if women and girls continue to be disadvantaged and gender equity is ignored. Non-discrimination is enshrined in the Nigerian Constitution but in practice the majority of Nigerian girls and women are unable to claim their constitutional entitlement as it is evident in the study area. If Nigeria is to maximise its "demographic dividend" as the population of working age increases and fertility declines, it must prioritise investment in women and girls to ensure that the next generation of all young adults are healthier, better educated and more able to contribute to economic growth and development. Investing in adolescent girls and women is not simply a question of human rights; it also makes economic sense.

4.12.19.2 Gender Based Violence

Domestic violence can be defined as physical abuse, sexual abuse, emotional and verbal abuse between people who have at some time had an intimate or family relationship. What constitutes physical, sexual, emotional and verbal abuses against women often times would be influenced by the socio-cultural norms of a particular society. Gender based domestic violence against women is often maintained or perpetrated by unhealthy societal and cultural practices. Physical violence based on WHO study [WHO, 2005], definition includes the women being;

- Slapped or thrown something at that could hurt her
- Pushed or shoved
- Hit with a fist or something else that could hurt.
- Kicked, dragged or beaten up
- Choked or burnt on purpose
- Threatened with or actually used a gun, knife or other weapon against her.

Sexual violence as defined based on WHO study [WHO, 2005] include;

- Being physically forced to have sexual intercourse against her will
- Having sexual intercourse because she was afraid of what her partner will do.

FGD revealed cases of both domestic and sexual violence against women in the area, this is largely blamed on the customs of marriage in the study area which involves bride price and dowry usually paid on women, this the believe promote the values that give men proprietary rights over women and girls and encourage polygamy. The cultural practices of the people of the area as it is in most African societies, give women in the society a second fiddle role to play.

4.12.19.3 Occupation of the Women in the Area

The contribution of women to the development of the various communities cannot be over emphasized. They are said to be very industrious and are majorly involve in agriculture and allied occupation. Focus Group Discussion also revealed that despite restriction placed on the women of the area by religion and culture; a lot of them have been to grow their home based business without support from their spouse. Interaction revealed 70% and 20% to be involve in farming and petty trading respectively, while 10% are into other business.

Investigations reveal that the women as a body are fairly organised and may engage in any remarkable cohesive interaction. The communities have women associations (Kugiya Mata) which play vital role in community organization. The women are more socially oriented than the male as can be inferred by their propensity to adorn identical apparels during festive occasions.

Plate 4.34: Women group after FGD in Sabon Gari

Plate 4.35: Men group with SE team after consultation in Tunga Alhaj

4.12.20 Vulnerable Groups

Gender disparities in susceptibility to project impacts may be regarded as one aspect of a more general socio-economic attribute – that of vulnerability. Factors other than gender that may render some households or persons more socio-economically vulnerable than others include:

- Impoverishment;
- Limited diversity in livelihood resources;
- Social isolation (which may be the result of belonging to a minority group or having recently moved into an area); and
- Disease or ill health.

The socio-economic survey conducted as part of the SIA assessed several indicators of socioeconomic vulnerability, including household ownership of moveable assets, social support networks, food security, and perceived needs and challenges. The statistics generated for these indicators indicate that many households in the local study area may indeed be regarded as socio-economically vulnerable. For instance, most households have suffered food insecurity in the year before the survey and lack of employment was one of the most frequently-cited challenges in most communities.

Some groups in the community have also been identified as potentially vulnerable to the likely impacts of the proposed project. Their vulnerability derives from several different factors, including inability to cope with certain envisaged changes in the society and economy. A key vulnerable group is the adolescent and youths. Within this group it is also possible to differentiate between the adolescent male and the adolescent female. For the male adolescent there is the tendency to abscond or drop out of school to seek casual employment at the project site. This temptation to drop out of school is re-enforced by the state of educational institutions, particularly the poor staffing and poor infrastructures which makes schooling uninteresting in public schools and high tuition fees in private schools. The adolescent male will be faced with a situation of giving in to peer pressure and groups that encourage truancy and school dropout, if these groups come into the community as itinerant workers or camp followers.

The teenage girl on the other hand is faced with managing her sexuality in an environment where there will be considerable exposure to sexual excesses and the continuous advances by older and more experienced working-class males whose income would be an effective instrument to lure the girls. Again, with this group there will be the likelihood of school dropout and teenage pregnancy. Teenage pregnancy had in some societies led to stigmatization of the girls. Many of the teenage mothers may not be able to return to complete their schooling or embark on any academic pursuits, even after they would have given birth to their babies.

Another vulnerable group is the elderly. In any economy, the elderly usually requires special attention which includes health care and welfare, but the required facilities for provision of these social services are inadequate in the study area. Additionally, widows and single mothers will have an uphill task providing for their households in an environment where there are public servants who earn salaries higher than what is generally obtained in the community.

4.12.21 Land Ownership

Land in the study communities belongs either to the community, family or individuals. In the 4 sampled communities, the ownership structure was the same. The land ownership pattern gives an indication of the level of community participation and ownership rights as a group. There is usually more community coherence when land is communally owned. This also gives more power to the traditional leadership since they decide for the community most of the time. Ownership rights over lands are handed down from one generation to another within the extended family. Such inherited land is put to any use as desired by the owner(s). These are the lands on which family members build their houses and are allocated farm lands for cropping. Land could be bought from owners who were willing to sell.

4.12.22 Security

Interactions and observation in the study area revealed that there is relative security of lives and properties in the area. This security is largely attributed to the homogeneity of the area and the presence and activities of the vigilante group also known as civilian JTF and the Nigeria armed personnel. This vigilante group plays a vital role in the provision of security to their various communities patrolling the community day and night as a way of checkmating crime. The vigilante group is manned by mostly youths, retired military and para-military men of the community.

There is also a divisional police headquarter in the Local Government Headquarters. The Nigerian Police Force in the local government area work in collaboration with youth organizations, army, religious organizations and the vigilante groups for effective community policing.

4.12.23 Infrastructure

As our study revealed, the availability of basic infrastructural necessities of life in the study area is limited. The local people also complained bitterly on this and expressed hopes that the proposed project coming into their area would help to ameliorate their socio-economic living conditions. It has been reported by the UNDP (2006) that infrastructural and social services in the North are generally deplorable and grossly inadequate for an estimated regional population of over 60 million people. The case is not different for many parts of the study area. The affected LGA and state government have been contributing different quota to the development of the social infrastructure in the study area.

In educational facilities, the surveyed communities have four (4) UBE Primary schools and 2 Government Secondary Schools. These schools are characterized by poor infrastructure except for the one in Sabon Gari built and donated by the project proponent. In terms of electricity, the project area is not linked to the national grid of any Electricity Distribution Company. Urgent steps are needed to connect these communities to the national grid. Those involved in various economic enterprises possess electricity-generating sets to ameliorate the effect of the unavailable power supply in the area.

General Hospitals located in the Local Government headquarter and 2 primary health care facilities in Sabon Gari and Amfani communities that serve as centre for primary and secondary medicare activities with few qualified nurses and no doctor. About marketing infrastructure, the study area has small makeshift market with no market infrastructures. The study area needs assistance in the construction of modern markets.

Major mobile communication service providers (MTN, Airtel, Etisalat and Glo) are functional in the study area though the services are characterized by poor network signals. The map of the project area showing infrastructure facilities is shown in fig 4.14, while plate 4.36 shows pictorial view of market and hospital facilities constructed by the project proponent in Sabon Gari.

Fig 4.14: Map of Project Area Showing Infrastructure Facilities


Plate 4.36: Market and Hospital Facilities Constructed By the Project Proponent in Sabon Gari

4.12.24 Health Survey and Disease Prevalence

The disease prevalence based on data and other information from the Primary Health Centres in the area shows it is divisible into infectious (i.e. communicable), non-infectious (i.e. non communicable) injuries and malnutrition.

Infectious diseases are the most prevalent of the diseases found in the study area. The four commonest types of infectious diseases here are diarrhea, measles and respiratory tract infection. The commonest non-infectious diseases are anaemia, hypertension and diabetes mellitus.

Records from Primary Health Centres in Sabon Gari and Amfani communities, series of in-depth interviews and focus group discussions (FGD) reveal the following as the most frequent illness in the study area; Cholera, Typhoid, Malaria etc. There is a General Hospital in the LGA headquarters.

Interactions revealed sources of treatment for the various ailments to be traditional with the aid of herb, modern-predicated on visit to health centre and self-medication or spiritual. Patent medicare stores/ roadside drug vendors are also very prevalent medicare avenues and thus enjoy a lot of patronage, even though the quality of dispensed drugs cannot be ascertained. Records received from health care centres revealed that typhoid is the most frequent illness followed by malaria in the study area. Series of in-depth interviews and focus group discussions (FGD) reveal the means of treatment of the various illness in the study area. FGD shows that visits to health centres and hospitals for treatment is always the last resort of majority of persons who claimed to be discouraged by the cost of treatment and long queues at the general hospitals in the area, and by the official documentary procedures and processes that have to be observed in health centres, in order to access medicare.

4.12.25 Pest and Animal Reservoirs of Infection

Houseflies, mosquitoes, sun flies and cockroaches are the commonest insects found in the study area. Mice, rats and lizards also constitute a nuisance. Various types of snake's form part of the ecosystem but are not rampant. Some households have domestic pets like dogs and cats. The people use insecticides, mosquito coils and herbs to control domestic pests; and poisons and mechanical traps to control rodents.

4.12.26 Disease Vectors

The commonest is mosquito which transmits *Plasmodium* which causes malaria in humans. Others are house flies and rodents. The environment around the project communities provides the necessary breeding grounds for these disease vectors.

4.12.27 Nutritional Status

Few respondents and focus group discussants however cited low income, family size and high cost of essential food items as accountable for poor nutrition. The major food substances consumed are rice, beans and cassava products such as garri and fufu. Meat, milk, egg, vegetables, fruits, and vegetable oil abounds in the study area but are hardly consumed by members of the communities, instead they are sold in the various community markets. Generally, the nutritional status of the area is considered poor.

4.12.28 Sanitation and waste Management

Since 1983, environmental sanitation has become a prominent issue in Nigeria and countless sanitation Waste disposal practices in the four communities are quite similar. Refuse and sewage are mostly disposed in the surrounding farm lands and communities' dump sites. Similarly, two methods of sewage disposal practiced are use of pier system toilets and water closet toilets. About 80% of households in the study communities dump their refuse in nearby farm lands, while 82% use the pit toilets.

The common refuse and sewage disposal practices in communities across the study area are not modern, hygienic or safe. In fact, most of these wastes eventually end up in the water bodies around the area or are carried downstream and deposited in other communities. Although those that are easily bio degradable (including sewage), decompose and also provide nutrients for plants and fishes, they are still sources of pollution and constitute a health hazard. Those that are not easily degradable (especially metals and plastics) are always visible and obvious pollutants and litter around the environment.

4.12.29 Psycho-Social Health Indicators Lifestyle

The questionnaire was designed to obtain information on the life-style and social habits in the study area, of interest in the survey were such habits as alcohol consumption, drugs and substance abuse and cigarette smoking. Cigarette smoking is prevalent among the youths predominantly. About 21.3 per cent and 8 per cent of the populations smoke and use alcohol respectively. No person admitted to smoking of Indian hemp or usage of hard drugs, bearing in mind the social implications of such act. It was however admitted in the Focus Group Discussion (FGD) that a few of the youths in the area indulge in the habit.

4.12.30 HIV/AIDS and Social Pathologies

Despite the measures for maximizing local employment, a large proportion of the construction workforce will originate from outside the local area. This means that it will be necessary for workers to find accommodation near the project site. However, as has been well-documented from other infrastructure projects, the presence of non-local construction workers, combined with an extended construction period may have a variety of social consequences:

- Construction workers, being a predominantly young, male, mobile population, are often sexually active. Long-distance truck drivers needed to transport building materials and equipment are similarly associated with sex workers. Such behaviour could increase the prevalence of HIV/AIDS, tuberculosis and other communicable diseases in the local study area during the construction phase. The fact that the current HIV/AIDS prevalence in Nigeria is relatively low does not completely obviate this risk. Other social pathologies frequently associated with a transitory population with disposable income (such as drug/ alcohol abuse, etc.) may also increase.

- An influx of construction workers may also be accompanied by an increase in crime such as petty theft, vandalism and poaching of domestic livestock. Even if particular instances of crime are not as a result of newcomers, it may still be attributed to them by local community and landowners.

- Negligence with regard to starting fires around the construction areas, which could pose a fire hazard; and
- A lack of control over contract employees in respect of ablutions, which could pose an environmental health hazard.

The risk of HIV/AIDs and social pathologies is assessed as being of moderate negative significance without mitigation, which remains moderate negative with mitigation.

Nigeria albeit due to its population size, is now the second largest HIV disease burden in the world with 3.2 million after South Africa which has 6.8 million of the disease. In 2016, Nigeria had 220,000 new HIV infections and 160 000 AIDS related deaths. In 2017 global information and education on HIV and AIDS report 3.1 million as having HIV/AIDS in Nigeria, 2.8% adult HIV prevalence (ages 15-49), 210, 000 new HIV infections, 150,000 AIDS related deaths, 34% adults on antiretroviral treatment and 26% children on antiretroviral treatment.

According to the national sentinel study on HIV/AIDs (2011), Niger State where the project is situated has a prevalence of 2.1-4.0% and 4.1-6.0. This figure for Niger is lower than the national average and corresponds to the lower tier of prevalence in Nigeria. It is noted however that a good amount of awareness education and advocacy on the disease and its prevention is ongoing and from interviews these are beginning to yield the desired results. The most important tool in prevention/control of STIs is health education which undoubtedly the study area can largely benefit from. The objective of health education is to create awareness of the problem and to motivate people to develop the right attitude to sex. Early diagnosis and early treatment of sick persons will eliminate the reservoir of infections from the area. Treatment however should be accessible and affordable; otherwise the people will resort to self-medication. Self-medication especially before or after exposure must be discouraged as this may lead to drug resistance.

The federal and state governments spend billions of naira yearly to create awareness on the grave negative effects of the scourge. This awareness seems to be yielding positive result in the area as over 99% of the respondents claim to know about HIV/AIDS and its means of transmission and prevention. Collaborating this, drug vendors locally referred to as chemists in the area said there is an increase in the number of condoms sold daily. However, the FGD revealed that a quarter of respondents acknowledged that they often had unsafe sex with high risk partners.

This project is likely to have a double – pronged effect on the study area. On one hand, it will improve the socio-economic status of the people thereby riveting their attention from sexual activities. On the other hand, however, improved economic status could precipitate change in lifestyle leading to high intake of alcohol and increased sexual encounters.

4.12.31 Physically and Mentally Challenged Persons

Most surveyed households in the area have cases of physically/mentally challenged individuals, majority of whom do not attend schools. No government or non-governmental organization (NGO) assistance has ever been offered to them, and their families/kindred who do not have enough to cater for them. This group of persons is however not discriminated against since they are familiar faces who reside with their kith and kin who largely understand them. They are however cautioned and restricted when they get out of hand occasionally.

4.12.32 Summary of Public Consultations and the Opinions Expressed

The proponent considers consultation as a major feature of its operations; the thrust of the consultation programme for the proposed project is to promote mutually beneficial relationships with all the stakeholders through close contacts and regular consultations and also with the aim of notifying the stakeholders of the nature, scale and timing of the proposed project, thereby eliminating any fears or apprehension. The process was also used to facilitate information gathering between the state government and the other stakeholders. Consultation exercise commenced at the very early stage of the environmental impact valuation and it is planned to continue throughout the project duration.

4.12.33 Levels of Consultation

Two levels of consultations, as are generally recognized in the ESIA process, were held. These are institutional and Project affected communities (PACs) involvement. The subject of this section relied heavily on both, though with emphasis on PACs involvement, i e. getting the public, host communities, all other stakeholders that may be directly or indirectly affected by the project to participate in assessing the project.

The public forum with Project Affected Communities, NGOs, and CBOs, youth groups, Women organisations, religious organisations and traditional bodies held in the project affected communities with the various village heads in attendance.

In all the consultation meetings, a brief on the project with regard to the following was given by the ESIA consultant.

- Purpose of the Public Fora
- Background to the project
- Project description
- Benefit description
- The benefits of the project
- Environmental Management
- Community Affairs and relations.

At the end of the presentation, participants were given ample opportunity to ask questions and/or make comments on the project. They were unanimous in praising the proponent for considering them suitable to host the project and promised to accord the proponent all the needed support.

4.12.34 Identification of Stakeholders

In preparing this ESIA report the consultation process is implanted at three (3) levels: The first level of consultation identifies the social and economic issues in the project area and ensures visible management commitment to addressing them. This level starts with the project conception.

The second level streamlines the issues and makes plans for specific actions. This level recognizes various phases of engagements among project proponent, host communities, village council, women/men's groups, and youth organization. The third level ensures regular communication with stakeholders throughout the project's life; the second and third levels of consultation commence at project inception and continue through the life span of the project.

The key stakeholders identified and consulted for the proposed project are: Host communities and Magama Local Government Area which is the Local Government involved in this project, Project Affected Persons (PAPs), Niger State Ministries of Environment, Lands, Urban and Town Planing, Nigerian Police, Department of State Services (DSS), Nigeria Security and Civil Defence Corp and Federal Ministry of Environment, Kugiya Matan Sabon Gari (Women Group), Kugiya Matasa Amfani other sociocultural groups were all consulted. In the course of planning, the project proponent has established close working relationship and a sense of partnership with those key stakeholders and the host communities and shall maintain these throughout the project life.

4.12.35 Outcomes of Consultation

The concerns expressed by the host communities are listed below, evidence of consultation with host communities and other stakeholders are also presented in Appendix 2 in form of attendance. Some of the photographs taken during socio-economic and community consultation is presented in this section too. At the project consultation/field data gathering meetings with various community stakeholders, community leaders and members and at FGDs a number of questions, issues and concerns were raised and certain expectations were also discussed by community members across the project impact communities.

4.12.36 Communities' Concerns

- Environmental damage: Most communities fear that construction activities will destroy the vegetation, cause turbidity in the rivers and affect the water that is used by households for drinking and other purposes.

- Loss of livelihoods: PACs also fear families in the communities will lose their farmlands, fish ponds, grazing area, economic trees and, therefore, lose their livelihood activities.

- Social problems: Introduction and increase in vices like drug use and prostitution, teenage pregnancy, school dropout, and insecurity during project construction.

- Health problems: Increase in the occurrence of STDs and HIV/AIDs.
- Payment of compensation: All compensation paid to families be revisited before commencement of the project.

Plate 4.37: A Group Photograph with Youth Leaders in Amfani Community after Consultation

4.12.37 Community Expectations

Expectations of the communities consist mainly of human capital development and development of infrastructural facilities. They basically include the following:

- Creation of employment opportunities for residents of the communities.
- Empowerment of community members through skills acquisition, award of contracts and provision of scholarships.
- Payment of compensation for loss of property to the communities.
- Infrastructural development in communities in terms of provision of potable water, electricity, functional orthodox health care facilities, renovation and equipping schools and erosion control projects.

CHAPTER FIVE

5.0 POTENTIAL AND ASSOCIATED IMPACTS

5.1 Introduction .

This chapter presents the methods used in identifying, screening, analyzing and ranking of potential and associated environmental, social and health impacts of the proposed Amfani Industrial Park and Smart City Project as well as the results from the entire process.

The use of appropriate impact identification and prediction methods is crucial for good EIA. A number of methods have been developed over the years for impacts assessment, while new approaches continue to emerge. Every method has merits and demerits, however all good methods have certain elements in common, which are widely accepted as essential for a good EIA. The Scientific Committee on the Problems of the Environment (SCOPE) (1979) suggested that the following qualities should be considered while choosing Impact assessment methods:

Comprehensiveness

This implies that the method should be able to detect the full range of important elements and combinations of elements, directing attention to novel or unsuspected effects or impacts, as well as to the expected ones.

Selectivity

This has to do with the ability of the method to focus attention on major factors. It is often desirable to eliminate as early as possible (i.e., during identification) impacts that would dissipate effort if included in the final analysis. Although screening at the identification stage requires some pre-determination of the importance of an impact. Lindblom (1959), Beer (1967), and Holling (1978) provide some guidelines on how to deal with this issue.

Mutually exclusive

This quality ensures that double counting of impacts or effects are avoided. However, experience has shown that this is difficult because of the many interrelationships existing in the environment.

Yield to Confidence limits

Subjective approaches to uncertainty are common in many existing methods and can sometimes lead to quite useful predictions. However, explicit procedures are generally more acceptable, as their internal assumptions are open to critical examination, analysis, and, if desirable, alteration.

Objectivity

The objectivity of impact assessments has been well emphasized by many regulators including the FMEnv. Objectivity minimizes the possibility that the predictions automatically support the preconceived notions of the promoter and/or assessor. Such pre-judgments are usually caused by a lack of knowledge of local conditions or insensitivity to public opinion. A second merit of objectivity is to ensure comparability of EIA predictions amongst similar types of actions. An ideal prediction method contains no bias.

Prediction of Interactions

Environmental, social, and economic processes often contain feedback mechanisms. A change in the magnitude of an environmental effect or impact indicator could produce unsuspected amplifications or dampening in other parts of the system.

In view of the foregoing and as clearly stated by Canter (1996), there is no universal methodology that can be applied to all project types in all environmental settings. The United Nations Environmental Programme (UNEP, 1996) also emphasizes the need to use tools from existing methodologies that best suit the specific project situation. Lohani et al., (1997), further pointed out that since no single method will meet all the necessary criteria of an EIA, the objective should be to select an array of methods that collectively meet assessment needs. They further state that of the variety of techniques and methods available, only a few are applicable to developing countries.

Generally impact assessment methods fall under seven types of approaches:

1. The Leopold matrix approach
2. The Battelle environmental evaluation system
3. Checklists
4. Matrices
5. Flowcharts and Networks
6. Mathematical/Statistical and computer models
7. Overlays using maps and GIS

Each approach has merits and demerits. In selecting an overall impact assessment methodology for the Industrial Park project, a number of widely used methods were reviewed and qualities considered appropriate, were incorporated in the assessment.

The major steps in the impact assessment methodology selected for this project are as presented in Figure 5.1.

5.2 Impact Assessment Methodology

The assessment of project impacts and their significance is required both for the environmental management of the project and to communicate project information to stakeholders. These requirements could be addressed using the following approaches;

Activity led assessment of Impacts and development of mitigation measures- this approach is often suitable for the implementation of management actions; for instance, a proponent will want to understand what all the noisy activities are, as well as their impacts in order to provide adequate noise control mechanisms.

Resource/Receptor or key issues led assessment of Impacts and development of mitigation measures - this approach is often more suitable for stakeholders; for instance, environmental quality regulators may require that all impacts on biodiversity be discussed together.

The approach adopted in this impact assessment was geared towards addressing both requirements. The methodology used for the proposed

Amfani Industrial Park and Smart City project construction and operation activities is summarized in Figure 5.1, while a description of the process and the results obtained on application of the method are described in the following sections. In order to effectively carry out the impact assessment and prediction, the following inputs and approaches were relied upon:

- Superimposing project components on existing environmental conditions to identify potential impact areas and critical issues;
- Field investigations;
- Consultation with experts, stakeholders and nearby communities;
- Development and maintenance of a comprehensive database on the biophysical and socio-economic characteristics of the environment of the project area;
- Experience from similar projects worldwide;
- Discussions with project proponents and design contractors;
- Published and unpublished documents providing guidance on performing
  Impact analysis.

Step 1

Identification and description of project phases associated activities and their possible interaction with environmental, social and health components

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Step 2

Preliminary identification of potential impacts on biophysical, social and health components of the environment.

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Step 3

Screening for impact importance; elimination of activity/environment interactions producing no effects. Selection of focus impacts for further assessment.

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Step 4

Detailed assessment of selected focus impacts under the following bases:

Nature: Positive or Negative; direct or indirect
Magnitude: Qualitative and Quantitative
Extent: Qualitative and Quantitative
Frequency
Location sensitivity
Cumulative effects
Duration; including reversibility and irreversibility

Figure 5.1: Schematic of the Impact Assessment Methodology

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Step 5

Final assessment and assignment of overall impact significance levels based on level four results and application of objective impact severity criteria and likelihood. Identification of impacts that requires mitigation.

5.2.1 Project Environmental Overview

The process adopted in the identification and assessment of the potential and associated impacts of the proposed Amfani Industrial Park and Smart City project considered various phases of the project, namely:

- Pre-construction:- this will include mobilization of materials and personnel, community engagement, permit to work, site preparation, including site clearing activities, etc;
- Construction / Installation: - foundations, building /other structures construction, and other associated earth works;
- Commissioning and Operation/Maintenance: - project inspection, commissioning as well as operations and subsequent maintenance activities;
- Decommissioning: - disusing/abandoning of project facilities

5.2.2 Identification of Impacts and Activities' Interactions

Details of the Industrial Park construction, operations and decommissioning activities that could engender environmental impacts are as follows:

- Site preparation (Bush clearing/ Surveying/ creation of access road and camping)
- Mobilization of construction elements
- Recruitment and community engagement
- Dredging
- Assemblage of heavy equipment and machines
- Civil Construction including fencing, Admin building and hotel, etc.
- Other services construction e.g. water treatment plant
- Onsite fabrication (metal works etc.)
- Building/other structure foundation.

- Building erection activities
- Waste management
- Fuel/hazardous material handling
- Painting and coating
- Fire/explosion (unplanned activity)
- Incident/Accidents (Unplanned activity e.g. building falling)
- Commissioning
- Operation and maintenance of the park (hotels, refinery, power plant, floating jetties, floating farms, etc.)
- Operation and maintenance of Airport, stacking area and other infrastructure facilities
- Security issues
- Material storage
- Power Infrastructure
- Maintenance
- Project decommissioning
- Emissions
- Abandonment/Restoration

At this stage of the impact assessment, a wide range of environmental components which project activities may possibly interact with were considered. The components that were not relevant to the project were not considered. The environmental components considered are presented in Table 5.1.

Table 5.1: Components of Environmental Aspects Prone to Project Activities

Aspect	**Components**
Biophysical	Atmospheric elements: Air Quality, GHG emissions, etc.
	Noise level
	Aquatic Ecology: Biota, Water and

	Sediment
	Terrestrial: Geology, topography, soil quality, vegetation, Wildlife
	Ecosystem
Human, Socio-economic and Cultural	Land-use pattern
	Local population level
	Socio-economic systems
	Socio-cultural Systems
	Basic Amenities and Infrastructure
	Transportation System
	Environmental justice
	Aesthetics

The project construction and operation activities were examined for their potential to result in changes to the environmental components in Table 5.1 using impact indicators/indices as presented in Table 5.2.

Table 5.2: Environmental Components and their Impact Indicators

Aspect	Environmental Component	Impact Indicators
Biophysical	Atmospheric elements	Gaseous emissions (like: NO_x, SO_x PM, CO) that contaminates ambient air quality and contribute to atmospheric impacts both at local and global level.
	Noise levels	Increase in ambient noise level
	Aquatic Ecology	Changes in the baseline physico-chemical and biological properties of surface water (Kainji lake,etc); Changes in the Physico-chemical properties of sediment; Changes in community composition and abundance of aquatic biota including; microbes, plankton, macrobenthos, fishes, mammals, reptiles, amphibians, birds species, etc.
	Geology	Changes in geology and geomorphology
	Soil	Changes in physico-chemical and

Aspect	Environmental Component	Impact Indicators
		biological properties of soil
	Topography	Changes in land terrain and topography
	Vegetation	Changes to vegetation population, health, species abundance and diversity and impact on endangered and economic species
	Wildlife	Changes in wildlife distribution and abundance
	Ecosystem	Changes in ecosystem level of impacts such as: animal and plant communities, nutrient balance, loss of habitats ,etc.
Human, Socio-economic and Cultural	Land-use pattern	Changes in land-use patterns such as agriculture, fishing, logging, hunting, etc,
	Local Population level	Immigration and in-migration of people
	Socio-economic system	Changes in employment opportunities, income differentials, inflation, difference in per capita income, inequality of benefits to local population, etc.
	Socio-cultural system	Changes in social structure, organization and cultural heritage, practices and beliefs, natural resources, rights of access, changes in value system influenced by foreigners, etc.
	Basic Amenities and Infrastructure	Access to goods and services such as housing, education, healthcare, water, fuel, electricity, sewage and waste disposal, consumer goods brought into the region, etc.
	Transportation System	Changes in transport systems and associated effects such as noise, accidents risk, changes in existing facilities, etc.
	Environmental Justice	Conflicts in choice making between development and protection natural resources use, recreational use, historical and cultural resources, tourism, etc.
	Aesthetics	Presence of unsightly or noisy facilities.

5.2.3 Preliminary Identification and Screening of Environmental Impacts

In line with widely recommended impact assessment approaches (FMEnv, 1995; UNEP, 1996; Canter, 1996; Lohani *et al*., 1997), the first level of impact assessment involved preliminary identification and screening of potential environmental impacts from anticipated activity-environment interactions based on understanding of the activities and nature of interaction with environmental components.

To further guide the identification and screening of impacts using the matrix, impact indicators or indices were developed for each of the environmental components interaction. Impact indicators are observable or measurable parameters of each environmental component that can be directly or indirectly linked to changes in environmental conditions. Table 5.2 gives a list of the typical impact indicators that were used for this impact assessment study.

A modified Leopold matrix (Leopold, 1971) was used for the identification and screening. The matrix arrays project activities against environmental (biophysical and socio-economic) components, and supports a methodical comprehensive and objective identification of impacts each activity could have on the environmental components. The matrix consists of a horizontal list of biophysical and socio-economic environmental components that could be affected by the proposed activities versus a vertical list of project activities, which represent environmental aspects, or sources of impacts associated with each project phase.

Entries in the matrix cells represent the nature and preliminary ranking of the impacts. Ranking of the severity is based on the colour code shown in Table 5.3 below.

Table 5.3: Impact Ranking Matrix

+	Positive Impact
0	Negligible/No Impact
1	Minor Impact
2	Moderate Impact
3	Major Impact

The impact ranking categories are defined as follows:

Positive Impact - this is impact that adds a measurable benefit to the environment.

Negligible Impact - this impact may occur but based on experience, available scientific information and expert knowledge will have very insignificant effect on the environment.

Minor Impact - this impact could either affect a large (as defined below) or moderate (less than 40%) amount of an affected resource and has mid to long-term effect, but is most likely reversible.

Major Impact - this impact would affect a large (higher than 40%) amount of a resource and/or has a relatively long-term effect.

In this preliminary screening, all potential impacts, whether likely or unlikely, are considered. The likelihood of an impact is further assessed in the detailed impact evaluation.

The result of the preliminary impact identification and screening is presented in Table 5.4.

Table 5.4: Modified Leopold Matrix – Preliminary Impact Identification and Screening Results

Impact Ranking Matrix

+	Positive Impact
0	Negligible/No Impact
1	Minor Impact
2	Moderate Impact
3	Major Impact

	ENVIRONMENTAL COMPONENT																
	Biophysical									**Socio-economics, Human and Cultural**							
	Air Quality and Noise	Soil Quality	Topography	Vegetation	Wildlife	Aquatic Ecology	Geology and Hydrogeology	Ecosystem		Land Use	Local population	Socio-economic System	Socio-cultural	Basic Amenities and Infrastructure	Transport System	Environment	Aesthetics and Visual Intrusion
PROJECT ACTIVITY																	
Mobilization of workers	0	0	0	0	0	0	0	0		0	3	+	1	1	2	1	0
Site clearing	1	2	0	3	3	1	0	1		2	0	+	0	0	0	2	1
Civil works	2	1	2	0	1	1	1	0		1	2	1	0	+	1	0	2
Wastes and emissions handling	2	2	0	0	0	0	1	0		1	0	0	0	0	0	2	2
Foundation	1	3	1	0	1	2	2	1		2	0	0	0	0	0	1	1
Haulage of equipment	1	1	0	1	1	0	0	0		0	0	0	0	0	3	2	1
Building/other structure erection	1	0	0	0	0	0	0	0		0	0	0	0	0	0	0	2
Operation and maintenance	1	2	0	0	1	2	1	1		0	2	+	1	+	2	1	2
Decommissioning	2	1	1	0	2	0	0	0		+	+	3	2	3	1	0	1

Identification and screening of impacts relied on the following:

- Documented impacts of similar projects in similar environments
- Consultation with thematic experts
- Professional judgment.

5.3 CHECKLIST OF ASSOCIATED AND POTENTIAL IMPACTS

The checklist of associated and potential impacts is shown in the following table.

Table 5.5: Checklist of Associated and Potential Impacts

Project Activity/Environmental Aspect	**Associated and Potential Impacts**
PRE-CONSTRUCTION • Permitting • Surveying • Mobilization • Recruitment • Site Preparation • Land acquisition	Employment opportunities arising from recruitment of skilled and unskilled project personnel
	Business opportunities for local contractors through sub-contracting activities
	Local support services from road side supply markets and shops etc
	Skill acquisition and enhancements to local indigenes and workforce.
	Improvement in quality of life for adequately compensated individuals
	Influx of people (migrant workers, sub-contractors and suppliers) and increased pressure on existing social infrastructure
	Increase of communicable diseases due to influx of people
	Increase in social vices(like theft, prostitution etc) resulting from increased number of people
	Community agitation over compensations, land disputes, wrong stakeholder identification, leadership tussles etc
	Increased traffic during mobilization on road with risk of accidents leading to injury/death and loss of asset
	Risk of terrorist attack and hostage taking leading to injury/death of personnel
	Exclusion of vulnerable groups from consultations which may lead to strife
	Nuisance (noise and vibrations) due to movement from heavy duty equipment and vehicles affecting site workers and wildlife
	Increase of dust particles and vehicular emissions

	Conflicts/community agitations over employment issues(quota and methods)

Project Activity/Environmental Aspect	**Associated and Potential Impacts**
	Disturbance of the vegetative cover/ loss of forest products(fuel wood, timber, medicinal plants) due to site clearing and preparation
	Waste Disposal • Wood, sand, paper, bottles, domestic waste • Waste from all materials used during the pre-construction stage.
	Contamination of surface water as a result of siltation caused by increased erosion during site preparation
CONSTRUCTION/ INSTALLATION: • Building Foundation • Dredging, etc. • Building/Installation of Golf course /Polo club facilities • Building of jetties & other platforms on Kainji Lake. • Building erection • Installation of electricity power infrastructure. • Painting and coating • Transportation and logistics etc. • Commissioning • Waste management • Logistics.	Workplace accidents from burns, cuts, bruises, trips and falls, object at height leading to injury of fatalities.
	Employment of local labor and skills acquisition for workers taking advantage on new opportunities.
	Increased business and economic activities as well as diversification of income sources due to supply contracting and sub-contracting
	Increase in revenue opportunities for local population due to presence of non-resident workers and travelers
	Generation of dust and automobile/heavy duty equipment emissions from construction earthworks.
	Flora/habitat loss and disturbance through vegetation clearing and earthworks within project site and access roads.
	Fauna disturbance and displacement as a result of migration away from construction activity area(this include impacts on birds)
	Soil/groundwater contamination resulting from accidental leakages and spill of hazardous substances(diesel, lubricants ,hydraulic oil etc)

Project Activity/Environmental Aspect	**Associated and Potential Impacts**
	Risks injury/death and loss of assets resulting from accidents associated with road transportation to and fro construction sites
	Traffic diversion and congestion along roads during installation.
	Potential collapse of buildings/structures on land as a result of unstable geotechnical conditions
	Reduction in wildlife population as a result of poaching due to easier access created by project site clearing
	Inhalation by onsite workers of cement dust and toxic fumes during foundation works and welding of material components
	Noise nuisance (including impulsive noise) from construction activities, resulting to temporal migration of sensitive mammals and rodents
	Visual intrusion as a result of alterations from accidental ignition of onsite diesel storage tanks
	Waste Disposal • Scrap metal, wood, sand, concrete, paper • Used oil and replace/obsolete equipment parts that may contaminate soil/ground water • Waste from project sites

Project Activity/Environmental Aspect	**Associated and Potential Impacts**
DEMOBILISATION • Demobilization after construction phase	Workplace accidents from burns, cuts, bruises, trips and falls, object at height leading to injury of fatalities.
	Soil/groundwater contamination resulting from accidental leakages and spill of hazardous substances(diesel, lubricants ,hydraulic oil etc)
	Traffic congestion during transportation of demobilized equipment and personnel

	Generation of dust and automobile/heavy duty equipment emissions
	Reclamation of marshaling yards and laydown areas
	Waste disposal (scrap metal, wood, sand, concrete, paper)
	Reclamation and restriction of access roads to prevent unauthorized uses
	Reclamation and restoration of areas used temporarily for construction.
	Loss of employment and business opportunities due to completion of construction phase
	Illegal access to Industrial Park towers leading to accident, sabotage, asset damage and loss
	Soil runoff and erosion resulting in sedimentation problems
OPERATIONS • Maintenance of all facilities, including Golf & Polo club, hotels, schools, jetty, fish farming, leisure facilities both, etc.	Increased electricity transmission and distribution capacity
	Increased business opportunities and quality of life (small, medium and large scale) due to enhanced power delivery and other business concerns.
	Improvement in environmental standards due to supply of electricity from Kainji dam which is a renewable energy source and reduced emission from standby diesel or fuel generators, use of fuel wood
	Reduced demand on petrol and diesel used for power generation and further reduction in greenhouse gases and noise emissions
	Injuries/fatalities of personnel due to road accidents during facility inspection and checks
	Enhanced aesthetic appeal due to presence and eventual operation of many facilities in the project site and kainji lake.

Project Activity/Environmental Aspect	**Associated and Potential Impacts**
	Electric shock and burns to members of the public in the event of electricity installation collapse or damage to distribution wires.
	Explosion and fire hazards at the facilities.
	Injury/ mortality of birds due to collision with wires around the project area.
	Fatal electric shock and severe burns to workers during facilities' maintenance work
	Unchecked encroachment on the project site, leading to land-

	use conflicts and accident
DECOMMISSIONING /ABANDONMENT • Unstringing of conductor wires • Tower/facility removal • Waste generation	Increased sedimentation process close to Kainji lake banks and floodplains within project site.
	Risk of accident and injury to workers during demolition of structures
	Increased dust and vehicular emissions
	Risk of soil and adjoining surface water contamination from accidental oil and hazardous substance leakages
	Traffic obstruction from transportation of decommissioned structures and equipment
	Availability of land for alternative uses

5.4 Impact Identification and Characterization

Impacts can be induced during the construction of the facility, and later during its operation. In the case of the Amfani Industrial Park and Smart City facilities, the main potential receptors are soil, surface water bodies, flora and fauna, occupational health, in addition to socio-economic amenities. Impact assessment defines the criteria and processes against which potential project impacts can be measured and mitigated. A multidisciplinary team comprising engineers, scientist, environmentalists, etc were involved in the identification and characterization of impacts of the Amfani Industrial Park and Smart City project.

5.4.1 Impact Identification

The existing baseline description of the environment and the various project aspects/ activities were used to develop a checklist of potential and associated impact of the proposed Industrial Park on the biophysical and socio-economic environment. The EIA Sectoral Guidelines for Infrastructures was used as reference in developing the checklist. See Table 5.5.

5.4.2 CHARACTERIZATION OF ASSOCIATED AND POTENTIAL IMPACTS

The checklist approach was adopted; this involved categorizing the project into activities/phases and then the project environment into various components. The interaction between these two elements (the project and environment) may lead to changes in the environment as shown below:

ENVIRONMENT + PROJECT ⟷ **CHANGED ENVIRONMENT**

This change may be direct or indirect, adverse or beneficial, cumulative or residual, long term or short term as described below.

Direct impact (D) – These are impacts resulting directly (direct cause-effect consequence) from a project activity.

Indirect impacts (I) – These are impacts that are at least one stop removed from a project activity. They do not follow directly from a project activity.

Beneficial Impacts (B) - These are impacts that would produce positive effect on the biophysical or socio-economic environment

Adverse Impact (A) – Adverse impacts are those that would produce negative effect on the biophysical or socio-economic environment.

Long term Impact (L) – These are impacts whose effects remain even after a specific project activity (e.g. permanent vegetation loss due to forest clearing)

Short term impact (S) - These are impacts whose effects will last only within the period of a specific project activity (e.g. noise due to construction activities).

Reversible Impacts (RV) - can be addressed on the application of adequate mitigation measures.

Irreversible Impacts (IRV) - These are impacts whose effects are such that the subject (impacted component) cannot be returned to its original state even after adequate mitigation measures are applied.

Cumulative impact (C) - These are impacts resulting from interaction between on-going project activities with other activities, taking place simultaneously.

Residual Impact (R) - These are impacts that would still remain after mitigation measures have been applied.

Table 5.6: Characterization of Some Potential and Associated Adverse and Beneficial Impacts of the Proposed Project.

Project Activity/Environmental Aspect	Associated and Potential Impacts	Impact Characterization									
		Direct	Indirect	Adverse	Beneficial	Reversible	Irreversible	Cumulat	Residual	Long Term	Short Term
PRE-CONSTRUCTION -Permitting -Surveying -Mobilization -Recruitment -Site Preparation -Land acquisition	Employment opportunities arising from recruitment of skilled and unskilled project personnel.	*	*		*	*					*
	Business opportunities for local contractors through sub-contracting activities	*	*		*	*				*	*
	Local support services from road side supply markets and shops ,etc.	*	*		*				*	*	
	Skill acquisition and enhancements to local indigenes and workforce.	*	*		*		*			*	
	Improvement in quality of life for adequately compensated individuals	*	*		*					*	
	Influx of people (migrant workers, sub-contractors and suppliers) and increased pressure on existing social infrastructure	*	*	*		*	*	*	*	*	*
	Increase of communicable diseases due to influx of people	*	*	*		*	*	*	*	*	*
	Increase in social vices(like theft, prostitution etc) resulting from increased number of people	*	*	*		*	*	*	*		*
	Community agitation over compensations, land disputes, wrong stakeholder identification, leadership tussles, etc.	*		*		*			*		*
	Increased traffic during mobilization on road with risk of accidents leading to injury/death and loss of asset	*		*		*	*	*	*	*	*
	Risk of terrorist attack and hostage taking leading to injury/death of personnel	*		*		*			*	*	*

	Exclusion of vulnerable groups from consultations which may lead to strife	*		*		*					*
	Nuisance (noise and vibrations) due to movement from heavy duty equipment and vehicles affecting site workers and wildlife	*		*		*		*			*
	Increase in dust particles and vehicular emissions	*		*		*		*			*
	Conflicts/community agitations over employment issues(quota and methods)	*		*		*			*		*
	Loss of ownership of land and properties by communities due to project dev.	*		*			*		*	*	
Project Activity/Environmental Aspect	**Associated and Potential Impacts**	**Impact characterization**									
		Direct	**Indirect**	**Adverse**	**Beneficia l**	**Reversibl e**	**Irreversibl e**	**Cumulati**	**Residual**	**Long Term**	**Short Term**
	Disturbance of the vegetative cover/ loss of forest products(fuel wood, timber, medicinal plants) due to site clearing and preparation	*		*			*		*	*	*
	Waste Disposal • Wood, sand, paper, domestic waste • Waste from laydown areas and project construction site (material, wood, etc.)	*		*		*		*			*
	Contamination of surface water as a result of siltation caused by increased erosion during site preparation	*		*		*	*		*	*	*
CONSTRUCTION / INSTALLATION: -Building foundation/earth works -Dredging, etc. -Building	Workplace accidents from burns, cuts, bruises, trips and falls, object at height leading to injury of fatalities.	*		*		*	*		*	*	*
	Employment of local labor and skills acquisition for workers taking advantage on new	*	*		*		*				*

erection - Power infrastructure-Conductor wire stringing, etc. -Painting and coating -Transportation and logistics, etc. -Commissioning -Waste management -Logistics.	opportunities										
	Increased business and economic activities as well as diversification of income sources due to supply contracting and sub-contracting	*	*		*		*			*	
	Increase in revenue opportunities for local population due to presence of non-resident workers and travelers	*	*		*	*	*			*	
	Generation of dust and automobile/heavy duty equipment emissions from construction earthworks.	*		*		*		*			*
	Flora/habitat loss and disturbance through vegetation clearing and earthworks within project site and access roads.	*		*		*	*	*	*	*	*
	Fauna disturbance and displacement as a result of migration away from construction activity area(this include impacts on birds)	*		*		*			*		*
	Soil/groundwater contamination resulting from accidental leakages and spill of hazardous substances(diesel, lubricants ,hydraulic oil etc)	*		*		*				*	*
Project Activity/Environ mental Aspect	**Associated and Potential Impacts**	**Impact characterization**									
		Direct	**Indirect**	**Adverse**	**Beneficia l**	**Reversibl e**	**Irreversib le**	**Cumulati**	**Residual**	**Long Term**	**Short Term**
	Risks injury/death and loss of assets resulting from accidents associated with road transportation to and fro construction sites	*		*		*	*	*	*	*	*
	Workplace accidents from burns, cuts, bruises, trips and falls, object at height leading to	*		*		*	*		*	*	*

	injury of fatalities.										
	Soil/groundwater contamination resulting from accidental leakages and spill of hazardous substances(diesel, lubricants ,hydraulic oil etc)	*		*		*				*	*
	Traffic diversion and congestion along roads during installations.	*		*		*		*			*
	Potential collapse of buildings/structures as a result of unstable geotechnical conditions	*	*	*		*					*
	Reduction in wildlife population as a result of poaching due to easier access created by project site clearing	*	*	*		*		*	*	*	*
	Inhalation by onsite workers of cement dust and toxic fumes during foundation works and welding of metallic material components	*		*		*			*		*
	Noise nuisance (including impulsive noise) from construction activities, resulting to temporal migration of sensitive mammals and rodents	*		*		*					*
	Visual intrusion as a result of alterations from accidental ignition of onsite diesel storage tanks	*		*		*					*
	Waste Disposal • Scrap metal, wood, sand, concrete, paper, etc. • Used oil and replace/obsolete equipment parts that may contaminate soil/ground water • Waste from laydown area and construction sites.	*		*		*		*	*		*

Project Activity/Environmental Aspect	**Associated and Potential Impacts**	**Impact Characterization**									
		Direct	**Indirect**	**Adverse**	**Beneficial**	**Reversible**	**Irreversible**	**Cumulative**	**Residual**	**Long Term**	**Short Term**
DEMOBILISATION		*		*		*	*		*	*	*
-Demobilization after construction phase		*		*		*				*	*
	Traffic congestion during transportation of demobilized equipment and personnel	*		*		*		*			*
	Generation of dust and automobile/heavy duty equipment emissions	*		*		*		*			*
	Reclamation of marshaling yards and laydown areas	*			*	*			*	*	
	Waste disposal (scrap metal, wood, sand, concrete, paper)	*		*		*		*			*
	Reclamation and restriction of access roads to prevent unauthorized uses	*			*	*		*	*	*	
	Reclamation and restoration of construction areas	*			*	*		*	*	*	
	Loss of employment and business opportunities due to completion of construction phase	*	*	*		*		*	*	*	*
	Illegal access to Industrial Park leading to accident, sabotage, asset damage and loss	*	*	*		*	*		*	*	*
	Soil runoff and erosion resulting in sedimentation problems	*		*		*				*	
OPERATIONS -Floating farm & jetties & other platforms on kainji lake inspection and checks -Material replacement -All facilities	Increased electricity distribution capacity within project area.	*	*		*			*		*	
	Increased business opportunities and quality of life(small, medium and large scale) due to enhanced power delivery from Kainji dam	*	*		*		*	*		*	*
	Improvement in environmental standards due to reduced	*	*		*			*		*	*

Project Activity/Environmental Aspect	Associated and Potential Impacts	Impact Characterization									
		Direct	Indirect	Adverse	Benefici	Reversibl	Irreversi	Cumulat	Residual	Long	Short
maintenance	emission from standby diesel or fuel generators, use of fuel wood.										
	Reduced demand on petrol and diesel used for power generation and further reduction in greenhouse gases and noise emissions due to constant supply 0f electricity from Kainji dam-a renewable energy source.	*	*		*			*		*	*
	Injuries/fatalities of personnel due to road accidents during facilities inspection and checks	*		*			*		*	*	
	reduced aesthetic appeal due to presence and eventual operation of Industrial Park	*		*		*			*	*	*
	Electric shock and burns to members of the public in the event of power structure collapse or damage to transmission line wires	*		*		*	*		*	*	
	Explosion and fire hazards at the facilities location.	*		*		*	*		*		*
	Injury/ mortality of birds due to collision with earth wires on towers	*		*			*		*	*	
	Fatal electric shock and severe burns to workers during maintenance work	*		*			*		*	*	
	Unchecked encroachment on the project site, leading to land-use conflicts.	*		*		*	*		*	*	*
DECOMMISSIONING /ABANDONMENT -Removal of all facilities -Waste	Increased sedimentation process close to Kainji lake banks and floodplains around the project site.	*		*			*			*	*
	Risk of accident and injury to	*		*			*		*	*	

Project Activity/Environmental Aspect	Associated and Potential Impacts	Impact Characterization									
		Direct	Indirect	Adverse	Benefici	Reversibl	Irreversi	Cumulat	Residual	Long	Short
generation	workers during demolition of structures										
	Increased dust and vehicular emissions	*		*		*					*
	Risk of soil and adjoining surface water contamination from accidental oil and hazardous substance leakages	*		*		*					*
	Traffic obstruction from transportation of decommissioned structures and equipment	*		*		*		*			*
	Availability of land for alternative uses	*			*		*			*	

5.5 Impact Evaluation

The potential and associated impacts identified and characterized were evaluated. The evaluation which was based on clearly defined criteria (legal/regulatory requirement, risk, frequency of occurrence, importance and public interest/ concern) was used to determine the significance of the impacts. The criteria and weighing scale adopted for the evaluation are described below.

Legal/Regulatory Requirements Here, the proposed project activities that resulted in impacts were weighed against existing legal/regulatory provisions to determine the requirement or otherwise for permits prior to the execution of such activities. Such legal/regulatory requirements were identified from the laws/guidelines, which have been reviewed in chapter one of this report. The weighting scale used is as follows:

Table 5.7: Legal/Regulatory Requirements Criterion

CONDITION	RATING
No legal/regulatory requirement for carrying out project activity	Low (0)
Legal/regulatory requirement exist for carrying out activity	Medium (3)

A permit is required prior to carrying out project activity which may result in impact on the environment	High (5)

Risk Posed by Impact

The health, safety and environmental risks associated with each impact were assessed and ranked as "low", "medium" or "high", using the Risk Assessment Matrix (Figure 5.2). Three criteria (consequence, probability of occurrence and severity) were used as basis for ranking the risks of the impacts. Risk:-was measured based on risk assessment matrix (RAM).

Increasing Severity

Consequence					**Increasing Probability**				
					A	**B**	**C**	**D**	**E**
Severity	**People**	**Asset Damage**	**Environmental Effect**	**Reputation**	**Practically Impossible**	**Not Likely to Occur**	**Possibility of Occurring Sometime**	**Possibility of Isolated**	**Possibility of Repeated**
1	Slight injury	Slight	Slight	Slight	Low Risk				
2	Minor injury	Minor	Minor	Limited					
3	Major injury	Localize d	Localized	Considerable			**Medium Risk**		
4	Serious injury	Major	Major	National					
	Multipl e fataliti es	Extensiv e	Massive	International					High Risk

Figure 5.2: Risk Assessment Matrix

The risks (measure of the likelihood and magnitude of an adverse effect) associated with Industrial Park projects were evaluated in terms of:

• risk to human health;

• risk to the biophysico-chemical environment

Based on the matrix above, the weighting used was as follows:

Table 5.8: Risk Attribute Matrix

Risk	Attribute – Environmental, Human Health, Safety and Reputation
Low (0)	This means that no further mitigation may be required
Medium (3)	This means that the impact can be mitigated with additional controls and modifications
High (5)	This means that the impact require avoidance or major control/mitigation

Frequency of Impacts Occurrence

Evaluation of the frequency of occurrence was rated as "high", "medium" or "low" based on the historical records of accidents/incidents, consultation with experts and professional judgment. The frequency criterion is summarized below.

Table 5.9: Frequency Criterion

Frequency	Attribute – Environmental, Human Health and Safety
High (5)	• Major degradation in quality in terms of scale (>1% of study area or habitat within the study area), appearance, duration (beyond duration of project) • Irreversible or only slowly recoverable (change lasting more than 1 year) degradation of environmental ecosystem level (population, abundance, diversity, productivity) • High frequency of impact (occur continuously and almost throughout the project execution period) • Geographic extent of impact (e.g. encompassing areas beyond the project area)
Medium (3)	• Degradation in quality in terms of scale (>0.1% of study area, habitat), appearance, duration (a few months) • Effect beyond naturally occurring impacts variability • Slow reversibility (change lasting a few months before recovery), lasting residual impact • Potential for cumulative impact • Intermittent frequency of impact (occur in only a few occasions during the project execution period) • Limited geographic extent of impact (large area within project area)
Low (1)	• Minor degradation in quality in terms of scale (<0.1% of study area, habitat, very localized), appearance, duration (a few days to a month) • Effect within range of naturally occurring impacts, changes, dynamics

	• Rapid reversibility (change lasting only a few weeks before recovery), no lasting residual impact of significance • No potential for significant cumulative impact • Low frequency of impact (occur in just about one occasion during the project execution period) • Only very localized geographic extent of impact (e.g. not more than a few meters from impact source point)

Importance of Impact

The importance of environmental component in respect of identified potential impact was also determined and rated as "high", "medium" or "low". The ratings were based on consensus of opinions among consulted experts including project engineers and other stakeholders in the proposed project. The importance criterion is summarized thus:

Table 5.10: Importance Criterion

Importance	Attribute – Environmental, Human Health and Safety
High (5)	• Highly undesirable outcome (e.g., impairment of endangered, protected habitat, species) • Detrimental, extended flora and fauna behavioral change (breeding, spawning, molting) • Major reduction or disruption in value, function or service of impacted resource • Impact during environmentally sensitive period • Continuous non-compliance with international best practices
Medium (3)	• Negative outcome (e.g., loss time injury from minor burns) • Measurable reduction or disruption in value, function or service of impacted resource • Potential for non-compliance with international best practices
Low (2)	• Non-detectable impact (e.g., emissions from automobile equipment) • Alteration in value, function or service of impacted resource that are not obvious • Within compliance, no controls required

Public Interest/Perception

Here, the interest/perception of the public on the proposed project and the identified potential/ associated impacts were determined through consultation with proposed project stakeholders. The ratings of "high", "medium" or "low" were assigned based on consensus of opinions among consulted known stakeholders. The public perception/interest criterion is summarized below.

Table 5.11: Public perception /interest criterion

Public Perception	Attribute – Environmental and Human Health
High (5)	• Elevated incremental risk to human health, acute and/or chronic • Possibility of life endangerment for community inhabitants and site personnel • Major reduction in social, cultural, economic value • Continuous non-compliance with international best practices • Any major public concern among population in the project region
Medium (3)	• Limited incremental risk to human health, acute and/or chronic • Unlikely life endangerment for community inhabitants and site personnel • Some reduction in social, cultural, economic value • Possibility of adverse perception among population • Potential for non-compliance
Low (1)	• No known risk to human health, acute and/or chronic • No known risk of life endangered for community inhabitants and site personnel • Minor reduction in social, cultural, economic value • Unlikely adverse perception among population

Consequence / Likelihood Evaluation

This impact assessment evaluates potentially significant impacts and prioritizes those potential impacts that require mitigation. Each potential impact is assigned a level of significance that reflects the significance of the consequence that could occur without consideration of control and/or mitigation measures, although reasonable best practices and planned control measures are assumed to be in place. Tables 5.12 and 5.13 provide definitions for the impact significance designations for environmental and worker/public consequences as well as environmental and worker/public likelihood of occurrence respectively. Potential impacts may stem directly from the proposed project or from secondary and cumulative effects.

Table 5.12: Consequence Criterion

Consequence	Severity Rating	Example – Environmental	Example – Workers / Public
Negligible	1	• Dropped objects • Small quantities of chemical or fuel spilled (<100litres)	• Slight injury (no medical / first aid treatment required)
Minor	2	• Small chemical, fuel spill (about 1 tonnes)	• Minor injury (lost time) • Minor exposure to toxic environment
Moderate	3	• Vehicle damaged, fuel spilled (<100 tonnes) • Moderate oil, fuel, chemical spill (50 tonnes) • Shoreline erosion	• Major injury (lost time) • Major exposure to toxic environment
Major	4	• Fuel and hazardous chemical leaks , significant volume or ignited, less than 15-day duration • Tanker lost,1500 tonnes of diesel spilled	• Single fatality • Multiple major injuries • Pirate attack, multiple injuries, kidnapping
Severe	5	• Major explosion, • Major fuel liquid release, 15-90 days duration	• Multiple fatalities

Table 5.13: Likelihood Criterion

Likelihood / Probability Rating	Attribute – Environmental / Socioeconomic (workers/public)
A	• No known occurrence in Industrial Park industry (>1,000 equipment years)
B	• Has occurred in Industrial Park industry (1,000 – 100 equipment years)
C	• Incident has occurred at Hydropolis (100 – 10 equipment years)
D	• Happens several times/year at Hydropolis (10 - 1 (equipment years)
E	• Happens several times/year in site location (10 - 1 (equipment years)

This consequence criterion (Table 5.12) is combined with a probability of occurrence (Table 5.13) to assess the potential significance of the routine or accidental impacts. Specifically the process followed in this assessment resulted in categorizing the identified potential impacts into High, Medium and Low risk categories as shown in Figure 5.3 below.

			Likelihood of Occurrence				
			A	B	C	D	E
			No known occurrence in Industrial park industry (>1,000 equipment years)	Has occurred in Industrial Park industry (1,000 – 100 equipment years)	Incident has occurred at HIL (100 – 10 equipment years)	Happens several times/year at HIL (10 - 1 (equipment years)	Happens several times/year in site location (10 - 1 (equipment years)
Severity	**1**	**Negligible**	**1A**	**1B**	**1C**	**1D**	**1E**
	2	**Minor**	**2A**	**2B**	**2C**	**2D**	**2E**
	3	**Moderate**	**3A**	**3B**	**3C**	**3D**	**3E**
	4	**Major**	**4A**	**4B**	**4C**	**4D**	**4E**
	5	**Severe**		**5B**	**5C**	**5D**	**5E**

Low Risk		**Medium Risk**		**High Risk**	

Figure 5.3: Consequence / Probability Risk Assessment Matrix

5.6 Results of the Impact Assessment

For each of the three main project phases (pre-construction, construction and operation), the potential impacts and benefits were described using characterization and criteria listed above – for example: extent, duration, intensity, nature etc. (Table 5.2) and Legal, risk, frequency, importance etc. The impacts were then assessed in terms of their significance (major, medium, or minor).

The levels of significance for potential impacts of the proposed project were assigned as those impacts to which the following conditions apply.

• Major significance =Impacts for which (L+R+F+I+P) is ≥15 with a consequence / likelihood rating of: 3E, 4D, 4E, 5C, 5D and 5E.

• Medium significance = Impacts for which (L+R+F+I+P) is between 10 - 14 with a consequence / likelihood rating of: 2D, 2E, 3C, 3D, 4B, 4C, 5A, 5B.

• Minor significance = Impacts for which (L+R+F+I+P) is ≤
9 with a consequence / likelihood rating of: 1A, 1B, 1C, 1D, 1E, 2A, 2B, 2C, 3A, 3B, 4A.

Table 5.14: Impacts Measures and Ratings

Project Activity/Environmental Aspect	**Associated and Potential Impacts**	**ASSESSMENT CRITERIA**						
		Legal	**Risk**	**Frequency**	**Importance**	**public**	**Likelihood/ Consequence**	**Impact Category Significance**
	PRE-CONSTRUCTION							
Permitting & Land Acquisition •Consultations Acquisition of all license to operate	Acceptance and co-operation/ participation from stakeholders (communities and government) leading to peaceful and timely execution of the project	-	-	-	-	-	-	**Beneficial**
	Uncertainty and increased	Low	Low	Med	Me	High	3D	Medium

Project Activity/Environmental Aspect	Associated and Potential Impacts	ASSESSMENT CRITERIA						
		Legal	**Risk**	**Frequency**	**Importance**	**public**	**Likelihood/ Consequence**	**Impact Category Significance**
•Stakeholder identification •Land Acquisition/Surveying.	perturbation due to a lack of information and communication.	(0)	(1)	(3)	d (3)	(5)		(12/3D)
	Integration of men and women concerns into the project design	-	-	-	-	-	-	**Beneficial**
	Exclusion of vulnerable groups from consultations which may lead to strife	Low (1)	Low (1)	Med (3)	Me d (3)	Med (3)	3D	**Medium (11/3D)**
	Community agitations over compensations, land disputes, wrong stakeholder identification, leadership tussles, etc	Low (0)	High (5)	Low (1)	Hig h (5)	High (5)	4D	**Major (16/4D)**
Transport of Personnel and Construction Elements • Federal Highway • All roads leading to project site • Kainj lake	Loss of land and properties by PAPs	Low (0)	High (5)	Low (1)	Hig h (5)	High (5)	4D	**Major (16/4D)**
	Increased traffic during mobilization on road with risks of accidents leading to injury/death and loss of asset.	Low (0)	High (5)	Low (0)	Hig h (5)	High (5)	4C	**Major (16/4C)**
	Risks of Terrorist, armed robbery attack and hostage taking leading to injury/ death of personnel	Low (0)	High (5)	Low (0)	Hig h (5)	High (5)	4C	**Major (16/4C)**
	Nuisance (noise and vibrations) due to movement from heavy duty equipment and vehicles affecting public and wildlife.	Low (0)	Med (3)	Low (1)	Me d (3)	Med (3)	3C	**Medium (10/3C)**
	Increase in dust particles and vehicular emissions.	Low (0)	Med (5)	Low (1)	Lo w (1)	Low (1)	2C	**Minor (6/2C)**

Project Activity/Environ mental Aspect	Associated and Potential Impacts	ASSESSMENT CRITERIA						
		Legal	Risk	Frequency	Importance	public	Likelihood/ Consequence	Impact Category Significance
	Work place accidents/incidents from the use of cranes, forklifts, etc. during loading and offloading of materials/equipment.	Low (0)	Med (3)	Low (1)	Med (3)	Med (3)	3C	**Medium (10/3C)**
	Obstruction of/damage to existing roads due to increased usage during mobilization.	Low (0)	Med (3)	Low (1)	Med (3)	Med (3)	3C	**Medium (10/3C)**
	Interference with other road users along mobilization route.	Low (0)	Med (3)	Low (1)	Med (3)	Med (3)	3C	**Medium (10/3D)**
	Leakage of fuel or lube oil onto land or into water bodies during transportation and storage may lead to increased chemical toxicity.	Low (0)	Med (3)	Low (1)	Med (3)	Med (3)	3C	**Medium (10/3D)**
Recruitment of Labour	Employment opportunities arising from recruitment of technical and non technical Industrial Park workers	-	-	-	-	-	-	
	Skill acquisition and enhancements to local indigenes and workforce.	-	-	-	-	-	-	**Beneficial**
	Influx of people (migrant workers, sub-contractors and suppliers) and increased pressure on existing social infrastructure	Low (0)	Med (3)	Med (3)	Med (3)	Med (3)	3D	**Medium (12/3D)**
	Increase of communicable diseases due to influx of people	Low (0)	High (5)	Med (3)	Med	Med (3)	3D	**Medium (14/3D)**

Project Activity/Environmental Aspect	Associated and Potential Impacts	ASSESSMENT CRITERIA						
		Legal	Risk	Frequency	Importance	public	Likelihood/ Consequence	Impact Category Significance
	and poor living conditions around pre-construction sites				(3)			
	Increase in social vices (like theft, prostitution) resulting from increased number of people	Low (0)	High (5)	Med (3)	Med (3)	Med (3)	3D	**Medium (14/3D)**
Site Preparation • Access to project site creation • Service roads • Camping, campsites & site clearing	Conflicts/community agitations over employment issues (quotas and methods)	Low (0)	High (5)	Low (1)	High (5)	High (5)	4D	**Major (16/4D)**
	Business opportunities for local contractors through sub contracting activities.	-	-	-	-	-	-	**Beneficial**
	Local support services from road side supply markets and shops etc	-	-	-	-	-	-	**Beneficial**
	Employment opportunities for local labourers used for land clearing purposes during site preparation	-	-	-	-	-	-	**Beneficial**
	Contamination of surface water as a result of siltation caused by increased erosion, during site preparation.	Low (0)	Med (3)	Low (1)	High (5)			
	Contamination of surface water	Low	Med	Low	Hig	Med	3D	**Medium**

Project Activity/Environmental Aspect	**Associated and Potential Impacts**	**ASSESSMENT CRITERIA**						
		Legal	**Risk**	**Frequency**	**Importance**	**public**	**Likelihood/ Consequence**	**Impact Category Significance**
	as a result of siltation caused by increased erosion, during site preparation.	(0)	(3)	(1)	h (5)	(3)		**(12/3D)**
	Disturbance of the vegetation cover / loss of forest products (fuel wood, timber, medicinal plants) due to site clearing and preparation.	Low (0)	Med (3)	Med (3)	Me d (3)	Med (3)	3D	**Medium (12/3D)**
	Loss/disturbance of wildlife due to habitat loss/fragmentation from vegetation clearing along ROW and access roads	Low (0)	Med (3)	Med (3)	Me d (3)	Med (3)	3D	**Medium (12/3D)**
	Soil compaction, destabilization from excavation and runoff erosion resulting in sedimentation problems.	Low (0)	Med (3)	Med (3)	Me d (3)	Med (3)	3D	**Medium (12/3D)**
	Derangement of fragmentation of wildlife habitats / increase in poaching due to an easier access for the local population and non-resident workers.	Low (0)	Med (3)	Low (1)	Hig h (5)	Med (3)	3D	**Medium (12/3D)**
	Waste Disposal • scrap metal, wood, sand, concrete, paper, domestic waste • Waste from laydown area (Material, wood, etc)	Low (0)	Med (3)	Low (3)	Me d (3)	Med (3)	3D	**Medium (13/3D)**
Fabrication and Metal works •Cutting, bending and	Workplace accidents from burns, cuts, bruises, trips and falls, objects at height, leading to injury or fatalities.	Low (0)	High (5)	Low (1)	Hig h (5)	High (5)	4D	Major (16/4D)

Project Activity/Environmental Aspect	Associated and Potential Impacts	ASSESSMENT CRITERIA						
		Legal	Risk	Frequency	Importance	public	Likelihood/ Consequence	Impact Category Significance
welding metallic/ steel components •Painting •Handling of conductor wires,	Employment of local labour and skills acquisition for workers taking advantage of new opportunities	-	-	-	-	-	-	**Beneficial**
	Risk of electrocution and burns (to onsite workers) from welding flashes and high currents during welding	Low (0)	High (5)	Low (1)	High (5)	High (5)	4D	Major (16/4D)
	Noise and attendant vibration effects from fabrication and associated welding equipments	Low (0)	Low (1)	Med (3)	Low (1)	Med (3)	2D	**Minor (8/2D)**
	Inhalation by onsite workers of cement dust and toxic fumes during foundation works and welding of tower components	Low (0)	High (5)	Low (1)	High (5)	Med (3)	3D	Medium (14/3D)
	Generation of metal scraps from conductor wires and steel elements associated with fabrication of electric infrastructure components.	Low (0)	Med (3)	Low (1)	Med (3)	Med (5)	3D	**Medium (12/3D)**
	Increased business and economic activities as well as diversification of income sources due to supply contracting and sub-contracting	-	-	-	-	-	-	**Beneficial**
	increase in revenue opportunities for local population due to presence of non-resident workers and travelers	-	-	-	-	-	-	**Beneficial**

Project Activity/Environmental Aspect	Associated and Potential Impacts	ASSESSMENT CRITERIA						
		Legal	Risk	Frequency	Importance	public	Likelihood/ Consequence	Impact Category Significance
	Soil / groundwater contamination resulting from accidental leakages and spills of hazardous substances (diesel, cleaning agents, lubricants, hydraulic oil)	Low (0)	Med (3)	Low (1)	Med (3)	Med (5)	3D	**Medium (12/3D)**
	Increased jobs and job opportunities from local labour hire and sub- contracting to indigenous suppliers.	-	-	-	-	-	-	**Beneficial**
	Generation of dust automobile / heavy duty equipment emissions from construction earth works.	Low (0)	Low (1)	Med (3)	Med (3)	Low (1)	2D	**Minor (8/2D)**
	Flora/habitat loss and disturbance through vegetation clearing and earthworks at project site and access roads.	Low (0)	Med (3)	Low (1)	High (5)	Med (3)	3D	**Medium (12/3D)**
Foundation / Earth Works •On-site geotechnical testings •Building foundations, earthworks, etc.	Fauna disturbance and displacement as a result of migration away from construction activity area (this include impact on bird life)	Low (0)	Med (3)	Low (1)	High (5)	Med (3)	3D	**Medium (12/3D)**
	Potential collapse of building/structures as a result of unsuitable geotechnical	Low (0)	Med (3)	Low (1)	High (5)	Med (3)	3D	**Medium (12/3D)**

Project Activity/Environmental Aspect	**Associated and Potential Impacts**	**ASSESSMENT CRITERIA**						
		Legal	**Risk**	**Frequency**	**Importance**	**public**	**Likelihood/ Consequence**	**Impact Category Significance**
	conditions							
	Reduction in wildlife population as a result of poaching due to easier access created by project site clearing	Low (0)	Med (3)	Low (1)	High (5)	Med (3)	3D	**Medium (12/3D)**
	Noise nuisance (including impulsive noise) from construction activities (e.g. piling) resulting to temporary migration of sensitive mammals and rodents.	Low (0)	Low (1)	Med (3)	Low (1)	Med (3)	2D	**Minor (8/2D)**
	Site conditions leading to increased malaria epidemic from uncontrolled mosquito breeding in swamp areas as well as water borne diseases e.g. diarrhoea associated with poor sanitary conditions	Low (0)	High (5)	Med (3)	High (5)	Med (3)	4D	**Major (16/4D)**
	CONSTRUCTION/INSTALLATION							
Building/other structure Construction and Erection • Crane lifting and erections • Bolts and nuts tightening • Anti climbing guards and step	Pollution of soil/water as a result spilled fuel and other waste oil discharge during tower construction and installation processes	Low (0)	High (5)	Low (1)	High (5)	Med (3)	3D	Major (14/3D)

Project Activity/Environmental Aspect	Associated and Potential Impacts	ASSESSMENT CRITERIA						
		Legal	Risk	Frequency	Importance	public	Likelihood/ Consequence	Impact Significance Category
bolts • fittings • Conductor wire stringing •Connectors fixing, etc								
	Traffic diversion and congestion along local roads during installations.	Low (0)	Med (3)	Low (1)	Med (3)	Med (5)	3D	**Major (10/3D)**
	Workplace accidents / incidents (trip/falls etc) from heights during conductor wire stringing and bolt/nuts tightening project activities.	Low (0)	High (5)	Low (0)	High (5)	High (5)	4C	**Major (16/4C)**
	Risks of injury / death and loss of assets resulting from accidents associated with road transportation to and fro construction sites	Low (0)	Med (3)	Low (1)	Med (3)	Med (3)	3C	**Medium (10/3C)**
	Risks of fire/explosions resulting from accidental ignition of onsite diesel storage tanks	Low (0)	Med (5)	Low (1)	Low (1)	Low (1)	2C	**Minor (6/2C)**
	Waste Disposal • scrap metal, wood, sand, concrete, paper, domestic waste • used oil and replaced/obsolete equipment parts that may contaminate soil/groundwater • Waste from laydown area and construction sites .	Low (0)	Med (3)	Low (1)	Med (3)	Med (3)	3C	**Medium (10/3C)**

Project Activity/Environmental Aspect	Associated and Potential Impacts	ASSESSMENT CRITERIA						
		Legal	Risk	Frequency	Importance	public	Likelihood/ Consequence	Significance Impact Category
	Induced secondary development within the neighbouring host communities from increased economic activities.	-	-	-	-	-	-	**Beneficial**
	Flooding of construction site when kainji lake overflows its banks.	Low (0)	Med (3)	Low (1)	Med (3)	Med (3)	3C	**Medium (10/3C)**
	CONSTRUCTION/INSTALLATION							
Demobilization • Demobilization after construction phase	Illegal access to Industrial Park area leading to accident, sabotage, asset damage, and loss	Low (0)	High (5)	Low (1)	High (5)	High (5)	4D	**Major (16/4D)**
	Site conditions leading to increased malaria epidemic from uncontrolled mosquito breeding in swamp areas as well as water borne diseases e.g. diarrhoea associated with poor sanitary conditions	Low (0)	High (5)	Med (3)	High (5)	Med (3)	4D	**Major (16/4D)**

Project Activity/Environmental Aspect	Associated and Potential Impacts	ASSESSMENT CRITERIA						
		Legal	Risk	Frequency	Importance	public	Likelihood/ Consequence	Impact Significance Category
OPERATION/MAINTENANCE								
Operations • Commissioning	Community dissatisfaction regarding the conduct of Hydrpolis on compensation issues may lead to strife before full operations of Industrial Park	Low (0)	High (5)	Low (1)	High (5)	High (5)	4D	**Major (16/4D)**
	Development of agricultural land due to easier access and consequent discovery of new arable adjoining lands for farming	-	-	-	-	-	-	**Beneficial**
Operations • Amfani Industrial Park & Smart City project (AIPASCP) after commissioning.	Increased electricity distribution capacities of the project area due the project development.	-	-	-	-	-	-	**Beneficial**
	Increased business opportunities and quality of life (small, medium, large scale) due to enhanced power delivery from kainji dam.	-	-	-	-	-	-	**Beneficial**
	Improvement in environmental standards due to reduced emission from standby diesel or fuel generators, use of fuel wood.	-	-	-	-	-	-	**Beneficial**
	Reduced demand on petrol and diesel used for power generation and further reduction in greenhouse gases and noise emissions due to supply of electricity from Kainji dam-a renewable energy source.	-	-	-	-	-	-	**Beneficial**
	Electric shock and burns to members of the public in the event of electric installations collapse or damage to high voltage wires	Low (0)	High (5)	Low (1)	High (5)	High (5)	4D	**Major (16/4D)**

Project Activity/Environ mental Aspect	**Associated and Potential Impacts**	**ASSESSMENT CRITERIA**						
		Legal	**Risk**	**Frequency**	**Importance**	**public**	**Likelihood/ Consequence**	**Impact Significance Category**
	Unchecked encroachment on the project site, leading to land-use conflicts.	Low (0)	Med (3)	Low (1)	High (5)	High (5)	3D	**Medium (14/3D)**
	Local fauna disturbances from facilities activities	Low (0)	Med (3)	Low (1)	High (5)	Med (3)	3D	**Medium (12/3D)**
	OPERATION/MAINTENANCE							
Operations • AIPASCP after commissioning	Reduced aesthetic appeal due to presence and operation of AIPASCP	Low (0)	Low (1)	Med (3)	Low (1)	Low (1)	2D	**Minor (6/2D)**
	Development of new infrastructures or improvement to existing ones.	-	-	-	-	-	-	**Beneficial**
	Proliferation of weeds around facilities.	Low (0)	Low (1)	Med (3)	Low (1)	Low (1)	2D	**Minor (6/2D)**
	Disturbance of bird habitats and avifauna sensitive species from activities of maintenance crew.	Low (0)	Med (3)	Low (1)	High (5)	Low (1)	3C	**Medium (10/3C)**
Maintenance • Maintenance of AIPASCP	Development of local maintenance organizations to encourage employment and empowerment within the communities.	-	-	-	-	-	-	**Beneficial**
	Limited knowledge of safety measures and behaviours associated with facilities operation that can lead to accidents	Low (0)	Med (3)	Low (1)	High (5)	Med (3)	3D	**Medium (12/3D)**

Project Activity/Environmental Aspect	Associated and Potential Impacts	ASSESSMENT CRITERIA							
		Legal	Risk	Frequency	Importance	public	Likelihood / Conseque	Impact Significance Category	
DECOMMISSIONING/ABANDONMENT									
Decommissioning / Abandonment • Dismantling of building/structures • All facilities removal • Waste generation	Increased sedimentation process close to Kainji lake and floodplains within project sites or area.	Low (0)	Med (3)	Low (1)	High (5)	Med (3)	3D	**Medium (12/3D)**	
	Risk of soil and adjoining surface water contamination from accidental oil and hazardous substance leakages and wastes from decommissioning.	Low (0)	High (5)	Low (1)	High (5)	High (5)	1E	**Major (16/4C)**	
	Increased dust and vehicular emissions during transportation.	Low (0)	Low (1)	Med (3)	Med (3)	Low (1)	2D	**Minor (8/2D)**	
	Increase in ambient noise levels above baseline conditions from movement and activities of decommissioning equipments and automobiles	Low (0)	Low (1)	Med (3)	Med (3)	Low (1)	2D	**Minor (8/2D)**	
	Traffic obstruction from transportation of decommissioned structures and equipments to receiving hub.	Low (0)	Med (3)	Med (3)	Med (3)	Med (3)	3D	**Medium (12/3D)**	
	Risk of accident and injury to worker during demolition of structures	Low (0)	Med (3)	Low (1)	High (5)	Med (3)	3D	**Medium (12/3D)**	
	Risks of terrorist attacks and possible hostage taking which may lead to injury or death of personnel.	Low (0)	High (5)	Low (1)	High (5)	High (5)	4C	**Major (16/4C)**	
	Availability of land for alternative uses	-	-	-	-	-	-	**Beneficial**	

5.7 DESCRIPTION OF IMPACTS

The information presented in this section are intended to provide a summary insight into the nature and level of significance of the identified impacts as well as a description of mitigation measures outlined in the various phases of the development.

Construction Phase

This refers to all construction and construction-related activities that will occur within the study area until the EPC contractor leaves the area. The construction activities will take approximately twenty four months to complete and will occur in phases. The first phase will involve the pre-construction activities. The construction phase will be treated as an integrated whole, as dictated by the nature of the activities and impacts under discussion.

Operational and Maintenance Phase

All post-construction activities, including the operation and maintenance of the Industrial Park are included in this phase.

Decommissioning Phase

Being a permanent development project, it is not envisaged that the industrial park will be decommissioned in the foreseeable future. However, after operational design lifespan of 25 years, a reassessment of the current status of the Industrial Park shall be carried out.

5.7.1 Socioeconomic impacts

The socio-economic and health assessment provided the baseline social profile of the study area. The Industrial Park will be located around seven communities including Amfani in Magama LGA, Niger state. The baseline social profile of the affected communities has been discussed in chapter four of this report.

Construction Phase

Employment Opportunities

Based on the results of the socio-economic assessment, the un-employment rates in the area are low to average. The locals are however optimistic about the increase in job availability that the development of the Industrial Park will bring. Any available jobs will provide an immediate positive impact on the employment and income situation at the level of the study area as well as at the regional and national levels. The impact is beneficial.

Employment of casual un-skilled labour would occur, for short-term contracts or for the entire construction phase. This could result in a positive spin-off during the construction phase as any level of employment in this region of moderate unemployment and low wage levels will have a beneficial social spinoff. The impact is beneficial.

Contracting

During the construction phase, there will be provision for sub-contracting to local supplies. Supplies will include raw materials that meet standards as required for the construction of the Industrial Park facilities. Equal opportunities will be given to sub-contractors from the host communities. This is a positive impact.

Information Management

Improper dissemination of information about the project and its activities may pose a risk. This is because lack of information and improper sensitization of stakeholders such as men and women groups, religious groups, vulnerable groups (e.g. aged and widowed) youths, etc about the project may result in local disturbances. This impact is assessed as medium.

Community Agitations

After land acquisition by the proponent, there is tendency for agitations by some groups of people or individuals over non-satisfactory engagement and compensations over land and other associated properties. This could lead to strife within communities or groups. This impact has been assessed and ranked with a major significance. During labour recruitment and prior to full construction activities, there is also potential for conflicts between neighbouring communities or individuals over employment quota systems, sub-contracting procedures or recruitment methodology. This will pose major significant impact on the project construction phase.

Socio-cultural Conflicts

Other potential socio-economic impacts are expected to arise from socio-cultural conflicts between the construction workforce and natives due to differences in believes and religion. Another challenge in this direction is increased demand on existing infrastructures due to influx of people to project area. These impacts have been ranked with a medium significance level.

Visual Effects

Setting up of all the facilities ranging from jetty, smart agricultural facilities within the Kainji lake, golf and polo club facilities, hotels, schools, etc may create visual intrusion by altering the normal land form pattern within the project area. This impact has been ranked as minor significance level.

Loss of Land

Acquisition and utilization of land for the Industrial Park and associated facilities may result in temporary and permanent loss of land, some of which are regarded as arable. The impact was ranked with a major significance.

Loss of Income

Completion of the construction phase of the project will lead to loss of employment and business opportunities. This impact has been assessed with a medium significance level.

Operational and Maintenance Phase

Community Agitations

After the construction phase of the project there exist the possibility of community or groups of individuals or individual dissatisfaction with the conduct of the proponent regarding compensation issues, recruitment of labour as well as general conduct during the construction and prior to operation. This impact could arise some few months to years after construction activities and could result in strife thereby affecting the operations of the Industrial Park. This impact has been assessed to have a major significant level.

Unauthorized Access

Prior to the operation of the Industrial Park, unchecked and unauthorized encroachment by locals or individuals into the Industrial Park may lead to land use conflict. This impact significant is ranked as medium.

5.7.2 BIODIVERSITY IMPACT

The construction of the proposed Industrial Park will result in the removal of large hectares of natural vegetation in the project area. The development may have a major, long-term, irreversible negative impact on the floral composition within the project site. Results from biodiversity studies conducted in the area shows the following ecological zones, Savannah, riparian vegetation along Kainji lake course, cultivated farmlands, and flood plains within the Industrial Park site. Based on the vegetation and faunal investigations, the most sensitive ecological zones are considered to be the rivers and floodplains. In addition, the vegetation zones that were identified within the Industrial Park site, are well represented outside of the study area, and are thus not considered threatened ecosystems.

Data on the floristic composition and fauna assemblage within the Industrial Park site and in the immediate vicinity of the proposed Industrial Park indicate presence of a varied assemblage of forest resources and plant species, some of which are economic and of ethno botanical importance to the people of the communities. The main impacts of clearing the vegetation may however, be secondary and will affect the species that depend on the area for survival through habitat loss, fragmentation and the impacts of edge effects.

Construction Phase

The construction phase is the most destructive part of the planned development. During the construction phase various impacts could cause loss and disturbance of vegetation and animal habitats. Selective clearing within the confines of the project site is expected to be carried out to the minimum foot print required during the construction phase to allow for foundations, erection of towers and placement of conductors on the towers. The impacts on vegetation and habitat loss due to vegetation clearing and other site preparation activities are put at a medium significant level.

Erosion

Erosion may take place when vegetation is removed, by the continual movement of vehicles and people, and where vegetation is cleared for construction. Areas of particular concern would be along the access roads, areas in which the laydown areas are located and disturbed areas around the towers. Impacts resulting from erosion around laydown areas, access roads, etc have been ranked with a medium significance.

River Bank Disturbances

Damage to river systems could occur where structures are erected close or within the Kainji Lake, and/or when maintenance tracks or construction camps are placed within Kainji lake banks. Rivers are sensitive to disturbance and therefore should the afore-mentioned activities occur, they would be on major significance. Fortunately, the industrial park is designed to maintain a minimum set back of 100 meters from the banks of Kainji Lake in the building of the manufacturing facilities to avoid this impact.. However, specific mitigation measures have been included to ameliorate any possible impacts.

Wildlife Disturbance

During construction there is expected faunal disturbance within the entire project site of the Industrial Park, in which sensitive ground dwelling animals like the ground squirrels, grass cutters will move out of the area during construction. The impact is anticipated to be medium.

Avifauna

There is no peculiar bird breeding areas/migration routes identified within the project site. The impact is low and therefore no mitigation is provided.

Operational and Maintenance Phase

During this phase the impacts on the vegetation and habitat of the fauna would be relatively low as the industrial park is designed to increase its vegetation structure through a robust landscaping plan implementation. This impact is minor.

Impacts on Birds

The earth wire is the biggest risk, since it is much thinner and could be unseen by a bird in flight. Electrical faults caused by bird excreta being deposited on electricity infrastructure show that birds could also have negative impacts on Industrial Parks. Baseline avifauna studies did not identify any bird migratory routes / breeding sites along the Industrial Park route. Large waterfowl/raptors are also not predominant in the area. This impact is ranked as medium.

5.7.3 HYDROLOGY AND AQUATIC SYSTEMS

The activities involved in these phases of the development may cause a negative short to long-term impact on the surface hydrology and ground water quality within the project area, especially the Kainji Lake. This will be as a result of activities which are slated to take place, including storage of hazardous substances on the site such as diesel and motor oil for the operation of machinery and stand-by generators, and similar materials for the construction of building and other structures foundations. Wetlands in the area majorly include the Kainji Lake and a shallow water body within the project site. Rivers are exposed to anthropogenic impacts, including water pollution, and shoreline erosion e.g. Kainji lake, etc.

Construction Phase

Erosion of stream banks

Access of construction vehicles and construction personnel onto the stream banks, and swampy areas can result in the onset of erosion. The clearance of vegetation will reduce the capacity of the land surface to retard the flow of surface water, thus decreasing infiltration, and increasing both the quantity and velocity of surface water runoff and erosion. Human activities, which disturb the soil structure, such as the compaction of soil along footpaths and vehicle tracks, and the disturbance of soil structure through movement of soil, can result in increased susceptibility to erosion. Roads and pathways created during the construction phase have the potential to become preferred drainage lines, resulting in gully erosion. This impact has been ranked to possess a medium significance level.

Sedimentation of streams and rivers

Clearance of existing vegetation will expose the upper layers of the soil horizon to soil erosion. The transport of eroded soil into the surface water resources, especially the rivers will impact on water quality. The movement of construction vehicles and personnel can also result in the onset of erosion and associated sedimentation of streams and rivers. The stockpiling of excavated earth and construction materials can result in contamination of runoff, through erosion of stockpiles. On the overall, impacts resulting to sedimentation problems as a result of soil erosion are adjudged to have a medium significance.

Aquatic Life disturbance

The riparian zone is an important corridor for the movement of wildlife, and as such the construction activities may temporarily impact on the movement of certain faunal species along the Kainji lake riverine corridor. The construction related activities that will result in a deterioration of the water quality, will ultimately influence aquatic species such as macro- invertebrates, fish, amphibians and birds. This impact would however be limited in terms of duration and is ranked at a medium significance level.

Surface water pollution

Hydrocarbons-based fuels or lubricants spilled from construction vehicles, construction materials that are not properly stockpiled, and litter deposited by construction workers may be washed into the surface water bodies. Should appropriate toilet facilities not be provided for construction workers at the construction crew camps, the potential exists for surface water resources and surroundings to be contaminated by untreated sewage effluents, lubricants and other hazardous substances from accidental leaks and spillages. Depending on the nature of the contaminant the impact could range from either medium significance to major significance categories.

Disturbance of Hydrological Regimes and Drainage Patterns

The presence of construction vehicles, personnel and material in floodplains and riparian zones, can result in a local change in flow patterns. This can result in a change in the flow patterns in these areas due to the presence of obstructions (i.e. vehicles, construction material, construction crew camps etc.). Human activities, which disturb the soil structure, such as the compaction of soil along footpaths and vehicle tracks, and the disturbance of soil structure through movement of soil, can also result in a change in the micro scale hydrology. Impact significance is ranked as major.

Operation and Maintenance Phase

The presence of the Industrial Park and associated structures would not result in a substantial increase in erosion during the operational phase. Erosion of stream banks would mainly take place during this phase as a result of the movement of maintenance vehicles and personnel. No impact is anticipated and no mitigation proffered.

Floral disturbance (riparian zone and floodplains)

The presence of the Industrial Park will result in a disturbance of the flora found in the riparian zone and floodplains. Clearing of the project site will result in floral disturbance. This will however be limited to the footprint area of the project site. Access roads to the project site may also need to pass through wetland areas and / or the riparian zone, which will also result in floral disturbance. A medium significance level was assigned to this impact.

5.7.4 Air Quality and Noise Pollution

Air pollution is a major criterion for the design of Industrial Park. Pollution has a negative effect on the operators of the industrial park facilities. The baseline data on the level of pollutant gases within the Industrial Park site has been assessed and found to be compliant to set regulatory limits for their natural environment.

Construction Phase

The construction of the proposed Industrial Park will generate minor amounts of pollutant gases (SO_x, NO_x, CO, VOCs, etc) from fuel combustion (light fuel oil) used for load carrying trucks and heavy duty equipments. Such pollutants will include airborne particulates that would especially result during dry/windy conditions as a result of equipment movements and localized earthworks. Emissions during construction activities will be localized and short termed, impact will therefore be minor. In addition, it is expected that there would be increase in dust particles (SPM) along earthed access roads and also on the generality of the project site during construction activities. Increase in SPM levels will specifically result from vehicular movements and construction earthworks (excavations, trenching, etc). These are expected to last for a short term and have a minor significance ranking.

Operation and Maintenance Phase

Dust and emissions generation during operations is envisaged to be low, requiring no mitigation as the energy supply to the Industrial Park will come from the Kainji dam which is a renewable energy source that produce negligible emission.

Noise

Noise has the potential to damage health, to detract from the quality of life, and to disturb or affect wildlife. During the studies the baseline noise levels in the project area were within acceptable limits.

Construction Phase

The construction period could result in a temporary increase of the noise levels due to construction and delivery vehicles moving to and from the site as well as general installation activities. Increase in traffic flow within the study area could increase the nuisance levels in terms of noise generation. These impacts from increase in noise levels are evaluated and ranked to pose minor significance levels during construction period as they will be short termed.

Operation Phase

During operation phase, some noise will be generated by normal activities and operations of the facilities. These modest noise levels will have limited impact on the health of people who live or work within the project site or to the wildlife that will occasionally venture around the project site. The impact as ranked with a minor significance level.

5.7.5 Health, Safety and Security Aspects

Construction Phase

In any civil works, public as well as construction staff SHE risks can arise from various constructions activities such as earth works, operation, and movement of heavy equipment and vehicles, storage of hazardous materials, traffic, waste disposal, etc. Because of the long duration of the construction phase, such activities need to be controlled and consequently the associated risks reduced to as low as reasonably practicable.

Transportation Related Aspects

Construction and transportation activities will increase traffic congestion, risk of injuries, terrorist attack, hostage and kidnapping as well as damage to assets. These impacts are expected to be of medium to major significance depending on the severity of the impact. Accidents arising from road trips (transport of materials and personnel) along mobilization routes may result in injury or loss of life of personnel as well as damage to company assets. The possibility of terrorist attack and hostage taking of expatriate personnel or locals during the construction of the project is likely. This may also result to injuries or fatality. These impacts are ranked from medium to major significance.

Workplace Accidents

The probability of an accident occurring at the project site during the phases of the development is high. This is due to the intense use of machinery and other heavy-duty equipment used especially in the construction phase. Work related incidents and accidents resulting from trips, falls, object at height during construction activities are likely to occur. These impacts pose a medium to major significance ranking all depending on the severity of the impact. If the impact results in fatality it is ranked as a major significant impact.

Communicable Diseases

Construction activities have the potential to create new malaria vector (mosquito) habitats. An influx of workers with no partial immunity to malaria parasite (Plasmodium sp) increases the risk of serious illness which may result to death. This impact if not managed is expected to pose a major significance characteristic.

Influx of resident and non resident workers into the project area also increases the risks of sexually transmitted diseases (STDs) and could impact adversely on the spread of these illnesses especially relating to Acquired Immunodeficiency Syndrome (AIDS). This impact if left unmanaged may result in long term health issues which may eventually lead to fatality. Impact arising from this is ranked as major.

Fires and Explosions

Fire and explosions may be described as technological hazards, which can cause serious injury or result in loss of lives and damage to properties and the environment. Flammable substances including diesel and motor oil may be stored or used on the project site for heavy-duty equipment. These substances are precursors for fires and explosions. Envisaged impacts from accidental explosions resulting in fire have been ranked with a major significance level.

Waste Handling and Disposal

A significant amount of solid waste (including, wood, metal scarps, office and domestic wastes, excavated spoils, etc.) will be generated in this phase of the project. The methods put in place for handling and disposing of these wastes to be generated play an important role in the significance of impacts expected from wastes management. Waste handling and disposal have been assessed to pose a medium impact to the environment.

Collapse of Building and Other Structures

There exists the possibility of shock and burns to users of the industrial park, including visitors due to collapse of Industrial Park building or other structures due to poor geotechnical studies which could lead to injury or fatality of affected persons. This is a major significant impact.

5.7.6 Decommissioning Impacts

The decommissioning phase refers to all the activities which relate to the proposed Industrial Park when it is no longer in use. Potential issues that relate to the decommissioning phase refers to impacts such as metallic installations lying strewn around, lack of rehabilitation of the access roads, overgrown vegetation within the project site, etc. During the decommissioning phase, the demolition activities are likely to have similar impacts on the environment as those identified for the construction phase. These include potential impacts such as sedimentation, surface water, visual impact, dust and noise pollution, a risk of fires and explosions, safety and security and traffic impacts, etc. Impacts arising from decommissioning activities have been ranked with significance levels of minor to major.

CHAPTER SIX

6.0 MITIGATION MEASURES FOR ASSOCIATED AND POTENTIAL IMPACTS

The identified potential and associated impacts of the proposed Amfani Industrial Park and Smart City Project construction have been identified and evaluated while the impacts significance (adverse and beneficial) have also been discussed in chapter five. Consequently, the mitigation and enhancement measures for the adverse and beneficial impacts of the proposed project are presented in this chapter.

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Mitigation measures are activities aimed at preventing, eliminating or minimizing the impacts and their effects to levels that are considered as low as reasonably practicable (ALARP). In proffering mitigation measures, the primary objectives were:

Prevention: methods aimed at impeding the occurrence of negative impacts, and/or preventing such occurrence from having harmful environmental/ social outcomes.

Reduction: limiting or reducing the degree, extent, magnitude, or duration of adverse impacts. Reduction can be achieved by scaling down, relocating, or redesigning elements of the project.

Control: ensuring that residual associated impacts are reduced to a level as low as reasonably practicable.

The framework for determining the form of mitigation measures to be applied for the significant impacts identified for the project is shown in Figure 6.1 below. The frequency, severity, sensitivity, scale, magnitude and nature of the impacts were taken into consideration in the assessment.

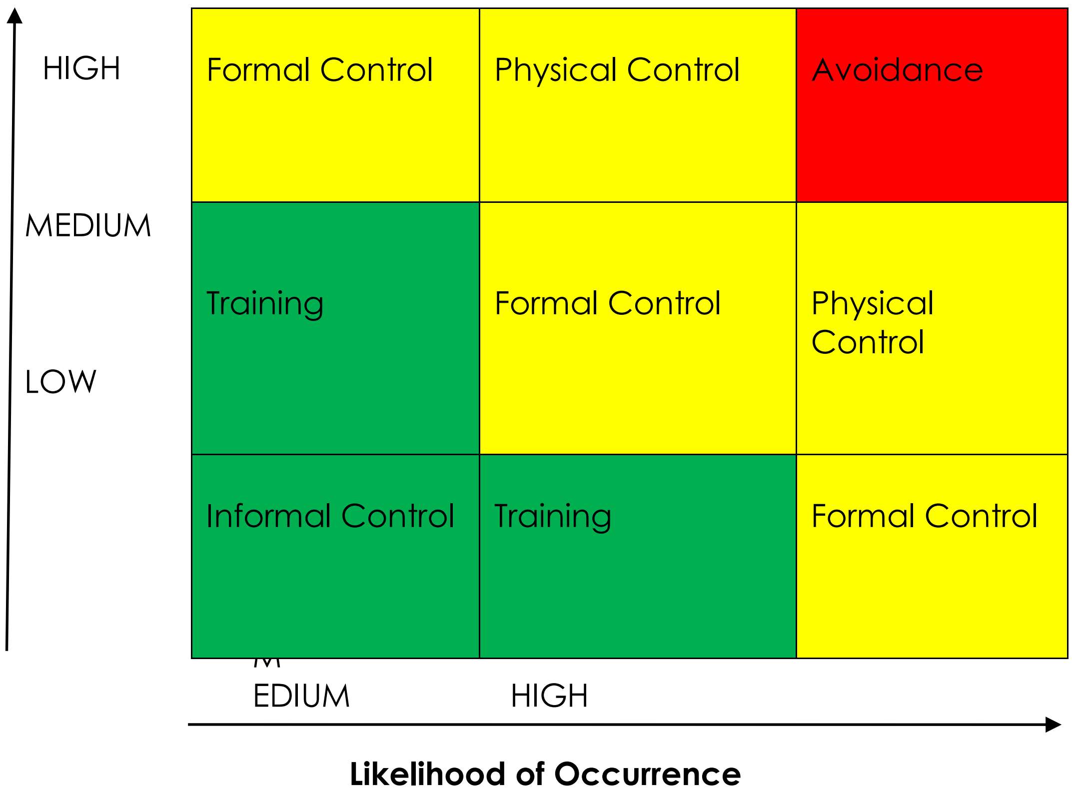

Figure 6.1: Mitigation Definition Criteria

Informal Control

This involves the application of sound judgment and best practice in mitigating the impacts of the of the project activities.

Formal Control

This involves the application of documented policy, process or procedure in mitigating the impacts of the project activities. It ensures that residual associated impacts are reduced to an acceptable level.

Physical Control

This involves the application of physical processes, barriers or instruments (pegs, fence, gates, sign post etc), not necessarily requiring any special technology in order to mitigate the impacts of the project.

Avoidance

This involves the modification of plans, designs or schedules in order to prevent the occurrence of an impact or impacts. Subsequently, the specific mitigation measures satisfying the mitigation criteria were established putting the following into consideration.

- Regulatory requirements
- Available resources and competencies
- On-site conditions
- Technology
- Public concerns

6.1 Proffered Mitigation Measures

Accordingly, this section presents the mitigation measures proffered for the identified impacts of the proposed Industrial Park project. These cost effective measures have been proffered with reference to best industry practice, national guidelines as well as Hydropolis Investment Ltd's SHE considerations. Hydropolis Investment Ltd (HIL) as proponent is responsible for implementation of stipulated mitigation measures. Based on the impact assessment overall significance rating in chapter five, the impact significance Major, Medium or Minor was established for each identified impact. The proffered mitigation measures for the identified potential and associated impacts are presented in Table 6.1 below.

Table 6.1: Proffered Mitigation Measures for the Proposed Amfani Industrial Park and Smart City Project (AIPASCP)

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
PRE-CONSTRUCTION		
Permitting & Land Acquisition • Consultations • Acquisition of license to operate • surveying • Stakeholder identification • Land clearing	Acceptance and co-operation/ participation from stakeholders (communities and government) leading to peaceful and timely execution of the project	HIL and EPC contractor shall: • Ensure that all relevant stakeholders are identified • Ensure that early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed
	Uncertainty and increased perturbation due to a lack of information and communication.	HIL shall: • Early engagement of stakeholders • Provide the opportunities for all affected groups (women, youths, religious, etc) to participate in consultations and ensure that all concerns are duly addressed. • Plan and execute consultations to educate community members and stakeholders on project activities, schedules and potential impacts. • Ensure consultation throughout project life span.
	Integration of men and women concerns into the project design Exclusion of vulnerable groups from consultations which may lead to strife	HIL and EPC contractor shall: • Ensure due consultation with relevant groups at all phases of the project. • Provide the opportunities for all affected groups to participate in consultations and that all concerns are duly addressed. • Establish and publicize grievance procedure

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
PRE-CONSTRUCTION		
Permitting & land Acquisition • Consultations • Acquisition of license to operate • Stakeholder identification • Surveying	Community agitations over compensations, land disputes, wrong stakeholder identification, leadership tussles, etc	HIL and EPC contractor shall: • Project will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities • Project will also develop and implement a Resettlement Action Plan to ensure equitable settlement of all project affected persons • Early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed. • Establish and publicize grievance procedure • Stakeholders (communities, Govt., land owners, etc.) are adequately consulted and relevant issues addressed • Agreed fair compensation for land are paid to identified owners promptly as per set standards. • As far as possible employ persons from the surrounding communities during the construction phase of the development to reduce the numbers of persons that will immigrate into the area seeking employment. This will also avoid any feelings of resentment and will ensure that the communities drive the project and derive the most benefits from the development.
	Improvement in quality of life for adequately compensated individuals	• Consulting all relevant stakeholders and legacy issues identified early, clearly defined , and agreed on • Fair compensations in line with national standards are agreed upon and paid

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	PRE-CONSTRUCTION	
Transport of Personnel and Construction Elements • Relevant Federal Highway • Mokwa to New Bussa Road • All roads leading to project site • Inland water ways (e.g. Kainji lake).	Increased traffic during mobilization on road with risks of accidents leading to injury/death and loss of asset.	HIL and its contractors shall ensure; • All vehicles and boats are certified road / water worthy prior to being mobilized for work activities. • Compliance to all roads and water ways safety transport rules including speed limits • Competency training and certification of drivers before mobilization. • Limit movement to day time only. • Follow traffic management guidelines(Chapter 7)
	Risks of terrorist attack, armed robbery attack and hostage taking leading to injury/ death of personnel	• Develop a project security plan that addresses all project related security concerns • Ensure security procedures are strictly enforced and continually improved based on updated risk information. • Consultation and good public relation with the stakeholder communities. • Ensure government approved security personnel is used on transport vehicles and boats when warranted • Limit movements of personnel and equipment to daytime only

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
PRE-CONSTRUCTION		
Transport of Personnel and Construction Elements • Relevant Federal Highway • Mokwa to NewBussa Road • All roads leading to project site • Inland water ways (e.g. Kainji lake).	Nuisance (noise and vibrations) due to movement from heavy duty equipment and vehicles affecting public and wildlife.	HIL and EPC contractor shall: • Machinery, vehicles and instruments that emit high levels of noise should be used on a phased basis to reduce the overall impact. These pieces of equipment such as drills, graders and cement mixers should also be used when the least number of residents can be expected to be affected. • Workers, especially those working with machinery, vehicles and instruments that emit high levels of noise should be supplied with ear plugs and ear muffs to reduce the risk of hearing impairment. Prolonged exposure to this impact should be reduced where possible. • Plan work activities to avoid heavy duty movement during peak hours • Consult with host communities and plan project activities accordingly • Limit movement and work activities to daytime only • Ensure equipment are properly maintained
	Increase in dust particles and vehicular emissions.	HIL and EPC contractor shall: • Ensure that all vehicles involved in the transport of construction material and staff and machinery involved in the construction are properly maintained and serviced. • Ensure that all material (sand and aggregate) stockpiled within the project site to be used in construction activities are regularly sprayed to reduce the effects of wind whipping. • Reduce speed within earth roads • Plan journey to reduce travel times • Vehicles carrying earth materials should be covered

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
PRE-CONSTRUCTION		
Transport of Personnel and Construction Elements • Relevant Federal Highway • Mokwa to New Bussa Road • All roads leading to project site • Inland water ways (e.g. Kainji lake).	Work place accidents/incidents from the use of cranes, forklifts, etc. during loading and offloading of materials/equipment.	HIL and its contractors shall ensure; • All personnel are qualified and certified for their relevant works • That approved safe work procedures are provided and complied with at all times • Use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site • Limit work activities to daytime only
	Obstruction of/damage to existing roads due to increased usage during mobilization	HIL and EPC contractors shall: • Roads to be assessed prior to commencement of work to establish the status and its capability to safely handle material and personnel transportation, and after completion to determine extent of impact and where necessary, take steps to reclaim areas damaged by project activities • Plan work execution to reduce travels and restrict where necessary, use of access roads.
	Interference with other road users within mobilization route	HIL and its contractors shall ensure that • Equipment, materials and personnel are mobilized after due consultation with relevant transportation authorities (FRSC, NURTW, etc) and other stakeholders to minimize interference within mobilization routes. • Travels to and from sites shall be planned to maximize each trip and minimize number of travels

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	PRE-CONSTRUCTION	
Transport of Personnel and Construction Elements • Relevant Federal Highway . • Mokwa to New Bussa Road • All roads leading to project site • Inland water ways (e.g. Kainji lake).	Leakage of fuel or lube oil onto land or into water bodies during transportation and storage may lead to increased chemical toxicity.	HIL and EPC contractor shall ensure: • Safe operating practices are enforced during mobilization • Implementation of project specific spill and emergency response plan • hydrocarbon/chemical spill containment and prevention measures and equipment are functional and effective on site and for equipment and vehicles • hydrocarbon and chemical transfers in safely contained areas • Double handling to be avoided where possible • When transfer has to take place, ensure it is effected in lined and secured areas where containment is possible • Educate personnel on hydrocarbon and chemical handling risks/hazards, through SHE briefings/tool box meetings

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
PRE-CONSTRUCTION		
Recruitment of Labour	Employment opportunities arising from recruitment of technical and non-technical Industrial Park workers	HIL and EPC contractor shall: enhance this beneficial impact by • Creating requirements for contractors to hire local labour • Ensure skills acquisition and development • Recognize and commend personnel with outstanding performance
	Influx of people (migrant workers, sub- contractors and suppliers) and increased pressure on existing social infrastructure.	HIL and EPC contractor shall: • Brief all employees to ensure awareness of any sensitivity to the local cultures, traditions and lifestyles • Continuous consultation while project is in progress • Implementation of community relations and engagement plan • Encourage hiring, as practicable, of appropriately qualified workers from areas in the vicinity of the project to discourage preventable influx of persons • Work with contractors to ensure that specialized skill workers from outside the areas have access to proper accommodations and other basic infrastructure • Educate all workers to enhance their Health, Safety, Security, and Environment awareness, and performance on the job • Maintain medical emergency response plan so that all injured or ill personnel can promptly access appropriate care

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	PRE-CONSTRUCTION	
Recruitment of Labour	Increase of communicable diseases due to influx of people and poor living conditions around pre-construction sites	HIL and EPC contractor shall: • Project will develop a health plan to address potential health issues • Carry out health awareness program (malaria, corporate stop AIDS program, etc.) • Provision of site medical personnel to attend to emergency situations • Engage the services of retainer clinics to manage health issues • Educate workforce on the prevention of malaria as well as encourage the use of mosquito nets in construction camps
	Increase in social vices (like theft, prostitution) resulting from increased number of people	HIL and EPC contractor shall: • Ensure its personnel and contractors undergo pre- employment background screening as required • Periodically discuss health and social education issues during toolbox/SHE meetings • Promptly deal with reported cases of misconduct to check recurrences

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
	PRE-CONSTRUCTION	
Recruitment of Labour	Conflicts/community agitations over employment issues (quotas and methods)	HIL and EPC contractor shall: • Project will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities • Project will also develop and implement a resettlement action plan to ensure equitable settlement of all project affected persons • Establish and publicize grievance procedure • Early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed. • All affected stakeholders and legacy issues are identified early, clearly defined, and agreed on. • Stakeholders (communities, Govt., land owners, etc.) are adequately consulted and relevant issues addressed • Agreed fair compensation/rent for land are paid to identified owners promptly as per set standards. • As far as possible employ persons from the surrounding communities during the construction phase of the development to reduce the numbers of persons that will migrate to the area seeking employment. This will also avoid any feelings of resentment and will ensure that the communities derive the most benefits from the development.

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
PRE-CONSTRUCTION		
Site Preparation • Access to Project site creation • Service roads • Camping and campsites • Site clearing	Business opportunities for local contractors through sub-contracting activities	HIL and EPC contractor shall: • Encouraging indigenous contractors and suppliers providing them opportunities to supply materials of acceptable standards • Encourage contractors to hire and to develop local labour • Workers are paid promptly as at when due
	Local support services from road side supply markets and shops etc.	
	Contamination of surface water as a result of siltation caused by increased erosion, during site preparation.	HIL and EPC contractor shall: • Employ appropriate industry practices in Industrial Park construction and ancillary facilities in order to avoid adverse alteration drainage pattern • Implement where appropriate sediment run-off controls and visually inspect after rainfall events • Laydown areas/Marshalling yards are designed to include erosion control • Reclaim as practicable topography of excavated or compacted upland areas upon completion of activities.

<table>
<tr><th>Project Activity/Environ mental Aspect</th><th>Associated and Potential Impacts</th><th>Mitigation Measures</th></tr>
<tr><td colspan="3">PRE-CONSTRUCTION</td></tr>
<tr><td rowspan="3">Site Preparation
• Access to project site creation
• Service roads
• Camping and campsites.
• Site clearing</td><td>Disturbance of the vegetation cover / loss of forest products (fuel wood, timber, medicinal plants) due to site clearing and preparation.</td><td rowspan="2">HIL and EPC contractor shall:
• Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora and fauna management.
• Vegetation clearing will be limited to minimum area required for work
• Utilization of existing accessible tracks as much as possible</td></tr>
<tr><td>Loss/disturbance of wildlife due to habitat loss/fragmentation from vegetation clearing within project site and access roads</td></tr>
<tr><td>Soil compaction, destabilization from excavation and runoff erosion resulting in sedimentation problems.</td><td>HIL and EPC contractor shall:
• Implement where appropriate sediment run-off controls and visually inspect after rainfall events
• Install siltation traps within the drainage design to collect silt and sediments ensuring that they do not end up in adjacent aquatic areas.
• Construction on steep slopes and in soft or erodible material will require erosion control measures and correct grassing methods.
• Laydown areas/Marshalling yards are designed to include erosion control
• Reclaim as practicable topography of excavated or compacted upland areas upon completion of activities.</td></tr>
</table>

Project Activity/Environ mental Aspect	**Associated and Potential Impacts**	**Mitigation Measures**
	PRE-CONSTRUCTION	
Site Preparation • Access to project site creation • Service roads • Camping and campsites. • Site clearing	Fragmentation of wildlife habitats/increase in poaching due to an easier access for the local population and non-resident workers.	• Where possible plan site clearing to allow species the opportunity to relocate to suitable nearby habitats and to reduce the shock to the various habitats that may be disturbed. • Prohibit poaching particularly by workers and educate workers on good biodiversity conservation policies.
	Waste Disposal • scrap metal, wood, sand, concrete, paper, domestic waste • Waste from laydown areas (Material and wood)	HIL and EPC contractor shall : • Develop project specific waste management plan (See Chapter 7) and ensure proper implementation • Provide adequate containers for waste collection • Periodically assess contractor activities to check the level of compliance to regulatory waste management requirements. •Safe operating practices are enforced during construction • Ensure use of only government approved waste management contractors

Project Activity/Environ mental Aspect	**Associated and Potential Impacts**	**Mitigation Measures**
	CONSTRUCTION	
Fabrication and Metal works •Cutting, bending and welding steel components •Painting • Handling of conductor wires and fittings	Workplace accidents from burns, cuts, bruises, trips and falls, objects at height, leading to injury or fatalities.	HIL and its contractors shall ensure; • All personnel are qualified and certified for their relevant works • That approved safe work procedures are provided and complied with at all times • Use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site • Limit work activities to daytime only where practicable
	Employment of local labour and skills acquisition for workers taking advantage of new opportunities	HIL and its contractors shall enhance this beneficial impact by • Creating requirements for contractors to hire local labour • Ensure skills acquisition and development
	Risk of electrocution and burns (to onsite workers) from welding flashes and high currents during welding	HIL and its contractors shall ensure; • All personnel are qualified and certified for metal works • That approved safe work procedures are provided and complied with at all times • Use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety goggles, etc. by all metal works personnel

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
CONSTRUCTION		
Fabrication and Metal works •Cutting, bending and welding steel components •Painting • Handling of conductor wires and fittings	Noise and attendant vibration effects from fabrication and associated welding equipment	HIL and EPC contractor shall: • Machinery, vehicles and instruments that emit high levels of noise should be used on a phased basis to reduce the overall impact. These pieces of equipment such as drills, graders and cement mixers should also be used when the least number of residents can be expected to be affected. • Workers, especially those working with machinery, vehicles and instruments that emit high levels of noise should be supplied with ear plugs and ear muffs to reduce the risk of hearing impairment. Prolonged exposure to this impact should be reduced where possible. • Ensure use of appropriate PPEs (ear plugs) by workers in areas with noise level above FMEnv (90dBA) hourly work area limits.
	Inhalation by onsite workers of toxic fumes during welding of Building/Other Structures components	HIL shall and its contractors shall: • Utilize environmentally friendly electrodes, spray and paint liquids for welding as well as painting. • Use of appropriate personal protective equipment such as welding masks by welders shall be enforced. • HIL shall also install fume expellers or blowers at confined welding areas. • Implement appropriate work-site practices.

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
CONSTRUCTION		
Fabrication and Metal works •Cutting, bending and welding Building/Other Structures steel components •Painting • Handling of conductor wires and fittings	Generation of metal scraps from conductor wires and steel elements associated with fabrication of Building/Other Structures components.	HIL and EPC contractor shall : • Develop project specific waste management plan and ensure proper implementation • Provide adequate containers for waste collection • Periodically assess contractor activities to check the level of compliance to regulatory and HIL waste management requirements. • Safe operating practices are enforced during construction • Ensure use of only government approved waste management contractors

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	CONSTRUCTION	
Foundation / Earth Works • On-site geotechnical testings • Building foundations, etc	Increased business and economic activities as well as diversification of income sources due to supply contracting and sub- contracting	HIL shall enhance this by: • Encouraging indigenous contractors and suppliers providing them opportunities to supply materials of acceptable standards • Encourage contractors to hire and to develop local labour
	Increase in revenue opportunities for local population due to presence of non-resident workers and travelers	
	Soil / groundwater contamination resulting from accidental leakages and spills of hazardous substances (diesel, cleaning agents, lubricants, hydraulic oil)	HIL and EPC contractor shall: • Plan and set on-site sanitary facilities for the disposal of wastewater. • Maintain vehicles, machinery and equipment in good condition in order to avoid leaks and spill of hazardous materials (lube oils, chemicals, etc.) • Ensure safe management of hazardous materials (chemicals, etc.) • Ensure handling of fuels such as fuelling of vehicles and machinery, and fuels transfers, take place in contained areas, where sufficient measures are in place to ensure containment of spills. • Plan emergency response measures and equipment are available, and personnel are capable of effectively using it for cases of accidental spill.
	Increased jobs and job opportunities from local labour hire and sub-contracting to indigenous	HIL and EPC contractor shall enhance this by: • Encouraging indigenous contractors and suppliers by providing them opportunities to supply materials of acceptable standards

	suppliers.	

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	CONSTRUCTION	
Foundation / Earth Works • On-site geotechnical testings • Building foundations, etc	Generation of dust and automobile / heavy duty equipment emissions from construction earth works.	HIL and EPC contractor shall: • Ensure that all vehicles involved in the transport of construction material and staff and machinery involved in the construction is properly maintained and serviced. • Ensure that all material (sand and aggregate) stockpiled within the site to be used in construction activities are regularly sprayed to reduce the effects of wind whipping. • All staff employed at the construction site must be provided with dust masks and be asked to use them. • Reduce speed within earth roads • Plan journey to reduce travel times • Vehicles carrying earth materials should be covered
	Flora/habitat loss and disturbance through vegetation clearing and earthworks within project site, access roads and at Building/Other Structures sites	HIL and EPC contractor shall: • Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora management. • Limit vegetation clearing to footprint required for construction purposes to minimize disturbances within proposed Industrial Park project site.

Project Activity/Environ mental Aspect	**Associated and Potential Impacts**	**Mitigation Measures**
	CONSTRUCTION	
Foundation / Earth Works • On-site geotechnical tastings • Building foundations, etc	Fauna disturbance and displacement as a result of migration away from construction activity area (this include impact on bird life)	HIL and EPC contractor shall: • Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora management. • Plan and execute construction works to minimize interference on wildlife • Maintain construction equipment to optimal function conditions • Monitor presence of wildlife species during construction activities
	Potential collapse of transmission Building/Other Structuress as a result of unsuitable geotechnical conditions	HIL and EPC contractor shall : • Carry out side by side geotechnical investigations during construction to determine suitability of soil to carry Building/Other Structures • Recommendations from geotechnical appraisals shall be appropriately implemented • Construction of Building/Other Structures foundations shall follow good industry engineering practices.
	Reduction in wildlife population as a result of poaching due to easier access created by project site clearing	HIL and EPC contractor shall: • Prohibit poaching by personnel • Periodically educate workforce on good principles of biodiversity conservation • Limit workforce concentration to project area and prohibit the possession of fire arms by members of workforce • Practice wildlife conservation principles (e.g. release back into the wild any wildlife incidentally caught by dug-up foundations or tranches.

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	CONSTRUCTION	
Foundation / Earth Works • On-site geotechnical tastings • Building foundations, etc	Noise nuisance (including impulsive noise) from construction activities (e.g. piling) resulting to temporary migration of sensitive mammals and rodents.	HIL and EPC contractor shall : • Machinery, vehicles and instruments that emit high levels of noise should be used on a phased basis to reduce the overall impact. • Workers, especially those working with machinery, vehicles and instruments that emit high levels of noise should be supplied with ear plugs and ear muffs to reduce the risk of hearing impairment. Prolonged exposure to this impact should be reduced where possible. • Regularly maintain construction equipment to optimal function • Limit heavy duty construction works to day hours only where practicable

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	CONSTRUCTION	
Building/Other structure Construction and Erection • Crane lifting and erections	Pollution of soil as a result spilled fuel and other waste oil discharge during building/other structure construction and installation processes	HIL and EPC contractor shall: • Develop and implement spill response plan • Maintain storage facilities at optimal holding condition • Train personnel in safe fuel handling procedures of chemicals and hydrocarbons • Ensure all fuel storage facilities are bunded and lined with

• Bolts and nuts tightening • Anti climbing guards and step bolts • Insulators and fittings, etc, • Construction/installation of floating jetties and farms, etc in Kainji lake.		impermeable materials • Vehicle and equipment maintenance activities implemented using proper containment or other strategies to guide against spills • Monitoring during maintenance of equipment to ensure that there is no discharge to the environment
	Traffic diversion and congestion within local roads during installation close to nearby roads.	HIL and EPC contractor shall : • Coordinate Building/Other Structures construction and stringing activities to avoid heavy traffic periods • Use warning signs and traffic wardens/directors • Ensure activities causing blockages at road crossings are carried out within shortest time practicable • In the case of longer road blockages, divert traffic to approved alternate routes in liaison with appropriate authorities • Consult with affected communities prior to closures to provide warnings and alternatives. • Follow guidelines for traffic management (chapter 7).
	Disturbances and death of aquatic life due to dismantling of floating structures in Kainji lake.	• HIL shall deploy high level technology standard that will guarantee minimal disturbances to aquatic life in Kainji Lake during construction/installation of all floating structures in the lake.

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	CONSTRUCTION	
Buildings /other structures Construction and Erection • Crane lifting and erections • Bolts and nuts tightening • Anti climbing guards and step bolts, etc. •Construction/installation of floating jetties and farms, etc in Kainji lake.	Workplace accidents / incidents (trip/falls etc) from heights during conductor wire stringing and bolt/nuts tightening project activities.	• HIL shall ensure SHE briefings prior to commencement of work activities • Develop standard work procedures where work hazards are identified and addressed • HIL shall ensure personnel use appropriate PPE • HIL shall design work area to internationally acceptable standards • Ensure availability of first aid facilities onsite • Ensure retainer clinics are engaged and site medical personnel are available in case of accidents • Maintain medical emergency response plan so that injured or ill personnel can promptly access appropriate care.
	Risks of injury / death and loss of assets resulting from accidents associated with road transportation to and fro construction sites	HIL and its contractors shall ensure; • All vehicles are certified road worthy prior to being mobilized for work activities. • Compliance to all roads safety transport rules including speed limits • Competency training and certification of drivers before mobilization. • Limit movement to day time only

Project Activity/Environ mental Aspect	**Associated and Potential Impacts**	**Mitigation Measures**
	CONSTRUCTION	
Buildings/other structures Construction and Erection • Crane lifting and erections • Bolts and nuts tightening • Anti climbing guards and step bolts • Insulators and fittings, etc, •Construction/installation of floating jetties and farms, etc in Kainji lake	Risks of fire/explosions resulting from accidental ignition of onsite diesel storage tanks	HIL and its contractors shall ensure; • All fuel storage tanks are kept at safe distances from work areas • Educate workforce on risks associated around storage areas and prohibit activities (such as smoking) that can ignite storage tanks • Designate no-smoking and smoke areas • Hold SHE meetings and talks on fire hazard
	Waste Disposal • scrap metal, wood, sand, concrete, paper, domestic waste • used oil and replaced/obsolete equipment pars that may contaminate soil/groundwater • Waste from lay-down area and project site	HIL and EPC contractor shall : • Develop and implement a waste management plan • Provide adequate containers for waste collection • Periodically assess contractor activities to check the level of compliance to regulatory and HIL waste management requirements. • Ensure engagement of government approved waste management contractors
	Localized economic benefits from materials supplies by local contractors	HIL and its contractors shall enhance this by: • Encouraging indigenous contractors and suppliers by providing them opportunities to supply materials of acceptable standards • Encourage contractors to hire and to develop local labour
	Induced secondary development within the neighbouring host communities from increased economic activities	

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
	CONSTRUCTION	
Building/Other Structures Construction and Erection • Crane lifting and erections • Bolts and nuts tightening • Anti climbing guards and step bolts • Insulators and fittings, etc. •Construction/installation of floating jetties and farms, etc in Kainji lake	Socio-cultural conflicts between the construction team and indigenous populace due to contrasts in believes and traditions	HIL and its contractors shall • Brief all employees to ensure awareness of any sensitivity to the local cultures, traditions and lifestyles • Establish and publicize grievance procedure • Continuous consultation while project is in progress • Implementation of community relations and engagement plan
	Visual intrusion as a result of alterations to normal landforms and aesthetic beauty of construction sites	• Where practically possible, provide a minimum of 100m buffer area between the Industrial Park camp sites and sensitive visual receptors; and • Rehabilitate disturbed areas around pylons as soon as practically possible after construction. This should be done to restrict extended periods of exposed soil. • Existing facilities might be used for lay-down and camp site areas
	Increased demand on existing infrastructure (roads, housing, medical facilities, etc) due to influx of workers / induced secondary development in the area during construction activities resulting in squatter settlements.	HIL shall • Encourage hiring, as practicable, of appropriately qualified workers from areas in the vicinity of the project • Work with contractors to ensure that specialized skill workers from outside areas have access to proper accommodations and other basic infrastructure • Educate all workers to enhance their Health, Safety, Security, and Environment awareness, and performance on the job • Maintain medical emergency response plan so that injured or ill personnel can promptly access appropriate care

Project Activity/Environ mental Aspect	**Associated and Potential Impacts**	**Mitigation Measures**
	CONSTRUCTION	
Building/Other Structures Construction and Erection • Crane lifting and erections • Bolts and nuts tightening • Anti climbing guards and step bolts • Insulators and fittings, etc. •Construction/installation of floating jetties and farms, etc in Kainji lake.	Permanent loss of land (some with arable potentials) potentials within the project site.	• Land owners shall be compensated for potential loss in revenue • Compensation shall be agreed between HIL and the landowner and implemented accordingly
	Site conditions leading to increased malaria epidemic from uncontrolled mosquito breeding, snake bites, as well as water borne diseases e.g. diarrhoea and cholera associated with poor sanitary conditions	HIL shall ensure: • Develop project health and safety plan to address all potential health issues • HIL shall ensure personnel use appropriate PPE • Provide on-site emergency response plan • Ensure availability of first aid facilities onsite • Ensure retainer clinics are engaged and site medical personnel are available to attend to emergency cases • Ensure that workers are provided with training on health risks, exposure, and management • Facilitate the implementation of appropriate latrines and other sanitation facilities. • Provide information, education and communication about safe uses of water and occupational safety. • Environmental management for vector control; avoidance via settlement location and design and use of bed nets and repellents; rapid diagnosis and treatment.

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	CONSTRUCTION	
Demobilization • Demobilization after construction phase	Workplace accidents from burns, cuts, bruises, trips and falls, objects at height, leading to injury or fatalities.	• HIL shall ensure SHE briefings prior to commencement of work activities • Develop standard work procedures where work hazards are identified and addressed • HIL shall ensure personnel use appropriate PPE • HIL shall design work area to internationally acceptable standards • Ensure availability of first aid facilities onsite • Ensure retainer clinics are engaged and site medical personnel are available in case of accidents • Maintain medical emergency response plan so that injured or ill personnel can promptly access appropriate care.
	Soil / groundwater contamination resulting from accidental leakages and spills of hazardous substances (diesel, cleaning agents, lubricants, hydraulic oil)	• HIL shall enforce good environmental demobilization procedures (e.g. cleaning sites and restoring to original status) • Use of drip pans during transfer of fuels and hazardous substances • Reclaim storage tank areas or contaminated soils • Carry out internal environmental assessment to check activities of construction team and status of lay-down areas, marshalling yards, Building/Other Structures sites, etc prior to demobilization.
	Traffic congestion during transportation of demobilized equipments and personnel	HIL and EPC contractor shall : • Coordinate demobilization activities to avoid heavy traffic periods • Use warning signs and traffic wardens/directors • Ensure activities causing blockages at road crossings are carried out within shortest time practicable • Consult with affected communities prior to demobilization to provide warnings and alternatives. • Follow traffic management guideline in chapter 7

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
	CONSTRUCTION	
Demobilizations • Demobilization after construction phase	Generation of dust and automobile / heavy duty equipment emissions.	• Ensure that all vehicles involved in the transport of construction material and staff and machinery involved in the construction is properly maintained and serviced. • Ensure that all material (sand and aggregate) stockpiled within the site to be used in construction activities are regularly sprayed to reduce the effects of wind whipping. • All staff employed at the construction site must be provided with dust masks and be asked to use them. • Plan journey to reduce travel times • Vehicles carrying earth materials should be covered • Install and operate air pollution control equipment e.g. mufflers.
	Reclamation of marshalling yards, Building/Other Structures sites, access roads (to prevent unauthorized access) and lay-down areas	HIL shall enhance this by: • Where possible contractor shall reclaim de-vegetated areas with topsoil, • Where possible, reclaim compacted floors with native plant species, etc. • Audit EPC contractor to verify reclamation of work sites, marshalling yards, lay-down areas etc
	Waste disposal (scrap metal, wood, sand, concrete, paper, domestic waste)	HIL and EPC contractor shall : • Provide adequate containers for waste collection • Ensure all waster are removed from site • Audit contractor on waste disposal activities to check the level of compliance to regulatory and HIL waste management requirements before leaving site.

Project Activity/Environmental Aspect	**Associated and Potential Impacts**	**Mitigation Measures**
	CONSTRUCTION	
Demobilization • Demobilizations after construction phase	Loss of employment and business opportunities due to completion of construction phase	HIL and EPC contractor shall • Shall ensure skills acquisition and enhancement programs to further empower the workforce for meaningful employment opportunities after the project • Establish and publicize grievance procedure • Pay due wages for worked period and settle all financial commitments to workforce before demobilization
	Illegal access to Industrial Park Building/Other Structures leading to accident, sabotage, asset damage, and loss.	HIL and EPC contractor shall : • Provide warning signs at access roads created to warn against dangers associated with Industrial Parks. • Through consultations, sensitize stakeholders and members of the communities on need to stay clear of the Industrial Park and hazards associated with it. • As much as practicable provide restrictions (e.g. anti- climbers) to unauthorized access to Industrial Parks and provision of security guard.

Project Activity/Environmental Aspect	**Associated and Potential Impacts**	**Mitigation Measures**
	OPERATION	
Operations • After commissioning and all facilities operations, including schools, hospital, electricity & telecommunication infrastructure, golf course, polo club, floating farms & jetties, leisure facilities, manufacturing facilities, etc.	Community dissatisfaction regarding the conduct of HIL on compensation issues may lead to strife before full operations of the Industrial Park	• Project will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities • Project will also develop and implement a resettlement action plan to ensure equitable settlement of all project affected persons • Establish and publicize grievance procedure • Early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed. • All affected stakeholders and legacy issues are identified early, clearly defined, and agreed on. • Stakeholders (communities, Govt., land owners, etc.) are adequately consulted and relevant issues addressed • Agreed fair compensation for land are paid to identify owners promptly as per set standards. • As far as possible employ persons from the surrounding communities during the construction phase of the development to reduce the numbers of persons that will migrate to the area seeking employment. This will also avoid any feelings of resentment and will ensure that the communities derive the most benefits from the development.

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
OPERATION		
Operations • After commissioning and all facilities operations, including schools, hospital, electricity & telecommunication infrastructure, golf course, polo club, floating farms & jetties, leisure facilities, manufacturing facilities, etc.	Increased electricity distribution capacities within the project area	• Take into account the various land uses while designing the project in order to minimize the loss of land, particularly productive land. • Timely completion of the project so that associated benefits such as reduction in environmental pollution, business opportunities, quality of life, etc shall take effect.
	Increased business opportunities and quality of life (small, medium, large scale) due to enhanced power delivery by Kainji dam.	
	Improvement in environmental standards due to reduced emission from standby diesel or fuel generators, use of fuel wood	
	Reduced demand on petrol and diesel used for power generation and further reduction in greenhouse gases and noise emissions.	

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
	OPERATION	
Operations • Commissioning and all facilities operations, including schools, hospital, electricity & telecommunication infrastructure, golf course, polo club, floating farms & jetties, leisure facilities, manufacturing facilities, etc.	Risk of collision of low flying air planes with Building/Other Structures and lines.	• Alternative analysis of the project site options ensured minimal to no interference with air traffic • HIL shall provide Aircraft Warning spheres and Building/Other Structures signs in areas where air traffic might occur in order to minimize risk of low flying aircraft colliding with Building/Other Structures and wires.
	Electric shock and burns to members of the public in the event of Building/Other Structures collapse or damage to electrical installation.	• Building/Other Structures shall be installed following the best engineering standard • Building/Other Structures shall be collapse tested to prove the Building/Other Structures design is in line with the HIL requirements • HIL shall carry out routine inspection of Building/Other Structures in order to allow early detection of damaged Building/Other Structures. • Reported cases of damaged or fallen Building/Other Structures shall be promptly attended to • Adequate and automatic fault/damage detection system shall be installed. • Personnel shall be trained on the detection/handling of such emergencies arising from accidental damage

Project Activity/Environ mental Aspect	Associated and Potential Impacts	Mitigation Measures
	OPERATION	
Operations • Commissioning and all facilities operations, including schools, hospital, electricity & telecommunication infrastructure, golf course, polo club, floating farms & jetties, leisure facilities, manufacturing facilities, etc.	Unchecked encroachment on the project site, leading to land-use conflicts and accident.	HIL and EPC contractor shall : • Provide warning signs at access roads to warn against unauthorized entry • Through consultations, sensitize stakeholders and members of the communities on government policies within established project site.
	Noise within the Industrial Park due to factories and manufacturing operations.	• The design of the Industrial Park shall be in line with standards observed by International bodies as well as HIL. • HIL shall assure during installation testing that national and international standards and limits are complied with.
	Mortality of birds, due to collision with Building/Other Structures.	The routine facility patrols by HIL maintenance crew will look out for any bird collisions. If any collision "hot spots" are identified, these can be mitigated reactively.
		Impact is beneficial and shall be enhanced by sustaining the Industrial Park life span, through adequate and effective maintenance activities as well as complying with federal government's policies and laws on industrial/infrastructural development.
	Development of new infrastructures or improvement to existing ones.	

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
OPERATION		
Maintenance •Building/Other Structures inspection and check. •Facility element replacements. •project site maintenance. • Maintenance of all floating jetties, farms, walkways, etc.	Proliferation of weeds around Building/Other Structures and within project site.	• HIL shall to extent practicable periodically carry out project site maintenance activities to manage project site of weeds and other creeping plants around the Building/Other Structures bases in a manner that minimizes adverse impacts on vegetation.
	Disturbance of bird habitats and avifauna from activities of maintenance crew.	• Disturbance of grassland during construction and operation should be kept to a minimum. • The activities of the construction and operations staff shall be restricted to the project site and immediate surrounds. • Develop policies that prohibits hunting by staff.
	Development of local maintenance activities to encourage employment and empowerment within the communities.	•Ensure the participation of men and women in local maintenance activities such as weeding of the project site.
	Maintenance of Building/Other Structures within sensitive environments e.g. riparian zones, floodplains, river banks, all floating facilities e.g floating jetties, farms, walkways, etc may lead to disturbance of hydrological regime (micro scale) in Kainji lake banks and other surface water bodies within the project site.	• Appropriate flow diversion and erosion control structures i.e. earth embankments shall be put in place where soil may be exposed to high levels of erosion due to steep slopes, soil structure, etc. • Access into the riparian zone and floodplains of rivers should be prevented as far as possible. Where access into these areas is required a preferred corridor should be determined. No deviation from these corridors should be allowed. • Areas to be rehabilitated should be identified and reclaimed. • Kainji Lake during routine of floating structures mounted within the lake.

<table>
<tr><th>Project Activity/Environ mental Aspect</th><th>Associated and Potential Impacts</th><th>Mitigation Measures</th></tr>
<tr><td colspan="3">DECOMMISIONING/ABANDONMENT</td></tr>
<tr><td rowspan="3">Decommissioning / Abandonment
•Dismantling of all structures, including schools, hospitals, floating farms and jetties, golf course, polo club, etc.
•Building/Other Structures/facilities removal
• Waste generation</td><td>Increased sedimentation process close to river banks and floodplains within the Building/Other Structures sites.</td><td>• Ensure that excavated and stockpiled soil material is stored on the higher lying areas of the site and not in any storm- water run-off channels or any other areas where it is likely to cause erosion or where water would naturally accumulate.
• Decommissioning activities should preferably take place during the dry season months to prevent soil erosion caused by heavy thunderstorms associated with the rainy season in the project area.
• The area shall be graded and re-vegetated to ensure that rainwater drains gradually over the site without creating erosion gullies.</td></tr>
<tr><td>Risk of soil and adjoining surface water contamination from accidental oil and hazardous substance leakages and wastes from decommissioning.</td><td>• Ensure that no wastes and hazardous materials generated on the site are dumped or deposited on adjacent/surrounding surface waters including roads or public places during or after the decommissioning period.
• Enforce proper waste management policies in line with FMEnv standards and requirements.
• Ensure that all project associated wastes and hazardous materials are disposed off in line with project waste management plan (see chapter 7)</td></tr>
<tr><td>Increased dust and vehicular emissions during transport.</td><td>• Wet all unprotected cleared areas and stockpiles with water to suppress dust pollution.
• Cover materials such as sand and other rubble during transport to and from the site with a tarpaulin.
• Ensure use of road worthy vehicles and equipment as well as skilled operators and drivers
• Limit speed of vehicles and travel time to and from decommissioning site.</td></tr>
</table>

Project Activity/Environmental Aspect	Associated and Potential Impacts	Mitigation Measures
DECOMMISIONING/ABANDONMENT		
Decommissioning / Abandonment • Dismantling of all structures, including schools, hospitals, floating farms and jetties, golf course, polo club, etc. •Building/Other Structures/facilities removal • Waste generation	Increase in ambient noise levels above baseline conditions from movement and activities of decommissioning equipment and automobiles.	• Limit work activities to daytime only • Ensure maintenance of vehicles and equipment • Provide and encourage use of PPEs.
	Traffic obstruction from transportation of decommissioned structures and equipment to receiving hub.	• Plan decommissioning activities in consideration of peak traffic times. • Ensure that the handling of equipment and materials is supervised. • Use signs, posts, and guides to manage traffic and direct users accordingly. • Follow traffic guidelines (see chapter 7)
	Risk of accident and injury to worker during demolition of structures	• Develop a work plan for safe demolition • Ensure hazards are identified and addressed prior to commencement of work. • Provide and enforce the use of PPE • Ensure that decommissioning and demobilization vehicles are under the control of competent personnel. • Provide adequate facilities on site to treat emergencies to staff.
	Disturbances of aquatic life due to dismantling of floating structures in Kainji lake.	• HIL shall deploy high standard technology that will guarantee minimal disturbances to aquatic life in Kainji lake during dismantling of all floating structures in the lake.
	Risks of terrorist attacks and possible hostage taking which may lead to injury or fatality of personnel.	• HIL and contractors shall ensure: • Ensure implementation of project security plan during decommissioning

		• Maintain ongoing cordial relationships with the stakeholder communities. • Certify government approved security guards are used on demobilization vehicles when warranted • When necessary HIL shall activate its emergency response procedure • Implement effective journey management plan.

Project Activity/Environ mental Aspect	**Associated and Potential Impacts**	**Mitigation Measures**
DECOMMISIONING/ABANDONMENT		
Decommissioning / Abandonment • Dismantling of all structures, including schools, hospitals, floating farms and jetties, golf course, polo club, etc. •Building/Other Structures/facilities removal • Waste generation	Availability of land for alternative uses	This is a beneficial impact and HIL, relevant government agencies together with stakeholders shall work out processes for land relinquishment or alternative uses as at the time of decommissioning.

CHAPTER SEVEN

7.0 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

7.1 GENERAL

This chapter presents the Environmental Management Plan (EMP) developed for the proposed Amfani Industrial Park and Smart City project (AIPASCP). An Environmental Management Plan (EMP) is the essential and standalone component of an EIA that provides the assurance that the mitigation measures developed for reducing the effects of adverse associated and potential impacts to as low as reasonably practicable (ALARP) as well as those proposed for enhancing beneficial impacts are implemented and maintained throughout the project life cycle. EMP is developed to ensure that the mitigation measures as described in **chapter six** of this report and `monitoring requirements as outlined in this EIA and any environmental compliance review shall actually be carried out in subsequent stages of the project. EMP is therefore an important management tool which sets out conditions and targets to be met during project implementation. This EMP contains among others the following key items:

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

7.2 The Objectives of the EMP

The objectives are to:

- ensure progressive reduction of the impacts of the project activities on the biophysical, socio-economic and health environment as low as reasonably practicable (ALARP) with the ultimate aim of eliminating them;
- ensure that all mitigation and enhancement measures prescribed during the impact assessment process for eliminating or minimizing the adverse project impacts as well as optimally enhancing the beneficial impacts are fully implemented; and
- provide part of the basis and standards needed for overall planning, monitoring, auditing and review of environmental and socio-economic performance throughout the project life cycle.
- demonstrate that emergency response measures will be in place. This will ensure that adequate responses in case of emergency have been established for the project; and set out the structure that will ensure compliance by HIL and its contractors, with the EMP.

These objectives shall be achieved by:

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

7.3 Management Organization

HIL shall retain the primary responsibility of ensuring that environmental commitments are met throughout the life cycle of this project. The company shall establish a schedule for responsibility and training on matters relating to environmental issues shall be a line responsibility for which all levels of personnel are accountable. Top management shall ensure that all environmental considerations are integrated into project execution. The Environment Department of HIL shall offer expert advice on protection measures and shall assist to monitor performance.

HIL shall appoint an Environmental Monitoring Team (EMT) to ensure effective implementation of the recommendations of the EIA and its management plan. This team shall be made up of representatives of the project team, Safety and Security Departments. The project Safety and Security Team Leader shall additionally provide leadership to the EMT. However, final environmental responsibility lies with the HIL Project Manager. The EMT shall liaise at a predetermined interval with contractors, engineers, quality assurance officers, supervisors and relevant HIL departments on all environmental matters. The Safety and Security Team Leader within the project, assisted by the EMT shall be the focal point for all environmental matters relating to detailed design and monitoring of construction of the Industrial Park, completion of other components of the project and all associated networks, operation of the Industrial Parks and decommissioning, restoration of sites and abandonment. The EM Team shall verify the effectiveness of the EMP implementation in liaison with Regulators (FMEnv & NSMEnv) and other stakeholders as appropriate.

Notwithstanding, all action parties within the project team shall demonstrate compliance directly from their line through to the HIL Project manager. In this way, HIL shall take responsibility for all environmental matters and ensure that contractors comply with all applicable environmental laws, regulations and policies as they apply to this Industrial Park project. In principle, the Contractor responsible for construction of the Hospitals, Schools, Fisheries, Farming on Kainji Lake, Jetty, etc shall be responsible for implementing those aspects of the EIA recommendations that pertain to the engineering, procurement and construction phase of the project. The Contractor responsible for laying of the electricity and telecommunication lines and line networks shall be responsible for implementing those aspects of the EIA recommendations that pertain to them. Similarly, the Contractor(s) responsible for the operation and maintenance of the Industrial Park and all networks shall implement those aspects of the EIA recommendations that are relevant to them during the operations and maintenance of these facilities.

The Contractors for this HIL project shall be required to submit, for approval, their proposal to manage Safety inherent in their contract execution. The EM Team through the Safety and Security Team Leaders will operate in an advisory capacity in all matters; the approval responsibility lies with the HIL Project Manager.

7.3.1 Use and Maintenance of the EMP

The EMP shall remain a dynamic working tool and will be owned by the HIL Project team. HIL Safety Manager is, however, the custodian of the document and may exercise auditing role to verify compliance by the project contractor. The EMP shall be updated and revised periodically, throughout the project's life span to incorporate improved technologies, better environmental regulations, management systems, guidelines and policies. Constructive suggestions by users (contractors, management, line and operating personnel) shall be assessed by the EM Team and integrated into the EMP.

7.3.2 Monitoring

Project activities shall be monitored in order to:

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

All contractors shall be required to self-monitor their performance with respect to environmental and social performance. The HIL safety Engineer shall also undertake quarterly environmental assessment and random walk through and spot checks throughout the project lifecycle. Assessment findings shall be reviewed by the project management team and where corrective actions are necessary, specific plans (with designated responsibility and timing) shall be developed to ensure continuous performance improvement.

In addition to assessing operational aspects and monitoring, assessments shall also consider compliance with agreed objectives and targets, and the effectiveness of the EMP and its implementation. The EMP shall, therefore, be subject to ongoing review and development to ensure that it remains appropriate for all aspects of the project. As is typical with all Federal Ministry of Environment approved projects, the ministry will carry out an assessment before the end of the project to confirm compliance of project activities to the terms and conditions of the EIA approval.

7.4 Regulatory Compliance

All environment-related regulations as they apply to Amfani Industrial Park and Smart City Project have been documented and described in this EIA. HIL management shall ensure compliance with these regulations throughout the project's lifecycle,

7.5 Detailed Design Guidelines

Safety and Environmental Premises cover the minimum performance standards for Safety critical elements to be applied to the design of the facilities for this Industrial Park Project have been established as part of the project phases. These standards and criteria are meant to ensure that the design of the facilities for this Industrial Park is in line with currently accepted Safety principles and policies as they apply to this project. In particular, the Safety premise has steered the design towards the goal of preventing/minimizing injuries, ill health, and damage to assets and the (natural and social) environment, to avoid/eliminate liabilities in the future. In the design of the facilities for this pro efficient use of natural resources and energy sources as a requirement has been taken into account. This is aimed at resource conservation and the protection of the environment through prevention/minimization of discharges that have adverse effects on the environment.

The Safety premise is flexible enough to permit refinements and extensions arising from formal safety deliverables that are likely to be produced during successive project development phases.

The driving force for the design is the reduction of risks to people, assets, reputation and the environment in compliance with the principle of As Low as Reasonably Practicable (ALARP). Any residual risks/effects after the application of the ALARP principle shall be managed through continuous improvement of the operation of the Industrial Park and other associated facilities.

7.6 Implementation of Mitigation and Enhancement Measures

The mitigation measures proposed for the significant negative impacts and the measures proposed to enhance the significant positive impacts presented in Chapter 6 have been developed into an EMP that provides a detailed action plan with roles and responsibilities for their implementation. Working through the EM Team, the SAFETY, SCD and Security Team Leaders shall ensure that these measures are complied with.

7.7 Transport Operations

The project shall manage all transportation operations in line with the following guidelines in order to forestall accidents

7.7.1 Pre-mobilization of Vehicles

All vehicles to be used for transportation of equipment, materials and personnel shall be pre-mobilized. The pre-mobilization shall be conducted to confirm that the vehicles are fit for purpose and that the drivers of the vehicles as well as their assistants have the necessary competencies needed for the job. It shall also be confirmed during the pre-mobilization exercise that a Job Hazard Analysis (JHA) has been conducted for the project and that all recommended precautions (mitigation measures) have been adopted.

7.8 Prevention of Accidents/Incidents

Prevention of workplace accidents and incidents during the proposed project shall be achieved using the JHA tool and written Work Instructions (WIs). Consequently, the SAFETY and Security Team Leaders shall arrange for JHA to be conducted for all SAFETY critical activities. Written and explicit work instructions from such activities shall be developed.

Compliance to regulatory standards, operations/maintenance codes and specifications as well as SAFETY guidelines shall form the basis for the execution of the proposed project. However, emergency situations could still occur as a result of equipment failure, weather, negligence and/or sabotage. Consequently, a contingency plan shall be developed as back up to other containment systems put in place to handle such occurrences. As a minimum, the contingency plans that shall apply to both HIL and contractors, shall address the following emergency situations.

- Fires and Explosions;
- Serious injury or illness;
- Weather related disasters; and
- Land vehicle mishaps.

The SAFETY and Security Team Leaders shall ensure that adequate security arrangements are put in place. Such plan shall have inputs from host communities.

The team shall also identify, evaluate and manage the risks to personnel and property arising from malicious practices, crime, civil disorder or armed conflict. The security activities shall be co-coordinated from a common viewpoint by stakeholders and be in line with HIL security guidelines.

In addition, each contractor shall be required to submit a project security plan to HIL for review and approval. As part of the Environmental Management Plan and with the approval of the HIL Industrial Park Project

Manager, the Security Team Leader shall organize security workshops to identify, evaluate and recommend contingency plans for all security risks associated with the Industrial Park Projects.

7.9 Training and Awareness

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

- SAFETY induction course,
- Emergency response drill,
- hazard recognition and incident reporting
- personal hygiene and site sanitation issues;
- Community interaction and relations management,
- Basic First Aid for first aiders and more in depth training for selected personnel, (numbers as required by HIL policy),
- Defensive driving,
- Permit to Work System, and
- SAFETY on site

Certificates of attendance shall be issued to successful participants. HIL shall also conduct SAFETY awareness campaigns for the host communities and general public with the aim of sensitizing them to the potential impacts and hazards associated with its operations and the appropriate response to accidents/incidents. The public awareness campaigns shall be conducted periodically and the proceedings documented for subsequent audit.

7.10 Maintenance Programme

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

7.11 Construction Guidelines

7.11.1 Site Preparation/Clearance

Site preparation/clearance works shall be carried out within defined perimeters and only when necessary. The maximum permissible time lapse between site clearing and initiation of construction operations shall be reduced to the barest minimum necessary to permit safe operations. Areas cleared in excess of operational requirements shall be reinstated with indigenous topsoil and vegetation.

During construction, acquired land not used for project activities shall be fenced off and left undisturbed. As an additional measure to mitigate decline in biodiversity, approved clearing of land for construction activities shall commence only from one section of the project site. This is to give any animals present in the area to be cleared the opportunity to move away.

7.11.2 Use of Public Rights of Way

All transportation and construction works shall be executed in such manners that will minimize traffic disruption. However, if operational Safety demands that public highways or roads be blocked, then the HIL Industrial Park Project Manager may approve such action only when temporary traffic control and diversion arrangements have been provided. Dumping or storage of litter/debris, tools and equipment in public or private highways and roads shall be prohibited. Contractors shall develop highway and road clearing strategies to ensure that public roads and highways are kept clear, safe and passable.

7.11.3 Health and Safety of Workers

Throughout the project development HEMP (Hazards and Effects Management Process) shall be applied and shall consist of identifying, assessing and controlling hazards, and putting in measures to recover from the consequences of hazards if the controls fail.

Operations at all work sites shall be subject to government, industry and HIL SAFETY policies and guidelines. All HIL and contractor staff shall be well informed and trained on the safety policies and guidelines. All facilities shall also be designed to enhance Safety planning and activities shall be executed within the confines of relevant legislation and stakeholders' interests.

Contractors shall provide adequate health services as well as site first aid services for its workforce. The first aid services shall be extended to work related visiting personnel and employed casual workers. All construction activities shall be properly managed through careful planning and the application of relevant safety policies including the following:

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

7.11.4 Emergency Response

In order to safe guard the lives of personnel and contractors during emergency situation, and implement an emergency response plan the following equipment shall be provided as minimum requirements for emergency response action.

- Safety showers at locations in the facility where accidental spillage of chemicals could occur. Supply shall be taken from the firewater system;
- Self contained (storage type) eye wash units shall be provided at battery rooms or units;
- Safety signs and notices shall be provided throughout the Industrial Park project site and in accordance with HIL requirements and standards;
- Walkways across pipes and working platforms on heavy machine and equipment shall be provided with non-slip surfaces;
- A general alarm system shall be provided, capable of giving an audible alarm in all areas of the Industrial Park facilities and visual display in areas of high background noise;
- Two sets of self-contained breathing apparatus shall be provided in the control building to allow rescue activities to be performed in smoke conditions.
- Emergency response procedures shall be put in place for snakebites, road traffic accidents, medieval/medial rescue and gas leaks.

During operations, fire fighting and associated facilities shall be inspected and tested on a periodic basis to verify inventory and function. Also, HIL shall carry out programmes to educate the relevant communities and local health facilities on what to do in case of a major incident of fire/accident. In situations where evacuation of personnel is necessary as a result of fire or any other related accidents, HIL shall follow the emergency medical evacuation procedure with responsible parties.

Table 7.1: Personnel Responsibilities during Emergency Evacuation

Action Party	Responsibility
Personnel at scene of incident	• Maintain calmness and alert people around • Contact site nurse or first aider / supervisor/safety officer. • Begin mustering action
Medical personnel on site	• Arrange and administer first aid for sick/injured
Site supervisor/safety officer	• Contact project engineer / safety manager and report the following; o precise location and time of incidence; o site condition o patient(s)/injured or casualty; and o other pertinent information
Site Supervisor	• Arrange for medical evacuation after due consultation with Management
SHE Manager	· To liaise with management to arrange for medical evacuation · Furnish management with available particulars/report about the emergency as provided by the site supervisor/safety officer · Conclude medical evacuation by ensuring the casualty is transferred from the first aid clinic (after a life saving treatment) to Hospital.

7.11.5 Pollution Control

i) Air Pollution

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

ii) Water and Soil Pollution

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

b) **Soil:** HIL shall ensure that all construction activities are performed by methods that will prevent pollution of the soil media by concrete mixtures, debris, and other objectionable pollutants. In the event of a significant soil pollutant from lubricant spill, relevant spill control measures shall be applied and contaminated soil shall be cleaned as appropriate. Regular checks shall be conducted on equipment to minimize any lube oil and combustible leaks from engines.

iii) Noise Pollution

HIL shall comply with all requirements for noise control and with regulatory standards. For example, HIL shall ensure that contractor plans activities such that FMENv and the World Bank Guidelines shall not be exceeded at the nearest communities especially at nights. All equipment shall be maintained at optimal working conditions and recommended work practices shall be employed to minimize noise. Night operations shall be avoided except when absolutely necessary. In such instances, adequate measures shall be taken to reduce the noise involved and keep working hours to a minimum.

Earmuffs shall be provided for all workers and any visitor within the vicinity of high noise generating equipment or operations. If noise levels at any time give rise to public complaint, the issue shall be treated, as public nuisance and HIL will take appropriate measures to resolve the problem with the appropriate authorities. In any case, communities shall be consulted prior to periods of expected peak noise levels; safe separation distances and buffer zones shall be established between the Industrial Park construction work sites and host communities to reduce the impact of high noise levels from the facilities. Also, noise mapping of the construction site shall be done and a map produced and visibly displayed. The possibility of encroachment up to the fence line is taken into account in the design of noise reduction measures.

7.11.6 Waste Management Guidelines

The handling, storage and disposal of all wastes that will be generated during the life of the project shall be in accordance with Federal Ministry of Environment guidelines and HIL approved waste management procedure. These guidelines are binding on all staff and contractors involved in the proposed project with respect to the:

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

A detailed waste management plan shall be developed for the wastes generated during the decommissioning and abandonment of facilities. This waste management plan for these wastes shall be subject to approval by the regulatory authorities prior to abandonment in the design of this plan the focus shall be on optimal recycling and reuse of materials.

i) Waste Handling

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

- Waste type identification
- Proper waste categorization
- Waste segregation information

• Recommended Management practices

ii) Waste Minimization

Waste minimization implies reduction to the greatest extent possible of the volume or toxicity of waste materials. The four principles of waste minimization process; recycle, reduce, reuse and recover shall be adopted as applicable. Opportunities to achieve significant waste volume reductions during the proposed project are functions of activity level, age, depreciation and maintenance level of facilities and operating equipment. As much as possible, excavated materials shall be used for landscaping or other remedial works on site. The key elements of the four waste minimization/management Principles /practices are outlined below.

Table 7.2: Waste Inventory

Category	Definition
Reduce	· Process modification / design change · Material elimination · Inventory control and management · Material substitution · Improved housekeeping
Reuse	· Chemical/oil containers · Re-use waste heat
Recycle/Recover	· Recycle scrap material · Recycle paper · Burn waste lubricating oil for energy recovery · Recover oil from tank bottoms

iii) **Wastes Inventory**

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

iv) Waste Disposal

All waste, shall be cleared regularly from the site and disposed off at HIL or Government designated areas and facilities. Wastes in transit must be accompanied and tracked by consignment notes. The waste consignment notes that contain the following information as a minimum:

• Date of dispatch;
• Description of waste;
• Waste quantity/container type;
• Consignee/driver name and means of transportation; and
• Confirmation of actual disposal (time and date).

Only government approved waste management contractors shall be engaged for the waste categories they are licensed to dispose. Waste management audit of contractors' facilities shall be carried out in consultation with the Chemical Environment department of HIL, and findings shall be properly documented and followed up. Accommodations, catering services and work sites shall maintain acceptable standards of hygiene and good housekeeping.

7.11.6.1 Operational Wastes and Disposal Methods

Waste shall be managed in accordance with Federal Ministry of Environment and HIL waste management guidelines and procedures. The Contractor will develop a Waste Management Plan to be approved by HIL and will be responsible for the management of all wastes from cradle to grave using licensed third party waste management contractors and facilities. Detailed inventory of the waste types, sources, and planned management practices during the proposed Industrial Park project is presented in Table 7.3.

Table 7.3: Waste Stream Management Guideline for Proposed Amfani Industrial Park and Smart City Project

Waste / Emission	Category	Hazard	Origin	Disposal Option(s)
CONSTRUCTION PHASE				
Wood scraps, pallets and packaging materials	Non-hazardous (combustible)	Attracts rodents	Wooden crates, paper cartons/sacks, plastic wrappings, Styrofoam, etc.	Wood pallets/paper cartons shall be returned to the supplier and non-reusable one safely contained and evacuated to approved facilities for incineration
Empty drums & aerosol cans (plastic & steel)	Potentially Hazardous (noncombustible)	Dependent of original contents of drum	Packaging of lubricating oil, fuel and corrosion chemicals	Residue from drums shall be purged and cleaned before reuse (subject to quality assurance). Return empty gas cylinders to supplier(s) for refilling. Return drums, barrels, and used containers to vendor or crush at site for recycling
Used and waste lube oil	Hazardous (combustible)	Potential to contaminate soil and water bodies	lube oil flushes and equipment vehicles	Recycle at a permitted treatment facility
Oily rags & sorbents; used protective clothing (hand gloves, coveralls, shoes, rainwear, etc.	Hazardous (combustible)	Potential water & sediment contamination from hydrocarbons	Maintenance & spill clean-up operations, regular work wear	Where possible, oily rags and protective clothing shall be washed and reused at site. Otherwise, these wastes shall be drained of excess hydrocarbon, packaged separately and contained Safely for incineration in approved facilities.
Paint & paint-related materials	Hazardous (combustible)	Potential to contaminate soil	Paint cans, spent thinner, epoxides, latex, etc.	Safely contained in designated containers and locations prior to evacuation to approved facilities for recycling or incineration.
Batteries: (lead-acid, nickel- cadmium)	Toxic and corrosive	Corrosive adverse environmental, health & safety effects. Lead or heavy metals may cause contamination to	Warning equipment, portable & emergency electrical tools & electronics, construction & transmission facilities	Lead-acid and Ni Cd batteries shall be safely kept at designated storage locations for evacuation to facilities where they will be recycled, incinerated and safely disposed.

Waste / Emission	Category	Hazard	Origin	Disposal Option(s)
CONSTRUCTION PHASE				
		surface water /sediment		
Spent lubricants	Hazardous (combustible)	Potential for water, soil, and sediment contamination by hydrocarbons	Engine and rotating equipment, lubricating system, etc.	Collect in properly labeled metal or plastic drums placed at designated strategic locations and sealed to prevent spill during evacuation. To be recycled or incinerated in approved facilities.
OPERATION PHASE				
Domestic waste (empty food containers, food waste, used cooking oils, office wastes, construction)	Non-hazardous (combustible, biodegradable)	Attracts rodent and arthropods.	Accommodation, office, canteen, worksite	Manually sort plastics and metals for recycling. Appropriate segregate and contain for evacuation to approved incineration facilities
Oil & fuel filter cartridges, waste water filters	Hazardous (combustible)	Potential water and sediment contamination from hydrocarbons	Internal combustion engines, equipment maintenance and repairs	Collect in properly labelled metal or plastic drums placed at designated strategic locations. Store in sealed, properly labelled metal or plastic drums placed in a closed container located within the designated hazardous waste storage area for evacuation to incineration sites.
Scrap metal chippings, scrap cables	Non-hazardous (combustible)	Safety risks	Scrapped equipment / engine parts /miscellaneous refuse metal	Recycled or re-used. Non reusable materials shall be stored in the designated containers for evacuation and disposal at recycling facilities.
Medical waste (soiled dressings, empty drug containers, used needles & syringes,	Hazardous (combustible)	Potential health risk	HIL clinics / health centers, site first-aid treatment	• All medical waste shall be packaged separately and safely contained in designated containers for

Waste / Emission	Category	Hazard	Origin	Disposal Option(s)
CONSTRUCTION PHASE				
expired drugs, blood & blood products, cultures and stocks)				incineration at approved facilities. • Empty drug carton/bottles may be re-used at the clinics subject to quality assurance. • Used syringes/needles, containers for storing blood & its products, and culture/ stocks media shall be autoclaved (sterilized) and shall be safely contained in designated containers for incineration at approved facilities.
Refrigerants (HCFC)	Non-combustion source-emission	Stratospheric ozone depletion, formation of photochemical smog;	Refrigerants & air Conditioners	Safely contain in designated locations for return to manufacturer, or to approved reuse, and recycling facilities.
Diesel fuel spill/leaks	Hazardous (combustible)	Potential to contamination of soil, water bodies & sediment	Fuel storage/transfer lines, leaking pipes, equipment, etc.	Store in sealed drums for recycling
Sanitary wastewater	Hazardous (non combustible)	Potential to contaminate water column & sediment	Sinks, shower, liquid effluent from toilets etc.	At camps, treated in sewage treatment plant to regulatory limits with certified equipment before discharge if feasible. Otherwise shall be collected and taken offsite to approved sewage treatment facilities and treated to meet regulatory requirements before discharge offsite.
Oil sorbents	Hazardous (combustible)	Potential to contamination of soil, water bodies &	Cleanup of small spills	Recycled or disposed of by certified oil recycler

Waste / Emission	Category	Hazard	Origin	Disposal Option(s)
CONSTRUCTION PHASE				
		sediment		
Sewage Sludge	Non-Hazardous	Potential to contaminate water column & sediment	On-site sanitary sewage treatment system	Sent offsite to sewage treatment facility
DEMOBILIZATION				
Contaminated soil affected by spills/leak	Hazardous (combustible)	Potential to contaminate groundwater	Top soil removed from spill/leak site	safely contained in sealed designated containers for evacuation to incineration facilities

7.11.6.2 Traffic Management Plan Guideline

Table 7.4 below presents the guideline for traffic management plan for the industrial park

Table 7.4 Guideline for Traffic Management Plan for Amfani Industrial Park

Objective	It is to ensure minimal interference with public transportation and navigation.
Target	Minimal interference with the use of public access site.
Actions	• All vehicles, boat to be used for the movement of equipment and materials shall be pre-mobilized by the Contractor-HSE personnel. Movement of large volume of material will be organized in such a manner as not to disturb other users of the site and shall be planned for low traffic period. • Access to construction sites shall be by means of transportation approved by management only. • All operators of passenger/materials haulage vehicles drivers and boat drivers shall be trained, tested and certified before they are engaged by the Contractor. Driver awareness and safety management programmes must be devised, implemented and recorded, for audit and monitoring purposes. • Speed limits should be adopted for trip duration and driver roasters arranged to avoid overtiredness. • Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents. • Using locally sourced materials, whenever possible, to minimize transport distances. Locating associated facilities such as worker camps close to project site (if possible) to minimize external traffic. • All transportation and construction works shall be executed in such a manner that will ensure minimal interference with the use of public access. • Vehicle use on site shall be restricted to the minimum required and only in accordance with the site plan prepared for the purpose of preventing unnecessary damage to non - working areas. Vehicles shall not move on side slopes prone to erosion or sensitive to disturbance without specific approved management measures. • Approved haul or access shall be planned and constructed to follow the natural contours, as far as possible. • Dumping or storage of litter/debris, tools and equipment into the Kainji Lake shall be prohibited.
Monitoring	The Contractor HSE personnel shall monitor all journeys and movements.
Reporting	Reports of any major disruption of traffic shall be prepared.

7.11.6.3 Surface Water Management Guideline

As an environmental sensitive resource, all surface water within the project area, especially the Kainji Lake shall be managed in a sustainable manner. Table 7.5 below presents the guideline for surface water management.

Table 7.5 Surface Water Management Guideline

Objective	It is to ensure minimization of surface water contamination and disturbances of hydrological regime.
Target	Comply with the Effluent Discharge limits of FMEnv standards
Actions	• All watercourses shall be protected from erosion and direct or indirect spills of pollutants, e.g. sediment, refuse, sewage, cement, oils, fuels, chemicals, wastewater, etc. • Specific erosion and sediment control measures and general surface water management measures for the project shall be developed by the construction contractor. • In the event of a spill, the Contractor shall take prompt action to clear polluted areas and prevent spreading of the pollutants. • Any work requiring the fording of watercourses by machinery and vehicles shall be undertaken at slow speed and with clean vehicles (no leaks, etc.) and along a single track. • Drip trays shall be used for all pumps, generators, etc. in order to prevent water contamination as a result of fuel spills or leaks. • The construction contractor shall take all reasonable measures to prevent soil erosion and the discharge of sediments and pollutants from the site during construction. • All erosion, sediment and pollution control infrastructure will be maintained on the project site at or above design capacity for the duration of construction of the project and until such time as all ground disturbed by the works has been stabilized and rehabilitated so that it no longer acts as a source of sediment. • All spoil (project muck) heaps shall be managed to minimize erosion or dispersal of the materials. • The fill material brought to the project site shall be contained within perimeter bunds and primary settling ponds. • All fill material brought to the project site will be managed in a manner that minimizes erosion and dispersal of those materials to downstream waters. • The construction contractor shall not permit the discharge of any water from the site to nearby surface water bodies unless expressly approved by regulators. • As much as possible all building structures should be constructed using a minimum set back of 100m from the Kainji lake and any surface water location within the project site. • Buffers should be developed close to all surface water body. • Very strict waste management measures in line with the above waste management guideline should be applied in the management of Floating farm, fisheries, floating jetties and indeed all platforms to be installed on the Kainji lake. • Adopt the use of appropriate technology that will guarantee minimal

	disturbances of the hydrological regime of Kainji lake during construction and installation of all floating platform facilities, including floating farm, floating jetties, floating walkways, etc.
Monitoring	Site environment officer shall conduct regular inspections of construction areas.
Reporting	Reports will be prepared by a consultant and submitted to the proponent

7.11.7 Prevention of Erosion

During construction of Building/Other Structures foundations, the contractors shall where necessary ensure that surface water flow on land or swamp areas are controlled and if necessary channeled into temporary discharge pits. Such pits shall be located, designed and constructed in a manner that will minimize the potential threat of erosion. Muddy water and surface runoff from work sites shall be drained into suitable silt traps before discharge into the environment. Excessive site clearing shall be avoided and exposed surfaces shall be re-vegetated as soon as practicable to minimize erosion.

7.12 Operational Guidelines

Other than during commissioning, start-up and rectification of system upset periods, the Industrial Park project facilities shall be operated in compliance with project engineering and environmental standards.

7.12.1 Noise Minimization Guidelines

Noise generators include the following

1. during site clearing and construction
2. during operation of the line - noise charged conductors
3. these controlled by appropriate clearance from the conductors

Noise and vibration generated by facilities and equipment shall meet the ergonomic requirements of HIL and other National and International Standards, Codes of Practice and Statutory Regulations. Where noise level exceeds the stipulated limits, it shall be treated as nuisance and the contractor concerned shall put in place adequate mitigation measures to ensure that the situation is properly addressed. All personnel working for a long period in high noise area shall be required to use earmuffs at all times. Permanent warning signs shall be posted at the boundaries of these restricted areas. The following noise limits shall be used in the design.

Areas in workshops and machinery buildings where communication is required
70 dB (A)

Workshops for light maintenance	70 dB (A)
Workshop offices, plant offices and con rooms	60 dB (A)
Open plan offices and control rooms	50 dB (A)
Social rooms, changing rooms, wash places and toilets	50 dB (A)
Offices and conference rooms	45 dB (A)
Sleeping areas	40 dB (A)

7.13 Site Inspection Procedures

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

• Examine and inspect all equipment that could cause accidents;
• Collect samples of any atmospheric emissions, effluent discharges or solid waste deposition for analyses and interpretation;
• Examine all construction and operation logbooks for environmentally related issues. After each inspection, the Team shall compile a site inspection report detailing the:
• Specific facilities or areas inspected,
• Details of project activities, and
• Highlights of any observed non-compliance/persistent negligence.

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

7.14 Audit Programme

Environmental audit shall be conducted at the project site before mobilization and during operation. Mobilization is to commence only after the HIL Industrial Park Project Manager on the advice of the SAFETY and Security Team Leader has provided authorization. Construction activities will be subject to regular audits after mobilization. The audit process shall be used to assure that the equipment used for construction and the operations of the Industrial Park and its associated facilities meet the requirements and specification outlined in the EIA and also to assess its environmental performance during these phases of the project. This will ensure that environmental protection and management procedures are being enforced.

7.14.1 Objectives

In implementing the audit programme, facilities perceived as having high environmental risks shall be thoroughly investigated. The audit programme shall;

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

After every audit exercise, the environmental auditor shall produce an environmental audit report that shall be submitted to HIL and the Industrial Park Operation and Maintenance department.

7.15 Environmental Monitoring Plan

The overall objective of (performance) monitoring shall be to identify any unanticipated changes to the biophysical, health and social environment brought about by the Industrial Park Project Baseline information against which development and post development impacts and mitigation measures can be measured and compared has been established. HIL shall ensure that deviations from the baseline beyond reasonable limits shall trigger corrective actions so that monitoring becomes a dynamic activity as opposed to passive collection of data.

This Environmental Monitoring Plan has been formulated with the aim of ensuring that all the identified significant impacts from the project are mitigated to as low as reasonably possible and that key performance indicators are monitored periodically to track how effectively mitigation measures are implemented. It specifies the mitigation measures, monitoring requirements, duration and frequency of the monitoring, and the action parties to manage the biophysical, social and health environment at the various phases of the project.

Table 7.3 presents the impact management and mitigation plan at the various stages of the Industrial Park project. In formulating this plan, care has been taken to ensure that HIL complies fully with FMEnv. regulatory control measures: international best practice and self imposed standards (HIL SAFETY Policy). In addition the plan also provides for measures to mitigate indirect impacts of the project that may result from influx of people into the project area as well as practical proposals for the enhancement of significant positive impacts.

It is recognized that many of the host communities lack basic infrastructure and have needs that though unrelated to the project, have generated concerns from stakeholders. These and related issues have been considered in a separate section on Community Development.

Once this proposed Environmental Monitoring Plan has been reviewed, it shall be prepared as a stand-alone document and signed by the asset manager. This is to ensure ownership and implementation of the EMP and shall be updated as results of monitoring determine the effectiveness or otherwise of the proposed mitigation/enhancements.

The EMP will also be reviewed as environmental regulations, guidelines and policies (including those of HIL) are updated and/or changed.

Details of the Environmental Management and Monitoring Plan (EMP) follow up process covering the project phases are presented in table 7.6 below.

Table 7.6: Environmental Management and Monitoring Plan (Amfani Industrial Park & Smart City Project)

Project Activities	Impact (Positive or Negative)	Indicator parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
			PRE-CONSTRUCTION					
Site Selection / Land Take	Loss of land for other land use option including agriculture		HIL shall pay adequate compensation to affected land owners using RAP document.	Federal and State Legislation	List of all bonafide land/properties owners	Once before land acquisition	One month before land acquisition	HIL
			HIL shall provide support for the productivity of the remaining farmers through provision of farming support facilities such as improved varieties of seedlings and other extension services	HIL Policy	Records of supportive actions	Six month during construction	Six monthly during construction	HIL Community Relation Team
	Decreased agricultural production		HIL shall provide support for the productivity of the remaining farmers through provision of farming support facilities such as improved varieties of seedlings and other extension services	HIL Policy	Records of supportive actions	Six month during construction	Six monthly during construction	HIL Community Relation Team
MOBILIZATION								
Mobilization of	Potential increase in		As much as possible, large and slow	HIL SAFETY Policy	Journey manageme	Weekly	Monthly	Contractor SAFETY

Project Activities	Impact (Positive or Negative)	Indicator parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
Equipment and Personnel	road traffic volume		moving vehicles should be scheduled during off peak periods		nt record; IVM record, night driving permit and statistics			adviser
			Ensure maintenance of all roads used by the project	None	Road maintenance	Monthly	Six monthly	HIL
			Raise community awareness of unusual activity through the safety team.	HIL SAFETY Policy	Records of awareness session	Monthly	Six monthly	HIL Community Relation Officers
	Potential increase in road traffic & Poor access management		• Pre-mobilization of all vehicles. • Schedule the delivery hours to avoid peak hour traffic, weekends and evenings • Position entry and exit points strategically to ensure minimal effects on traffic. • Implement a traffic management plan.(see table 7.4)	HIL contract agreement	Smooth and free traffic flow	Weekly	Monthly	HIL Contract Holder
			Visible warning signs	Federal	Number and	Weekly	Monthly	HIL

Project Activities	Impact (Positive or Negative)	Indicator parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
			on roads and vehicles	Traffic Regulation	adequacy of signs and speed breakers			
	Incidents		Speed breakers at section traversing communities	HIL alcohol and drug and SAFETY Policy	Journey management record; IVMS record, night driving permit and statistics	Weekly	Monthly	HIL
			First aid training of workforce and provision of first aid boxes in operational vehicles	HIL standards	Number of first aid certificates issued and records of vehicle first aid boxes audit	Weekly	Monthly	HIL
			HIL shall maintain / repair all roads regularly used by the project	FMW Standards	Percentage of Completion	Monthly, six months prior to mobilization	Monthly	HIL
	Increase in noise level		Enforce night driving policy (no night driving except when unavoidable)	HIL SAFETY policy	Night driving permit	Weekly	Monthly	HIL
			HIL shall ensure that all vehicles and equipment conform	World Bank Guidelines	Vehicle maintenance records	Monthly	Monthly	HIL

Project Activities	Impact (Positive or Negative)	Indicator parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
			to FMEnv & World Bank limits for noise					
	Reduction in air quality (dust, exhaust fumes)	SPM, NOx, SOx, COx	HIL shall ensure that only vehicles with pre-mobilization certificates are used to reduce emission from vehicle exhaust	FMENV Standards	Pre-mobilization certificates and statistics	Weekly	Monthly	HIL
CONSTRUCTION								
Site preparation (land clearing, excavation)	Loss of loss Loss of flora and fauna	Biomass, Pathogenic Characteristics	Site clearing shall commence from developed areas to provide escape sites for wildlife	None	Site clearing inspection records	Daily	Weekly	HIL
			Hunting by the workforce shall be prohibited	HIL Policy	Compliance records	Weekly	Monthly	HIL
			HIL shall educate construction workers and host communities on the sensitive nature of the biodiversity of the area and the need for conservation	HIL Policy	Records of SAFETY meetings and community enlightenment sessions	weekly	Monthly	HIL
	Loss archeological sites	Archeological sites discoveries	Follow Chance Find procedures (see Appendix 5)	Ministry of Culture policy	Compliance Chance Find Procedure	Daily	Monthly	HIL
	Loss of		HIL shall limit	HIL Policy	Site clearing	Daily	Weekly	HIL

Project Activities	Impact (Positive or Negative)	Indicator parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
	habitat	Biomass,	cleared area to what is required		inspection record			
		Pathogenic Characteristics	HIL shall encourage the re-vegetation of land cleared for temporary use where feasible.	HIL/FMEnv Policy	Implementation records	One month after site clearance	Three monthly	HIL
	Community unrest		HIL shall ensure that all host communities are represented in the employment of locals during land clearing and excavation to avert any conflict that could arise from perceptions of unfairness	HIL Policy	Employment records for locals	Weekly	Monthly	HIL
			HIL shall ensure that land clearing and execution jobs are reserved exclusively for the host communities	HIL Policy	Employment records for locals	Weekly	Monthly	HIL
			HIL shall abide by all MOUs signed with the host communities	HIL Policy	Records of compliance with MOU items	Monthly	Quarterly	HIL

Project Activities	Impact (Positive or Negative)	Indicator parameters	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional / Monitoring	Frequency of Formal Reporting	Action Plan
	Stress on existing security structures		HIL shall ensure that both contractors and HIL personnel develop a high level of security consciousness both within and outside the work area.	None	Statistics of security breaches	Weekly	Monthly	HIL
	Stress on existing security structures		Security reports shall be reviewed by the HIL's Amfani Industrial Park Project Manager	HIL Policy	Security reports	Weekly	Monthly	HIL
			If required, special security force shall be established and deployed for the project. This shall include deploying some of HIL police to strengthen security in the area	HIL Policy	Number of special security personnel	Weekly	Monthly	HIL
			HIL shall ensure that a liaison to foster partnership with the community so as to guarantee security for the project is	HIL Policy	HIL – Community meetings	Monthly	Monthly	HIL

Project Activities	Impact (Positive or Negative)	Indicator parameters	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional / Monitoring	Frequency of Formal Reporting	Action Plan
			established and sustained					
			In order to beef up security for the project, HIL shall contact government authorities to improve the strength of the police force and they shall providing assistance, to ensure improved security	HIL Policy	deployment of police personnel and records of security equipment.	Monthly	Annually	HIL
			HIL shall ensure that safety workshops to identify, evaluate and recommend contingency plans for all security risk are regularly organized	HIL Policy	records of security workshop	Monthly	Monthly	HIL
	Increase in dust and noise	SPM	HIL shall ensure that nose masks and earmuffs are worn by site workers during evacuation	HIL SAFETY Policy	SPM, records of respiratory disease and noise levels	Monthly	Monthly	HIL
			Water shall be sprayed on construction sites to reduce dust levels	World Bank Standards	Records on compliance, SPM at selected sites	Weekly	Monthly	HIL

Project Activities	Impact (Positive or Negative)	Indicator parameters	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional / Monitoring	Frequency of Formal Reporting	Action Plan
			especially during dry season		within 500m band			
	Potential alteration in Water quality. Disturbances or loss hydrological regime/aquatic	Physico-chemical and Heavy Metals	The project contractor/HIL shall ensure that measures are adopted to avoid incursion into areas adjacent to the work site or any secondary effects from pollution, sedimentation, or accidental spills.	HIL/FMENv. Policy	Records of Inspections of construction areas and assessment of the condition and operability of site drains conducted	Weekly	Monthly	HIL/Site Health & Environ. Officer.
			Implement controls such as berming, use of secondary containment and trays to ensure all transfer of fuels and chemicals are properly managed to prevent spillage outside of bunded areas. Also see table 7.4 for further details on surface water management,	HIL/FMENv. Policy	Records of inspection of all fuels and chemicals storage areas to ensure adequate containment and handling	Weekly	Monthly	HIL/Site Health & Environ. Officer.

Project Activities	Impact (Positive or Negative)	Indicator parameters	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional / Monitoring	Frequency of Formal Reporting	Action Plan
			Provide bunded storage areas for fuels and hazardous substances with spill cleanup kits in accordance with FMEnv requirements/standards	HIL/FMENv. Policy		Weekly	Monthly	HIL/Site Health & Environ. Officer.
			Use appropriate technology that will guarantee minimal disturbances to aquatic life /all hydrological regime during construction/installation of floating jetties, farms, walkways, etc in Kainji lake.	HIL/FMEnv guidelines & policies	Records of inspection of all hydrological regimes in Kainji lake	Weekly	Monthly	HIL
	Potential increase in erosion		HIL shall re-vegetate areas not needed for construction as soon as possible following completion of work.	HIL Policy	Records of re-vegetation exercise	Monthly	Quarterly	HIL
	Threat to health of workers (Snake		HIL shall provide and ensure usage of PPE by field workers	HIL Policy	Compliance records	Weekly	Monthly	HIL
			HIL shall ensure that	HIL Policy	First aid training	Monthly	Quarterly	HIL

Project Activities	Impact (Positive or Negative)	Indicator parameters	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional / Monitoring	Frequency of Formal Reporting	Action Plan
	bites, insect stings, injuries, etc)		an adequate numbers of trained first aiders are available at work sites		records and statistics			
			HIL shall ensure that anti-venom/anti-histamine is provided on site to mitigate snake bites and insect sting	HIL Policy	Records of anti-venom/anti-histamine at site clinic	Monthly	2-monthly	HIL
			HIL shall ensure that awareness is created among site workers on the likelihood of exposure to poisonous wildlife and plants	HIL Policy	Awareness records	Monthly	Monthly	HIL
Influx of labour and followers	Changes in local population		Prior to commencement of the construction phase, HIL shall advertise construction jobs that will be available. This will hopefully discourage unqualified personnel from moving into the	None	Records of applications at employment office and copy of advertisement	Weekly	Monthly	HIL

Project Activities	Impact (Positive or Negative)	Indicator parameters	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional / Monitoring	Frequency of Formal Reporting	Action Plan
			project area, thus reducing the rate at which population will grow					
			HIL will look into the development of off-site job recruitment to discourage influx of people	None	Documentary evidence of implementation	3-months	6-monthly	HIL
			Movement of unauthorized persons into camps shall be strictly restricted	HIL Policy	Records of access control	Monthly	Quarterly	HIL
	Increase in morbidity (including STIs) and mortality		Health awareness on the mode of transmission of STIs (including HIV/AIDS)	None	Statistics of health awareness lectures	Intensive phase one to two months prior to mobilization and quarterly there after	Quarterly	HIL SD and Occupational Health teams
			As much as possible, psychological support shall be provided to persons living with the HIV virus	Government Policy	Records of HIV Support Programs	Quarterly	6-monthly	HIL SD and Occupational Health teams
			Immunization of	None	Records and	Records	During	HIL

Project Activities	Impact (Positive or Negative)	Indicator parameters	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional / Monitoring	Frequency of Formal Reporting	Action Plan
			workforce as appropriate		statistics of immunization	and statistics of immunizatio n	mobilization	
			HIL shall enforce Expatriate malaria policy	HIL Policy	Compliance	Complianc e	Monthly	HIL
			Vector control to reduce incidence of malaria (such as regular spraying of camp and provision of insecticide treated nets (ITN)	HIL	Records of statistics of ITN distribution	Records of statistics of ITN distribution	Monthly	HIL

r	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
	Awareness campaign shall be carried out to enlighten the communities/field workers on the common communicable diseases and the health implications of drug and alcohol abuse, unprotected sex, prostitution and the need to sustain cultural values	None	Statistics of health awareness lectures	Monthly	Quarterly	HIL
	Alcohol and drug policy shall be implemented to encourage health lifestyle for workers	HIL Policy	Records of violation	Monthly	6-monthly	HIL
	HIL shall support the activities of the state action committee on STIs/HIV/AIDS within the local government	None	Records supportive action to SACA	Monthly	Quarterly	HIL Occupational Health team
	HIL shall provide site clinic to take care of minor illness for all workers	HIL Policy	Statistics of attendance morbidity and mortality	Weekly	Monthly	HIL
	HIL shall provide condoms for construction workers	HIL Policy	Condom availability to workers	Monthly	Quarterly	HIL

Project Activities	Impact (Positive or Negative)	Indicator Parameters	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional / Monitoring	Frequency of Formal Reporting	Action Plan
	Increase in social vices		Intensive enlightenment campaign and health education for the abatement of abuse of drugs, alcohol in the communities and among workers throughout the life of the project	Law against smoking in public places and NDLEA Act	Enlightenment campaign/health education statistics; records of cased of abuse in the workforce	At least 3 months before commencement of construction activities then 6-months thereafter	Annually	HIL
			HIL shall ensure that contractor enforces the alcohol and drug policy for staff	HIL Policy	Records of violation	6-monthly	Annually	HIL
			HIL shall support sporting activities	None	Number of sporting activities	6-monthly	Annually	HIL
			HIL shall support public health lectures with emphasis on common communicable diseases such as malaria, TB, STIs including	None	Statistics of health awareness lectures	1 to 3 months before mobilization and then quarterly thereafter	Quarterly	HIL

			HIV/AIDS					
			HIL shall support local security systems	None	Records of HIL support	Quarterly	6-monthly	HIL
			HIL shall provide condoms for construction workers	HIL Policy	Number of condoms provided and distributed	Monthly	Quarterly	HIL

Project Activities	Impact (Positive or Negative)		Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
			HIL shall ensure that contractor implements social and health awareness programs for all workers at induction and on a continuous basis throughout the life of the project	HIL Policy	Statistics of social health awareness programme	At induction and quarterly thereafter	Annually	HIL
	Pressure on existing infrastructure		HIL shall make adequate accommodation arrangement prior to mobilization of workforce to reduce pressure on local housing	Public health law (CAP 103); building regulations code	Accommodation plan	3 months prior to mobilization	I month to mobilization	HIL
			HIL shall support the health recreational facilities for workers within their camp	HIL Policy	Support provided	Monthly	Monthly	HIL OH Team
			HIL shall extend water supply from the camps/worksite to communities at strategic points.	None	Number of water stand point outside the camps	Monthly	Quarterly	HIL

Project Activities	Impact (Positive or Negative)	Indicator Parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
	Increase in inflation level		HIL shall support skill development and enhancement of the local communities through training	None	number of beneficiaries of skill acquisition	6-monthly	Annually	HIL SD Team
	Changes in culture, lifestyle and habits		HIL shall carry out enlightenment campaigns to encourage positive influences on cultural values and healthy lifestyle (e.g. breast feeding habits, alcohol and drug use, exercise, monogamy, high moral values with regard to sexuality, etc) and discourage adverse influences (e.g. prostitution, drug abuse, alcoholism etc)	None	Records of enlightenment	6-monthly	Annually	HIL

Project Activities	Impact (Positive or Negative)	Indicator Parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
	Loss of biodiversity	Biomass, Pathogenic Characteristics	HIL shall limit cleared area to what is required	HIL Policy	Compliance	Once during construction	Once during construction	HIL
			HIL shall ensure that site clearing is commenced from developed (e.g. roads) to undeveloped areas and provide escape sites for wildlife	HIL policy	Compliance	Once during construction	Once during construction	HIL
			HIL shall undertake to educate construction workers on the sensitive nature of the biodiversity of the area and the need for conservation	HIL policy	Records of enlightenment sessions	Monthly	Annually	HIL
			HIL shall ensure that hunting by employees of the contractors shall be prohibited	HIL Policy	Plans for enforcement and records of violations	6-monthly	Annually	HIL

Project Activities	Impact (Positive or Negative)	Indicator Parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
			HIL shall re-vegetate land cleared for temporary use where feasible	None	Compliance	2 months after construction	6 months after construction	HIL
	Reduction in air quality	SPM, NOx, SOx, COx,	• HIL shall ensure that all mobile and stationary internal combustion engines are properly maintained • The Contractor shall be responsible for dust control on site to ensure no nuisance is caused to a Landowner or neighboring communities;	FMENV Standards	Maintenance record	Monthly	Annually	HIL
Waste generation and disposal	Increase in breeding ground for disease vectors and other		HIL waste management policy shall be enforced.	HIL Policy	Compliance	Weekly	Monthly	HIL

	agents of disease							
	Increase in Nuisance effect		HIL shall enforce adequate waste management on site	Public Health Law (CAP 103.), HIL Policy	Compliance	Monthly	Quarterly	HIL

Project Activities	Impact (Positive or Negative)	Indicator Parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
	Blockage of natural drainages		HIL shall ensure that wastes are disposed of at appropriate locations provided for waste disposal and collected as quickly as possible	Public Health Law (CAP 103.), HIL Policy	Records of supportive action	Quarterly	Annually	HIL
	Pressure on existing waste management system		HIL shall explore ways to assist the communities in managing waste	Public Health Law (CAP 103.), HIL Policy	Records of supportive action	Quarterly	Annually	HIL SCD team
OPERATION AND MAINTENANCE								
construction site decommissioning	Impacts associated with construction site decommissioning		Remove all structures comprising the construction camp, chemical soil contamination clean up	HIL Policy	Compliance and visual monitoring	Weekly	Annually	HIL, Contractor & SHE Engineer
	Presence of associated infrastructure in the construction site		Fences, barriers and demarcations associated with the construction phase are to be	HIL Policy	Compliance	Weekly	Annually	Proponent, Contractor HSE

Project Activities	Impact (Positive or Negative)	Indicator Parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
			removed from the site unless stipulated otherwise by the Engineer.					
	Collapsed of Industrial Park telecommunication infrastructure or electricity infrastructure components leading to electrocution of humans and animals		HIL shall undertake regular inspection of facilities integrity	HIL Policy	Compliance	6-monthly	Annually	HIL
	Noise disturbance from inspection vehicles, etc.		Communities to be informed of inspection schedule	HIL Policy	Maintenance Records	6-monthly	Annually	HIL
Operation of all structures mounted on Kainji lake e.g floating jetties, farm, walkways, etc.	Disturbance or loss of aquatic life/all hydrologicalregime.	Records of condition of hydrological regime.	HIL shall use appropriate technology that will guarantee minimal disturbances to hydrological regime during operation/maint	HIL/FMEnv Policy	Maintenance records	quarterly	6-monthly	HIL

Project Activities	Impact (Positive or Negative)	Indicator Parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
			enance phase of floating jetties, farm, walkways, etc.					
ABANDONMENT AND DECOMMISSIONING								
Surface equipment dismantling, excavation, removal and disposal of concrete works, dismantling of floating farms, jetties, walkways and other platforms, materials and pipes mounted in Kainji lake.	Increase in dust generation	SPM	HIL shall ensure proper use of appropriate PPE	HIL Policy	Compliance	Weekly	Monthly	HIL
			HIL shall ensure that water is sprayed to reduce dust levels	None	Records of compliance	Daily	Weekly	HIL
	Increase in noise levels		HIL shall inform communities in advance of likely increase in noise level during decommissioning	HIL Policy	Compliance	Monthly	Annually	HIL
			HIL shall ensure proper use of PPE (ear muffs)	HIL Policy	Compliance	Monthly	Annually	HIL
	Increase in respiratory tract disease	SPM, NOx, SOx, COx,	HIL shall ensure that all personnel are medically certified for the operation prior to engagement	HIL Policy	Compliance	Monthly	Annually	HIL
			HIL shall enforce appropriate use	HIL Policy	Compliance	Weekly	Monthly	HIL

Project Activities	Impact (Positive or Negative)	Indicator Parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
			of PPE (noise mask)					
			HIL shall use barriers to minimize the spread of dust	None	Compliance record	Monthly	Quarterly	HIL
	Danger of electrocution from charged conductors		HIL shall follow laid down regulations for decommissioning of the Industrial Parks	HIL Policy	Compliance records			HIL
	Increase in waste generation		HIL shall ensure that waste are disposed of in accordance with her waste management plan for this project	HIL Policy	Compliance	Weekly	Monthly	HIL
	Potential for community unrest (from employment, pollution and resistance to dismantling of equipment)		HIL shall ensure fair community representation in the employment of local labour.	None	Employment records	Quarterly	Six-monthly	HIL

Project Activities	Impact (Positive or Negative)	Indicator Parameter	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameter for Monitoring	Frequency of Inspectional/ Monitoring	Frequency of Formal Reporting	Action Plan
			HIL shall abide by the MOUs signed with the communities for this project	Contractual	Compliance with MOU items	Yearly	Once during decommissioning	HIL
	Disturbance of hydrological regime in due to demolition and dismantling of floating farm, jetties, walkways, etc in Kainji lake		HIL shall deploy appropriate technology in the dismantling or demolition of floating farm, jetties, etc that will guarantee minimal disturbances to hydrological regime in Kainji lake.				Once during decommissioning	HIL

7.16 Managing Stakeholder Perceptions

Public interest in this project is expected to be high. The issue of industrial park development appears to be a sensitive one. The project will have impacts on the surrounding communities especially during construction and operation (e.g. noise, traffic, dust, emissions, etc.) and from the influx of workforce.

Effective and realistic measures to mitigate/enhance these impacts have been proposed. Nevertheless, stakeholder perceptions are bound to persist. In executing the Industrial Park project, HIL shall manage these perceptions by employing and sustaining dialogue as well as involvement of the communities and other stakeholders in all phases of the project. In particular, HIL

- shall ensure that the communities are involved in the environmental monitoring and management plan for this project.

- Use available records on community development and other community-based activities as evidence of good corporate neighborliness.

7.17 EMP and Community Development

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

7.18 Responsibilities and Cost for EMP Implementation and Monitoring

Mitigation measures for each of the phases have been presented in **Chapter 6**. The contractor will be directly responsible for financing the implementation of mitigation and monitoring measures from inception to the completion of the Industrial Park project. The cost of impacts mitigation monitoring will be included in the contract value and will be monitored by HIL designated representatives assigned to the project.

HIL shall be responsible for auditing of the activities of the Contractor and for the associated funding. Annual auditing of the facilities and activities from inception to completion of the Project is estimated to cost about N35,000,000. During operations, HIL will be responsible for financing and managing mitigation measures and monitoring activities in line with their established practices nationwide.

Part of the conditions of the approval of the EIA by the Federal Ministry of Environment (FMEnv) is that there will be regulatory monitoring of the approved project impacts mitigations and monitoring measures. The timing and frequency of the monitoring is determined by the FMEnv. FMEnv works closely with the state Ministry of Environment in monitoring the implementation of the EIA approval terms and conditions. Funding of the Impacts Mitigation and Monitoring (IMM) is borne by the proponent, in this case, HIL. Current practice is that FMEnv issues an approval letter which includes the cost of IMM and other conditions that has to be fulfilled prior to the issuance of the approval. Meeting the conditions, along with payment of the funds have therefore become prerequisites to the issuance of the EIA approval. Payment prior to approval also ensures that the funding for monitoring is secured and the activity effected as at when due. The current cost shall be determined by the FMEnv.

7.19 Decommissioning, Restoration and Abandonment

The need may arise to decommission the Industrial Park. HIL standard procedures for decommissioning Industrial Parks shall be invoked. The activities planned for this phase of the project include:

- Dismantling of building including excavation
- Dismantling of all surface equipment including power and telecommunication installations.
- Removal and disposal of concrete works
- Removal and disposal of all platforms mounted in the Kainji Lake, including floating fisheries, polo club facilities and golf course facilities, floating farm, floating jetties, etc.

For abandonment, strict adherence to facilities abandonment policy of HIL and guidelines of the FMEnv, which includes restoring the project environment to its original status as much as possible, shall be encouraged. The procedure shall be in accordance with approved HIL, FMEnv and international industry standards.

CHAPTER EIGHT

8.0 CONCLUSION

The report presents the Environmental Impact Assessment of the proposed Amfani Industrial Park and Smart City project. The Industrial Park shall be a centre of conglomeration of industries operating with state-of-the-art facilities and delivering in a highly environmentally sustainable manner using cutting edge and smart technologies in Niger State. The Industrial Park project is part of the efforts Hydropolis Investment Limited to contribute to the growth of Nigerian economy.

This EIA shall serve as a reference platform against which future changes in the environment vis-à-vis the project in view can be monitored. The document shall also provide the necessary information required for the issuance of Approval and Environmental Impact Statement for the proposed project by the FMEnv and other interest groups.

Multidisciplinary approach was employed in the assessment of the natural environmental status and sensitivities of the various ecological components of the project area with the use of extensive literature survey, field sampling, measurement/testing, analysis and methodologies compatible with national and international standards.

The sensitivity of the environment to element of the proposed project activities were identified and assessed and appropriate mitigation measures were developed to reduce their adverse effects to ALARP on one hand and enhance their beneficial contributions on the other hand.

An Environmental Management Plan (EMP) covering the biophysical and socio-economic aspects of the project was developed in order to ensure that mitigation measures would be established and maintained throughout the life cycle of the project. Mitigation measures were based on best available technology, safety, health and environmental considerations.

Consultation with the host communities was carried out and is expected to continue throughout the life cycle of the project.

On the basis of the outcome and findings of this EIA document the proposed Amfani Industrial Park and Smart City Project is capable of achieving its goal of growing Nigeria economy in an environmentally sustainable manner if the recommendations made in this report are implemented methodically with due diligence.

APPENDIX 1-QUESTIONNAIRE

AMFANI INDUSTRIAL PARK SMART CITY PROJECT

SOCIO –ECONOMIC IMPACT ASSESSMENT STUDY

IN-DEPTH INTERVIEW SCHEDULE FOR KEY INFORMANTS – LOCAL STAKEHOLDERS

Name of Community: ________________________ Questionnaire No.__________
L.G.A __________________State__________________ Ethnic Group__________
GPS Reading_____________ Distance from proposed Project _________

Date of Interview: ___________Name of Respondent: ____________________

1. **RESPONDENT'S SOCIAL DATA**

1.1 Sex: Male ☐ Female ☐

1.2 Social status (Post held in community/ occupation)…………………….

1.3Age (years):
Less than 15…… 15 – 24……… 25 – 34…….. 35–44……
45 –54……… 55 – 65…… Over 65 ……

1.4 Are you a native of this community? a. Yes …………………… b) No ……………
b. If No, state your town/ village of origin? …………………………………………………

1.5 How long have you lived in this area? (Years)
0 – 5 ….. 6 – 10…..11 – 15…. 16 – 20……..above 20 years…. Since birth…………

1.6 Marital Status:
Single……… Married……….. Divorced………..Widow/ Widower…………

1.7 Family type:
Monogamous (one man, one wife)….. Polygynous (one man, many wives) ….. Specify ( )

1.8(a) **Household size:**
1-5…………6 – 10……… 11 – 15………16 – 20………above 20…….

(b)Distribution:

Adults:	Male………. Female………
Children:	Male…… Female…………
Youth:	Male……… Female…………

Elderly: Male……… Female………..
Dependants: (not direct children) Male……… Female………..
Handicapped/Disabled: Male…… Female………..
Type of disability Physical (No)…. Mental (No) ….. (list reqd.)

1.9 Number of children:

a. Infants (0 – 5 years): Males…… Females ….
b. School age: Males ……Females……
c. No of children in school: Males…… Females…….
d. No of school-age, but not currently in school: Males ….. Females ……….

1.10 Household Type

Thatched ……… Thatched/wooden…...Thatched/mud……. Zinc roof/wooden …..
Zinc roof/mud ….. Zinc roof/block ……… Others (Specify)……………………………

1.11 Religious affiliation:

Christianity… Islam…… Traditionalist….. Others (specify)………………

1.12 Highest level of educational attainment:

No Formal Education ……Pry School ……Quranic Sch.…….. Sec. School ………
Vocational / Technical School ……. Tertiary School (Specify) ………………..

1.13 Occupation: Pry. (Major) occupation **…………**Sec. (Minor) occupation**………..**

2.0 Community Information

2.1Composition of the community: Describe this community in terms of the proportion of the under listed characteristics: (Tick only one column per group)

Characteristics Proportion Characteristics Proportion

	None	¼	½	¾	All		None	¼	½	¾	all
Age: Adults						Children/Youth					
Religion: Christian						Muslim					
Indigenes						Migrants					
Status: Better-off						Poor					
Gender: Male						Female					
Majority ethnic Group(_______)						Minority ethnic Groups					

* Indicate here if there is a proportion of the population that are traditional worshippers.

2.2: Traditional (Cultural) Heritage

(a) Name of major traditional god/s ……………………. Shrine/s location/s………………………

(b) Name of major cultural festival/s in your community………. period of observance…………

(c) Name of important cultural site in your community……………………………………………

(d) What is the most important cultural event in your community? …………………………………………

(e) Name some sacred animals in your community……………………………………………

(f) In the last 12 months, has there been any disturbance/destruction to nos. b and c above? ....

2.3: Intra and Inter Ethnic Relations

a) Describe the hierarchy (arrangement from top to bottom) of authority in this community starting from the Emirate Council……………………………………………………………………

……………………………………………………………………………………………………

b) Who or which group of indigenes speak for your community on land matters? (e.g. village head, village council etc.)

....

c) Who do people usually report their problems to in this community?

	Not at all	Sometimes	Regularly
Traditional Ruler			
Police			
Family elder			
Imam/ Priest			
Political leader			
Others (Specify)			

d) Mention any **recent conflict** in your community!

i) Who were those involved?

ii) What was the **cause** of the conflict?

iii) How was it **resolved?**

2. **Economic Scenario**
a) **Household Income per month**

Income sources	Income in the last one year	Present income	Reasons for change in income
Paid Employment			
Unemployed			
Crop farming			
Livestock rearing			
Trade on household provisions			
Trade on farm/fish produce/equipment			

Pensions			
Rent of housing/returns			
Rent of fishing boats			
Motor/ Cyclist transportation			
Boat building/repairs/ transportation			
Hunting			
Seasonal herder			
Artisan (carpentry, mason, etc)			
Handicraft (pottery, dyeing, blacksmithery,weaving, tailoring)			
Processing (garri, local gin, fufu, etc)			
Collection of forest products (fruits, vegetables, firewood etc)			
Collection of sea products (periwinkle, crayfish etc)			
Farm labour			
Other income sources (specify)			

b) Household Expenditure per Month

Items	**Amt spent in the last one year**	**Amt spent presently**	**Reasons for Change in amount spent**
Food			
Clothing			
Fuel			
Education			
Health			
Others (specify)			

c) **Household Structure and assets**

	Yes	No		Yes	No
House (Block/ corrugated iron, hut, wood, thatched) etc			Stove		
Fan			Boat		
Generator			Fridge		
Motorcycle			Car/Bus/Truck		
Bicycle			Cattle		
Others (specify)			Goat/ sheep		

d) **Household Resources Use**

	Yes	No		Yes	No
Fuel wood			Electricity		
Charcoal			Solar Power/Panel		
Kerosene stove			Generator		
Gas Cooker			Medicinal plants and crafts		
Water			Others (specify)		
Stream/ River					
Borehole					
Earthen well/ dug pit					
River					
Pipe borne					
Rain water					
Stored run-off					

e) **Properties owned within proposed ROW:**

Plantation (Type?)…………………Farm land(s)………………… House ………………… Business (Specify)………………………… Others (Specify)………………………………

State major use of land in your community……………………………………………………

Do you use any Land for your business? .... If yes- Answer the following:
Tenure of use: Full Time…… Seasonal………….

Status of use: Ownership……..Leasehold…….. Share Cropper………
Labourer……………..

f) Properties owned elsewhere in the community:

Plantation (Type?)…………………Farm land(s)………………… House ………………… Business (Specify)………………………… Others (Specify)………………………………

g) List major crops grown in your community……………………………………………………..

h) List major livestock reared in your community…………………………………………………

i)List 2 most important income-generating activities in this community ____________________

j) Specify your total monthly income from all sources per year: less than ₦ 10,000; ___________
₦11,000- ₦50,000________ less than ₦ 51,000- ₦100,000 _______ more than ₦100,000________

k)How much do you save monthly? ______ No savings; ___less than ₦ 1,000; ___________
less than ₦ 5,000________ less than ₦ 10,000 _______ more than ₦10,000________

l) Have there been any changes in items (**i) and (j)** in the last 12 months?__________
Specify____

m) Have you ever received any loan/ credit for your business expansion? ________________
Specify ____

4. Standard of Living

a) Which of the following types of houses is common in this community (Enumerator to note)?: mud and wattle thatch; _____ mud and wattle zinc; _____Earth block/Thatch; ______Earth Block/Zinc; ____ Cement Block/Zinc; ______Cement Block/Asbestos; _________Timber Wall/Thatch; ___________ Timber Wall/Zinc; ____

b) What category of people is more common in your community? _____________ Landlords;______________ _tenants _________________

c) Do you consider most dwelling houses adequate in size for each household?
Yes; ____ No. ________

d) What proportion of houses/households you have visited/known would you consider as having modern facilities/conveniences (e.g. cars, TV. Fan, motorcycle etc): none; ______
¼; _____½;______¾; ______ all ______

e) What fraction of your income (e.g. ½; 1/3 ; ¾ etc.) do you spend on the following? Food;_____ clothing; _______ education;______ health care;_____ housing _____ transportation; _____ etc (specify) ________

f) What proportion of this community would you consider to be poor (e.g. ½; 1/3; etc)___________________

g) What do you think are the reasons for poverty in this community?____

h) What do you think is the proportion of functionally educated (can read and write) people in this community (e.g. ½; ¼ etc) _______________

i) What would you say is the proportion of jobless people in this community? (e.g. ½; ¾ etc)____

j) Which of the following 3 groups have the highest proportion of jobless people in this community? The uneducated; ____the partially educated (Primary and Secondary education);______the well educated (more than secondary education)__________________

k) List 3 frequently eaten food items in order of importance (1)______(2)_______(3)______

5. Community Organization/ Assistance

a) List the common groups and organizations found in this community._______________

b) Which are the 2 most important groups? _____________________________

c) Mention any project that has been undertaken by any of the mentioned groups in the community………………………………………………………………………………………

d) Please specify any project on-going/planned targeted at the women in this community?
……………………………………………………………………………………………..

e) Please specify any project on-going/planned targeted at the youth in this community?
……………………………………………………………………………………………..

f) What are the major environmental problems in your community?
Soil fertility…………Pest attacks / invasion…………... Soil Salinity…………………
Erosion………… Flood ……………………… Others (Specify)………………………

g) Has the government or any other organization embarked on activity to help reduce environmental problems in your community? Yes; _______ No;_____________

h) If yes, what types of development programmes and which organizations?____________
____What have been the impact?____.

____

i) Are you aware of any plan to locate any Power plant project in your area? Yes……… No…………

j) If yes, please give details about this proposed project……………………………………
………………………………………………………………………………………

6 Community Perceptions

a) Did Company officials come to your community to discuss with you what they were planning to do?____

b) Do the company officials ever come to discuss their activities with your community? Yes, regularly; __________ Yes, occasionally; ________ no, not at all ________ if yes, what do they discuss? ____

c) Do they ever discuss your problem with you or consult you before they site their installations?

____

d) How would you characterize the relationship between the Company and your community? Very good; _______ fair; ____ poor;______ hostile; ___what is the reason for the "chosen" relationship? _______________________________________

e) Has any of your communal lands been taken over by the Company? Yes; ____No; ______ If yes, what proportion of your land has taken over? Over ½; _____ ¼ - ½; _____
over ¼; _____ a very small size; ____

f) Have there been cases of electricity related problems in this community? Yes; ___ No;______ I don't know;_______

g) If yes, give details about the latest problem _________________________-
____

h) What should be done to help the people of this community?_________________________

____

i) List your three most important personal needs:
a)………………………..b)……………….

c)……………………………………………………………………………………….
….

k) List the three most important needs of your community:
a)………………………………
b) ………………………………………
c)…………………………………………..

Thank you for your assistance and God bless you!

AMFANI INDUSTRIAL PARK SMART CITY PROJECT

SOCIO –ECONOMIC IMPACT ASSESSMENT STUDY

FOCUS/ GENERAL GROUP DISCUSSION GUIDE

Name of Community___________________ LGA:______________________
Type of Group:____________ Male:___________ Female:_____________

List of Participants (b/w 8 – 10)

1	2
3.	4.
5.	6.
7.	8
9.	10.

Name of Moderator __________Name of Note taker _________Date_________

A. Community Characteristics

1. Composition of the community: How would you describe this community in terms of the proportion of the population by sex, age, religion, social status, migrant status and ethnic background? (Use the table to record responses.)

Characteristics Proportion Characteristics Proportion

	none	¼	½	¾	All		none	¼	½	¾	all
Age: Adults						Children/ Youth					
Religion: Christian						Muslim					
Indigenes						Migrants					
Status: Better-off						Poor					
Gender: Male						Female					
Majority ethnic Group(_______)						Minority ethnic Group					

Record the consensus of opinion not the responses of one person.
* Indicate here if there is a proportion of the population that are traditional worshippers.

2. How would you rate the level of infrastructural development in this community?

High __________ average _________ very low ___________

Use the table below to indicate the type of facilities available and their condition:

Type of facility	Tick if present	Tick if functioning	Condition: Good/ poor	Any plan to Improve.
Access road				
Public transportation				
Local market				
Primary school				
Secondary school				
Dispensary/maternity				
Electricity				
Stable water supply				
Others:				

Record the consensus of opinion not the responses of one person.

* Indicate here if there is any plan by community or outside agency to improve the facility.

3. List the common social groups in this community:

4. a). How would you characterize this community in terms of cooperation and social harmony? Do people work together or are there cases of fighting between groups within the community? What are the likely causes of such conflict, if they occur?

   b). In the case of conflict between groups within the community, how are such problems resolved?

   c) Have there been any recent cases of conflict with groups outside the community? Yes; ___ No; _____ if yes, what were the causes?

   d). How have such conflicts with outside groups been resolved?

B. Livelihood Activities of Local Population

7. Which of the following activities are practiced in this community? Indicate if women, men or both are engaged in each activity. Also indicate if each activity is declining or not

Activity	Gender M/F/B*	Tick if activity is threatened or declining	If threatened, give reasons
Paid Employment			
Unemployed			
Crop farming			
Livestock rearing			
Trade on household provisions			
Trade on farm/fish produce/equipment			
Pensions			
Rent of housing/returns			
Rent of fishing boats			
Motor/ Cyclist transportation			
Boat building/repairs/ transportation			
Hunting			
Seasonal herder			
Artisan (carpentry, mason, etc)			
Handicraft (pottery, dyeing, blacksmithery,weaving, tailoring)			
Processing (garri, local gin, fufu, etc)			
Collection of forest products (fruits, vegetables, firewood etc)			
Collection of sea products (periwinkle, crayfish etc)			
Farm labour			
Food vendor (hawking)			
Other income sources (specify)			

*M = Males only engage in this activity; F = females only; B = both males and females engage in this activity.

8.A) Over the last 1 -5 years, have there been any changes in these activities? Yes, improved; ___ Yes, declined; ___ No change ____

B) Which activities have improved? Which has remained the same?

C) Why has there been a change, if any?

9. List the major crops grown here:

10. List the common fish breeds and other river/swamp produce harvested in your waters?

C. Community Perceptions

12. Do Company officials ever come to discuss their activities with your community? Yes, regularly; __________ Yes, occasionally; ________ no, not at all ________ if yes, what do they discuss? ____

13. Do they ever discuss your problem with you or consult you before they site their installations?
____

14. How would you characterize the relationship between the Company and your community? Very good; _______ fair; ____ poor;______ hostile; ___what is the reason for the "chosen" relationship? ______________________________________

15. Have there been cases of electricity related problems in this community? Yes; ___ No;______ I don't know;_______

16. If yes, give details about the latest problem.
…………………………………………………

17. Has the Government/NGO/Company embarked on any activity to try to reduce the environmental problems in your locality?
Specify_________________________

18. What are the advantages and disadvantages of the proposed project in your
community?____
_

19. Overall, do you think the activities of the company will have?
Good effect; _____________ No. effect; _______Bad effect;_____________

20. What should be done to help the people of this area?

Paired Needs Rank Matrix

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**Total**	**Rank**
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8												
9.												
10												

Thank you for your assistance. God bless you.

APPENDIX 3
Checklist on Infrastructural Facilities

Name of Settlement/ Community: …………………………………………………….

1. **Water Supply:**

Type of Supply	Available in Community (Yes/No)	Used by what proportion of population	Used for which purposes: drinking/washing/bathing	Any development projects/ plans to improve water supply?
Private borehole				
Public borehole				
Private wells				
Public wells				
Creek or Stream				
Rain water				
Others				

*Everyone, more than ½; less than ½; very few; no one

2. **Electricity:**

Source of Supply	Available in Community (Yes/No)	Used by what proportion of population	Regularity	Usual voltage: Good/ poor	Any development projects/ plans to improve electricity?
Public electricity from Eko Electricity Desco					
Community Generator					
Private Generators					
Others					

*Most of time, occasionally, very seldom, etc

3. **Educational Facilities:**

Type of Educational Facility	Availability in community. (Yes/ No)	No. of Rooms	Condition of School	Any development projects/ plans to improve electricity?	If none, where is nearest school
Primary School					
Secondary School					
Tertiary institution					
Others					

4. **Health Facilities**

Type of Health Facility	Availability in community. (Yes/ No)	No./ type of Medical staff	No. of beds	Any development projects/ plans to improve Health facility?	If none, where is nearest Health facility
Primary Health Care					
Hospital					
Patent Chemist					
Others					

b) What type of Traditional health care is available? ……………………………………

5. **Transportation**

Type of Transportation	Availability in community. (Yes/ No)	proportion of population using	Dependability of service	Frequency of Service	Remarks: Describe the most common routes /destination
Truck/ lorry					
Bus /Car					
Speed boat / ferry					
Canoe					
Motorcycle					
Bicycle					
Others					

6. **Markets**

Type of Market	Availability in community. (Yes/ No)	Approximate no. of Sellers	Buyers from where? Locality/ Other Village/ Cities	Frequency of Market: daily or how many days interval	Types of products sold- only locally produced or wide range of goods
Local Village square/ no permanent stalls					
Open stall market					
Permanent Lock- up stalls					

7. **Other facilities**

Type of Facility	Availability in community. (Yes/ No)	Number of Staff	Any project or plans to improve?	If none, where is nearest facility?
Police station or Police Post				
Bank (Name: ……..)				
Post Office				
Town Hall				
Others …………				

8. **Religious Facilities**

Type of Facility	Found in Community (Yes/ No)	Number of Churches/ Mosques/ Shrines and Names
Churches		
Mosques		
Shrines		

APPENDIX 2- LIST OF ATTENDANCE FOR STAKEHOLDER'S CONSULTATION

EIA OF AMFANI INDUSTRIAL PARK SMART CITY PROJECT

STAKEHOLDERS' CONSULTATION ATTENDANCE

Community: Anfani Date: 23 — 11 — 2019

SN	Name	Community/Organisation	Phone Number	Signature
1	Jumsa Bawa	Anfani	081870117	
2	Mohammed Umar	Anfani	08537134?7	
3	HamZa Buhari	Anfani	08025739307	
4	kabiru Dagachi	Anfani	081712194481	
5	Kabiru umar	Anfani	08028225687	
6	Aliyu Hamma	Anfani	09081632132	
7	Mai Laka musa	Anfani	0	
8	Samaila S/Pawa	Anfani	08119713313	
9	Umaru mai Shayi	Anfani	08114754049	
10	Zubairu Yusif	Anfani	09058275386	
11	Adam usman	Anfani	07025849907	
12	Lukman Bashar	Anfani	08183478883	
13	Dahiru Aliyu	Anfani	09094994778	
14	Nasiru Ahmadu	Anfani	09052179286	
15	Sunusi Abubakar	Anfani	08128325323	
16	Sani Abubakar	Anfani	08132853208	
17	Umaru Ibrahim	Anfani	08055919155	
18	Kabiru muse	Anfani	08144079287	
19	Abdullahi Hamma	Anfani	08	
20	umaru Wudi	Anfani	08123452179	
21	Awal Shafiu	Anfani	~~0807~~08779?8950	

EIA OF AMFANI INDUSTRIAL PARK SMART CITY PROJECT

STAKEHOLDERS' CONSULTATION ATTENDANCE

Community: Sabon Gari Date: 23-11-2015

SN	Name	Community/Organisation	Phone Number	Signature
1	Umar Gado	Sabon Gari		
2	Ibrahim Saibi	"		
3	Rabi Bubakar	"		
4	Isiaka Gado	"		
5	Aminu Muhammed	"	07068566423	
6	Zakari Muhammed	"		
7	Iliyasu Sani	"		
8	Nasiru Abubakar	"		
9	Yusuf Abubakar	"		
10	Aliyu Sani	"		
11	Ali Gado	"		
12	Gado Hassan	"		
13	Hassan Muhammed	"		
14	Gado Muhammed	"		
15	Isah Sahabi	"		
16	Yaian Saibi	"		
17	Umar Gado	"		
18	Alhassan Muhammed	"		
19	Awal Mohammed	"		
20	Badamasi Mohammed	"		
21	Awal Ibrahim	"		

EIA OF AMFANI INDUSTRIAL PARK SMART CITY PROJECT

STAKEHOLDERS' CONSULTATION ATTENDANCE

Community: Tunga Alhaji Date: 24/11/2019

SN	Name	Community/Organisation	Phone Number	Signature
1	Alhaji Ibrahim	Village head		
2	Muhammed Iri			
3	Abubakar Awarch			
4	Abubakar Muhammed			
5	Usman Salihu			
6	Umar Mohammed			
7	Garba Dambuka			
8	Garba Osi			
9	Ali Abbas			
10	Musa Kunku			
11	Mallam Dan Umaru			

EIA OF AMFANI INDUSTRIAL PARK SMART CITY PROJECT

STAKEHOLDERS' CONSULTATION ATTENDANCE

Community.. Date....23-11-2019..............................

SN	Name	Community/Organisation	Phone Number	Signature
22	Aliyu Musa	Sabon Gari		
23	Musa Abubakar	"		
24	Koreh Usman	~~08159256271~~	08159256271	

APPEDIX 3: ATTENDANCE LIST FOR SCOPING WORKSHOP

APPENDIX 4: ATTENDANCE LIST FOR EIA SITE VERIFICATION EXERCISE

APPENDIX 5: CHANCE FIND PROCEDURE

APPENDIX 6: LETTER OF INTRODUCTION TO HON. COMMISSIONER,

MINISTRY OF ENVIRONMENT, NIGER STATE

APPENDIX 7: INTRODUCTION LETTER TO THE CHIARMAN, MAGAMA LGA, NIGER STATE

APPENDIX 8: LETTER OF INTRODUCTION TO HIS ROYAL HIGHNESS, EMIR OF KONTANGORA, NIGER STATE

APPENDIX 9: MINUTES OF CONSULTATION MEETINGS WITH THE AFFECTED COMMUNITIES

Minute of Meeting held in Amfani

The meeting started at 2.30pm with an opening prayer from the community's secretary and was held at the residence of the village head on the 23rd November 2019. The meeting was a rallying point for all major community's stakeholders that needed to be consulted for the EIA of the proposed project in the area.

Introduction

The Socioeconomic team leader presented the crux of the meeting followed by the introduction of EIA team present and self-introduction by stakeholders also present.

The essence of the visit of the team which was to conduct the EIA for the proposed Complex in their domain and also to assess their socioeconomic status was presented to the stakeholders by the consulting team.

The socioeconomic team head commended the project host community for their peaceful disposition and also agreeing to meet with the EIA within a short notice. The consultant also employs the project host community to be open to the consulting team as their opinions, expectations and concerns will form a core part of the report.

The Consultant also stated that the EIA report is an important document that will describe the baseline information of the project host community, impacts, mitigations and environmental management plan of the proposed project. The consultant went further to opine the EIA permit is one of the documents needed to proceed with the proposed project and appeal for full support from the project host community.

He specifically stated that the team is in the community to hear from, learn and deliberate with the community in other to elicit useful information that will be mainstreamed into the project planning, operation and decommissioning.

Following this explanations, the consultant enjoined the people to ask questions and make contributions as much as possible.

Responding, Alhaji Tumba Bawa expressed delight at the visit and pray that the visit will translate to an improve social infrastructure in the area. He decried what he describes at the neglect of the area by the Federal Government and Niger State and plead that proponent will give them priority as the play a vital role in the provision of land required for the infrastructure.

The community leaders and stakeholders also cautions the proponent in handling of social and legacy issues in other to avert crises that may affect project sustainability; and this according to them underscores the need for social profiling of the community.

CONCERNS AND EXPECTATIONS

The people expressed fear over what the term neglect from Federal Government and Niger State Government and hope the coming of Free Trade Zone in the area will attract more government presence and development. The also listed the following as their expectations;

- Provision of necessary social infrastructure/amenities like pipe borne water, access road etc.
- Employment opportunities should be provided for indigenes in the proposed project as both junior and management staff in accordance with standardized procedures.
- The women of the area should be majorly recognized by the project proponent in the form of provision of soft loan and grant and setting up of a craft centre in the area.
- Provision of modern and more equipped hospital in the area

- Provision of standard and well equipped secondary school for community's residents

The community leaders also raise fears concerning impacts of the proposed project ranging environmental to social. Some of the fears raised are;

i. Erosion as a result of construction
ii. Destruction of livelihood and economic trees
iii. Rise in crime rate and outbreak of health issues as a result of camp workers etc

Responding the consultant assured the people that one of the aim of the EIA was to address all the potential impacts of the proposed project and that the people have no need to fear.

The community leaders also took turn to pledge their support to the project and the project proponent.

The meeting ended around 4.01pm with a closing prayer from Awal Shapiu.

Minute of Consultation Meeting at Sabon Gari

Venue of the Meeting:	Village Head Residence
Date:	23rd November 2019
Language of Communication:	English/Hausa
Time:	10 am
Number of people in attendance:	23

The meeting started around 10am at the residence of the Village head. The consultation had in attendance representatives of Tunga Alhaji and other neighbouring villages. The village head welcomed the Socioeconomic team to his residence and prayed that whatever good they brought with them to Sabon Gari community will follow them back in double fold. He asked the team to introduce themselves and also inform the stakeholders their mission in Sabon Gari.

Responding, The Socioeconomic team head thanked the village head for the warm reception and accepting to have the meeting despite short notice. He then introduced the accessing team with him and intimated the village head that the team is in the area to consult with them and also assesses the socioeconomic status of the people in order to make far reaching decision that will impact positively on the lives of the people and most importantly officially inform the community of the proposed free trade zone in the area.

Speaking further the village head registered his happiness with the project proponent on the way and manner the relocation exercise was done and the social infrastructure so far delivered to the people of his domain. He equally pleaded with the proponent to consider extending same gestures to other nearby villages. He went further to express his ready to continue to support the project proponent.

The Team lead went on to intimate the stakeholders present that the EIA report is an important document that will describe the baseline information of the project host community, impacts, mitigations and environmental management plan of the proposed project. The Socioeconomic team lead opine that the EIA permit is one of the documents needed to proceed with the proposed project and appeal for full support from the project host communities.

He specifically stated that the team is in the community to hear from, learn and deliberate with the community in other to elicit useful information that will be mainstreamed into the project planning, operation and decommissioning. Following this explanations, the consultant enjoined the people to ask questions and make contributions as much as possible. He went further to ask few questions from the FGD guide which the people collectively answered.

CONCERNS AND EXPECTATIONS

The community stakeholders present took turn to reassure the project proponent of their readiness to support the project in whatever way possible and listed the following as their expectations from Federal Government, and the proponent;

- Provision of necessary social infrastructure/amenities like access road etc.
- Employment opportunities should be provided for indigenes in the proposed project as both junior and management staff in accordance with standardized procedures.

The community leaders promised to accord the project proponent the necessary support. The consultation meeting ended around 1pm with a closing prayer from Aliyu Musa

Community Consultation in Gungawa

The meeting commenced at 10am with an opening prayer from the village head and was held at the palace of the village head on the 24th November 2019. The meeting offered Gungawa traditional leadership an opportunity to interact with the Socioeconomics consultants and also an opportunity for the consultants to receive first-hand information as regards the base line socioeconomic activities, health and potential impacts of the proposed project.

The Socioeconomic team leader thereafter introduced the Socioeconomic team. Responding the village head, also introduced the council members with him and thank the consulting team for deeming fit to consult with the traditional institution in the area. This he maintained will bring blessings to the project and the proponent.

Communities' perceptions/concern

On their perceptions and concern about the proposed infrastructure in the area, the village head said the people have no fear and believed that the coming of the facility will usher in a new era of physical and social development in the area. He alleged that the community have suffered neglect in the past from government at all levels.

Communities' Expectations

On the expectations of the community from government and the proponent, He took time to list the following as the expectations of the people of the area;

- Provision of necessary social infrastructure/amenities like good drinking water, access road, General hospital etc.
- Employment opportunities for the indigenes, construction of Schools and road network

He also took time to explain to the team, the traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems and community efforts at solving them and development prospects of the area.

The consulting team lead by Robert Martins thanked the village head and promised that the issues raised will be documented in the EIA report. The meeting ended around 4.00pm with a closing prayer from Baba Alhassan.