ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

OF

THE AKAMKPA QUARRY PROJECT

AKAMKPA QUARRY LIMITED
NO 249, MURI OKUNOLA, VICTORIA ISLAND,
LAGOS, LAGOS STATE

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LIST OF ABBREVIATION AND ACRONYMS

A.C. I	American Concrete Institute
AISC	American Institute of Steel Construction
ALARP	As Low As Reasonably Possible
A.S.T.M	American society for testing and material
APHA	American Public Health Association
ARV	Anti-retroviral drugs
AQL	Akamkpa Quarry Limited
BAT	Best Available
Technology BOD	Biochemical Oxygen
Demand cfu/g	Colony forming unit per
gram cfu/ml	Colony forming unit per
millitre cm	Centimeter
C	Carbon
Ca	Calcium
CDC	Community Development Committee
CEC	Cation Exchange Capacity
Cl^-	Chloride
Cu	Copper
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CRMoW	Cross River Ministry of Works
Db	Decibel
E	East
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency in USA
FEPA	Federal Environmental Protection Agency
FRSC	Federal Road Safety Corps

FMEnv	Federal Ministry of Environment
GC	Gas Chromatograph
GPS	Global Positioning System
Ha	Hectare
HAZOP	Hazard and Operability
HEMP	Hazards and effects Management Process
HNO_3	Trioxonitrate (V) acid
HP	High Pressure
HSE	Health, Safety and Environment
HUB	Hydrocarbon Utilizing Bacteria
HUF	Hydrocarbon Utilizing Fungi
H_2SO_4	Tetraoxosulpate (VI) acid
Km	Kilometers
Max	Maximum
Min.	Minimum
m	Metres
mg/kg	milligram per
kilogram mg/l	milligram per litre
ml	millilitre
mm	millimeter
ms^{-1}	metres per second
N	North
NE	North East
NGOs	Non-Governmental Organizations
NMT	Non-Motorise Transport
NOx	Nitrogen Oxides North West
^{O}C	Degree Celsius
PAH	Poly Aromatic Hydrocarbon
PC	Personal Computer
PU	Per Unit

Ph	Hydrogen ion Concentration
PGM	PGM Nigeria Limited
ppm	Parts per Million
ppt	Parts Per Thousand
QC/QA	Quality Control /Quality Assurance
RE	Resident Engineer
ROW	Right of Way
S	South
SE	South East
Spp.	Species
SPM	Suspended Particulate Matter
SSW	South West
STDs	Sexually Transmitted Diseases
STIs	Sexually Transmitted Infections
SW	South West
TFC	Total Fungal Count
TDS	Total Dissolved Solid
THB	Total Heterotrophic Bacterial Count
THC	Total Hydrocarbon Content
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
VOC	Volatile Organic Carbon
W	West
WHO	World Health Organization
%	Percentage
<	Less than

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EXECUTIVE SUMMARY

ES 1.0 General

This report presents the Environmental Impact Assessment (EIA) for the Akamkpa Quarry Plant proposed by Akamkpa Quarry Limited. The proposed Akamkpa quarry project comprises of two site Quarry I and II that are two kilometres apart land with land take of 80 and 40 hectares respectively, located in Obung Community of Akamkpa Local Government area of Cross Rivers State. The EIA of the proposed project was conducted in accordance with the statutory requirements for environmental management in Nigeria. These include the EIA Act No. 86 of 1992, the Federal Ministry of Environment (FMEnv) Procedural Guidelines for Industries. The Health, Safety and Environment (HSE) Policy of the Akamkpa Quarry Limited also form the basis for the EIA. The main objective of this project is to extract mineral materials and these will be done by drilling and blasting of the body of rocks into smaller units of specific sizes. These units are then loaded /conveyed to another location for crushing. This activity will be followed by transportation of the crushed materials to the project site.

ES 1.2 Objectives of the EIA

The objectives of the EIA for the proposed project are to:

- Provide information on the current ecology (ambient air quality, soil, fauna, flora, microorganisms, biological diversity, surface water, groundwater, geology, hydrogeology) of the environment within which the Quarry industry is to be located.
- Determine the impacts of the project on the environment including impact on socio-economic and socio-cultural activities of the community.
- Examine the health situation of the human population around the project site
- Examine and assess the significant potential and associated impacts of all activities and auxilliary facilities in all phases of the project(mobilisation, site preparation, construction, operation, abandonment) on the natural, social and health environments.
- Provide recommendations for the mitigation of identified adverse impacts and enhance beneficial impacts of the project.

- Develop an Environmental Management Plan for the implementation of the mitigation measures and an Environmental Monitoring Plan for monitoring the efficiency of the mitigation measures.

ES1.3 Project Location

The proposed Akamkpa Quarry project comprises of two site Quarry I and II located in Obung Community of Akamkpa Local Government area of Cross Rivers State. The geographical coordinates of Quarry I are 5°20"30''N and 8°24'00"E, while that of Quarry II are 5°20"45''N and 8°24'45"E (Figures 1.1 and 1.2). The land take are 80 and 40 hectares respectively for Quarry I and II.

ES 2.1 Need for the Project

Akamkpa Quarry Limited intention is to participate efficiently in the conversion of rocks into usable material by the society, by converting these heavy rocks into usable materials like sand, gravel, granite and other product which would be used for construction and erecting of structures. This will in turn help in converting our natural resources into something that can be useful to man.

ES 2.2 Significances of the Project

On operation, the benefits of the Incinerator are numerous and cannot be over-emphasized. Some of the benefits of the project include:

- Conversion of natural resources into material usable by man.
- Production of sand, stones, gravel, granites and other related products.
- Provision of employment opportunities for many skilled and unskilled Nigerians, especially those from the host communities.
- Enhancement of the provision of basic social amenities to the host communities.
- Poverty alleviation through increased derivation fund to local and state governments.
- Promotion of good relationship between Akamkpa Quarry Limited and the host community through increased socio-economic assistance.

ES 2.3 Project Development Options

During the Project planning phase which was a major component of the EIA process three project development options were considered

Option 1 (Do Nothing or No Development Option)

This amounts to cancellation of the construction of the proposed quarry project. In this case no impact associated with the project will occur. The disadvantages of adoption this option include;

- The rock deposits will not be mined and thus its economic value cannot be assessed and utilized profitably
- Loss of revenue paid to the Government to obtain the mining license lease and other logistic expenses
- The risk of forfeiting the right over the mine fields after the stipulated years of non-development
- Loss of revenue to the Local, State and Federal Government and the host community
- Loss of job opportunities that the project execution would have afforded some indigenous inhabitants of Akamkpa
- Loss of commercial and economic benefits to Akamkpa Local Government Area

This option was rejected

Option2: Delayed Option

This means the manifest and associated benefits of the project will be delayed, so this option was also rejected.

Option 3

This option involves going ahead to implement the project. This will make the Government and Akamkpa Quarry Limited (AQL) achieve their goal of harnessing the rock deposits thus contributing to the national economy and the revenue profile of the company. The option would also be beneficial

to members of the project host community, Cross Rivers State and Nigeria in general. This was the reccommended option in view of its importance in providing rock aggregates for different aspects of construction and building industry in the Nigerian economy. This option was accepted.

ES 2.4 Project Scope

The scope for the proposed Quarry Plant include;

- Extraction of rock from the earth through the application of explosives.
- Breaking or disintegrated rock fragments
- Conveying of materials by the dump truck to the crushing machine
- Screening and dropping of standard graded sizes that are the end products of the processing stage

ES 3.0 Legal and Regulatory Framework

The EIA of the proposed project was conducted in accordance with the National, international, Cross Rivers State legal and Regulatory framework for environmental management and Akampa Quarry Limited, HSE Policy. These include the EIA Act No. 86 of (1992), the Federal Ministry of Environment (FMEnv). Other regulatory requirements include The National Effluent Limitation Regulation, S.I.8 of (1991), Pollution Abatement in Industries, Industries Generating Wastes Regulation, (1991, (No. 42, Vol. 78, August, (1991), The management of hazardous and solid waste regulation, S.I.15 of (1991) (No. 102, Vol. 78, August, (1991), Environmental Impact Assessment Act Act No. 86 of 1992, The Land Use Act of 1978, Federal Land Use Act(CAP 202LFN) (2004) The Nigerian Criminal Code Act (Chapter 77) laws of the Federation of Nigeria 1990, National Effluent Limitation Regulation, FEPA/FMEnv, S.1..8 (1991), National Pollution Abatement in Industries and Facilities Generating Wastes Regulation, FEPA/FMEnv S.1.9(1991), National Environmental Protection (Management of Solid and Hazardous Waste) Regulation, FEPA/FMEnv S.1.15(1991), National Environmental Standards and Regulation Enforcement Agency (NESREA) Act (2007), Ministry of Mines and Steel Policies on Environmental Mining and Minerals Act 2011, The Labour Act (1990), The Nigerian Urban and Regional Planning Act (1992), Public Health Law – CAP 103 of the Laws of Eastern Nigeria (1963), Cross Rivers State Environmental Protection Agency Law, Cross Rivers State Private Health and Allied Establishments Authority Law, Cross Rivers State Public

Health Law, Cross Rivers State Public Health Law, Cross Rivers State Noise Pollution Control Law. World Bank Guidelines on Environmental Assessment {EA} (1991), Paris (France) Good Practice for Environmental Impact Assessment of development Projects 1991, World Heritage Convention 1978, Convention on International Trade in Endangered Species of Wild Fauna and Flora 1975, Vienna Convention for the Protection of the Ozone Layer 1985, Protocol on Substances that deplete the Ozone layer (1987), United Nations Guiding Principles on the Human Environment (1972), Rio Declaration on Environment and Development 1992, UN Convention on Biological Diversity (1994), Convention Concerning the Protection of the World Cultural and Natural Heritage Sites (or World Heritage Convention)1972, United Nations Framework Convention on Climate Change (1992), Endangered Species (Control of International Trade and Traffic) Act 11 of (1985), African Convention on the Conservation of nature and Natural Resources 1968, Jakarta Mandate on Biodiversity1995, Basel Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and Their Disposal 1989, Montreal, Canada- Cartagena Protocol on Biosafety Convention on Biological Diversity 2000, Paris (France) UNESCO Convention (1972), Stockholm (Sweden) Declaration on Human Environment 1972, Bonn Convention on Conservation of Endangered Species 1979, Bern, Switzerland Convention of Protection of Workers against Occupational Hazards 1979, International labour Organisation(ILO) Convention on Indigenous and Tribal People in Independent Countries (1989), Protocol on Cooperation in Combating Pollution 1981, The Solid Waste Management Act of (1976),

ES 4.0. Study Approach

The fieldwork, which was witnessed by representative of the FMEnv took place on 5th July, 2019 during the wet season. A one season sampling was approved by the Federal Ministry of Environment (FMEnv). Sampling covered the proposed Quarry Plant Facility site and the adjoining areas, so as to have comprehensive data of the environmental characteristics of the area. The environmental components sampled include soil, sediment, biodiversity, ground water, air, noise and meteorology. Socioeconomic and Health Impact study was conducted around the proposed facility area. On the whole, sampling was accomplished in 12 soil sampling points, 2 ground water sampling points with 1 control, 2 surface water sampling points with one control, 2 sediment sampling points with 1 control

and 12 air quality, meteorology/noise sampling points with 1 control. The samples were preserved prior to physical, chemical and biological characteristics analyses. The sampling points and their geographic co-ordinates as well as the sampling procedures/methodology and equipment are presented in the appendix

ES 4.1 Description of the Environment

ES 4.2 Air Quality

All the air quality indices studied were within regulatory limits. The concentrations of NO_2 ranged between 0.010-0.094ppm with a mean of 0.04ppm. The concentrations of SO_2 ranged between 0.01–0.04 ppm mean of 0. 01ppm.Volatile organic carbon (VOC) ranged between 1.06-5 ppm with a mean of 2.33 ppm. Carbon dioxide ranged between 515 - 721 ppm with a mean of 591.18ppm. Carbon monoxide was not detected in all the sampling points monitored. The mean concentrations of suspended particulate matter (SPM) measured in all the sampling points ranged between 19.0 – 24.6 µg/m^3 with a mean of 20.64µg/m^3

ES 4.2.1 Noise

In all the sampling points, noise levels measured were below the tolerable limit or noise level zone that could cause annoyance and they were within the values of 90dBA stipulated by the FMEnv and WHO.

ES 4.3.1 Surface Water Physico Chemistry

The pH of the surface water samples ranged from moderately acidic to slightly acidic. The pH ranged from 5.62 – 6.10 with a mean of 5.62. The pH of the control station was slightly acidic (6.63). The values for total dissolved solid (TDS) ranged from 12.0 – 190 mg/l and the mean TDS, 15.5mg/L. The TDS for the control station was 73.0 mg/l.

The salinity of the surface water was low (0.01ppt) indicating a freshwater aquatic system. The salinity of the control station was 0.01ppt. Electrical Conductivity of the study area ranged from 19.0 – 30.0µS/cm while that of the control station was 121. 0 µS/cm. The control station had a higher ionic concentration than the study area.

The calcium (0.412-10.6mg/l) and Mg (0.157 - 2.58mg/l) concentrations in the study area were lower than in the control stations. The concentrations of zinc and copper in the surface water were low and similar to that of the control station. The concentration of Iron was low and ranged from 1.61 – 2.01mg/l. This was similar to that of the control which was1.42mg/l. High concentrations of Total Petroleum Hydrocarbons (315-700mg/l) and the absence of oil and grease (<0.01mg/l) in the study area were observed. Higher concentrations of TPH were observed in the control stations (1,217mg/l) than in the study area suggesting hydrocarbon contamination in the study area and pollution in the control station. The sources of hydrocarbons in the surface water may result from in- puts from watercrafts such as flying boats or deliberate discharge of hydrocarbons.

ES 4.3.2 Surface Water Microbiology

The microbial populations were normal for freshwater aquatic systems. The heterotrophic bacterial populations represented the highest microbial group of organisms in the water samples. The percentage hydrocarbon utilising bacterial and fungal populations were low suggesting low levels of exposure of resident microbial populations to hydrocarbons. This was at variance with TPH levels observed in the surface water. These results suggest that the hydrocarbon contamination/pollution may be temporal and may result from inputs from the watercraft used for sampling or the infrequent discharge of hydrocarbon containing materials into the aquatic system hence low percentage HUB and HUF of water samples in both control and study area. The study samples supported higher microbial counts compared to the control samples indicating that microorganisms at the study stations were exposed to more nutrients in these areas than the control station.

ES 4.4.1 Sediment Physico- Chemistry

The sediment within the study stations was slightly acidic with a pH, ranging from 6.14 – 7.31 and a mean value of 6.42. The pH of the control station was neutral (7.31). The concentration of Na was lower in the study stations when compared with the control station. The concentrations of other exchangeable cations in the study station were similar with that of the control. These results suggest

that the control station showed tidal influences due to closer location to the ocean. The sulphate concentrations of the control station were higher than that of the study stations. Phosphate and nitrate concentrations of the study area were similar to that of the control stations The copper, chromium and lead values of the sediments was less than the equipment detection limit except for one sediment which had lead values of 1.79mg/kg. The concentrations of Fe and Pb were higher in the study stations than in the control station while Zn recorded higher concentration in the control than in the study stations. The values of other heavy metals were similar for both control and study stations. The total petroleum hydrocarbons in the sediment in the study area were slightly high compared with the control station. The values ranged from 314 - 351mg/kg with a mean value of 489.5 mg/kg, while the oil and grease values for the sediment in both the study area and control was <0.01mg/kg.

ES 4.4.2 Sediment Microbiology

The heterotrophic bacterial and fungal populations in the study station were similar to that of the control station. The percentage (%) hydrocarbon utilising bacterial and fungal populations of both the study area and the control station were high and suggestive of exposure of resident microbial populations to hydrocarbons. These results support the high TPH concentrations obtained in the sediment. The fungal populations were very low suggesting unsuitable environmental conditions for the growth of fungi in both study area and control.

ES 4.5.1 Soil Physico-Chemistry

The soils of the study area varied from moderately acidic to slightly acidic with a mean pH for top soil (0-15cm) of 6.24 and 6.25 for subsoil (15-30cm). The soil pH in this area was good for agriculture activity

There was no difference between the temperature of the top soil (24 ^{o}C) and that of the bottom soil (24^{o}C). Nitrogen is one of the essential elements necessary for plant growth, especially vigour and is listed among the fertilizer key elements in soils of Nigeria. In the study area mean values 213mg/kg and 137.6mg/kg were recorded in the top and bottom soils of the study area. There was decrease in total Nitrogen with depth.

Total phosphorus was very low in both soils and far below the critical limit of 15 mg/kg especially in the study area; mean values recorded were 0.672 mg/kg in top soil and 0.673 for bottom soil in the

study area. Mean chloride concentrations of 43.6.0 and 43.3 mg/kg were recorded in the top and sub soil of the study area. The chloride level in the soil was suitable for plant growth.

Magnesium values ranged from 264mg/kg to 2016 mg/kg. The exchangeable bases decreased slightly with increasing depth in both the study area. The relatively higher levels of iron, magnesium and Calcium are not necessarily due to pollution, but rather as a result of the genesis of soil formation. High concentrations of Fe were recorded in both top and sub soils of the study area. Spatial variations were observed in some locations. In some stations there was an increase in concentration of Fe with depth while in some others there was a decrease.in concentration. The spatial variation is probably due to differences in moisture content, clay content, cation exchange capacity, organic matter content and pH of the different sites. The concentrations of the micronutrients/heavy metals (Zn, Cu, Cr, Cd, Mn, V and Ni) were within the permissible limits in the soil. The soils were free from heavy metals contamination. Total Petroleum Hydrocarbon (TPH) of the soil in the study area was high (107 to 398 mg/kg). In some locations top soil concentrations were higher than subsoil concentrations in some locations the converse was the case. The study revealed that the soils had been contaminated with hydrocarbons of mineral oil origin. Oil and grease contents were very high (289 to 632 mg/kg).

ES 4.5.2 Soil Microbiology

The Total Heterotrophic Bacterial population presented the microbial group with the highest population when compared with fungi. The vertical variation with depth of the microbial population was not evident. The Total Heterotrophic Bacterial population was low compared to soils within the Niger delta. The microbial population showed levels of stress probably due to high levels of hydrocarbons within the soil. Soil TPH levels were high indicating hydrocarbon contamination/pollution of the soils within the study area. The % HUB (1.0 to 71.4%) was high suggesting long term exposure of resident heterotrophic bacterial populations to hydrocarbons of mineral oil origin.

ES 4.6.1 Geology

The study area is underlain by sedimentary formations of Late Tertiary and Holocene ages. Deposits of recent alluvium and beach ridge sands occur along the coast and the estuaries of the rivers, and also along the flood plains of creeks. The area is characterized by fresh water, beach ridge sands and mangrove swamps. Erosion was noticed at some areas within the study area. This is attributable to loose soil and lack of vegetation cover in those areas. There are three major lithostratigraphic units defined in the subsurface of the Niger Delta Basin. The Benin Formation (Oligocene-Recent), the Agbada Formation (Eocene-Recent) and the Akata Formation (Paleocene-Pleistocene). The sedimentary thickness within the basin is in excess of 8000m (24000ft). These units are overlain in most parts of the delta by Quaternary deposits comprising four (4) geomorphologic units. These are (a)The Deltaic Plain Belt (b)The Freshwater Swamps and Meander Belts(c)The Saltwater Mangrove Swamp Belt (d) Coastal Islands and Beach Ridges.

ES 4.6.2 Hydrogeology

The study area is characterized by freshwater mangrove swamp. Fresh water aquifers within the deltaic terrain are much deeper, usually in excess of the estimated total thickness of the alluvial deposits. The likelihood of saline intrusion to near surface aquifers is a function of the distance of the site to the shoreline but more especially, in addition, areas affected by tidal influence between the direct contacts relationships of the near-surface aquifers to surface flows. This poses a saline pollution effect on this group of aquifer systems and is the case with the aquifers near the sea in the study area.

ES 4.7.1 Groundwater Physico- Chemistry

The ground water samples were acidic in nature. The pH values of the samples ranged from 3.61 – 3.99 with a mean of 3.73. The pH exceeded WHO limits for domestic water acceptability. The values for total dissolved solid (TDS) was 54.0 – 241.0 mg/l and the mean TDS, 123.0mg/L. These values were within international regulatory limits (500mg/l) for domestic water acceptability. Salinity values ranged from 0.04 - 0.18ppt with a mean value of 0.09ppt. The salinity values exceeded regulatory limits (0.02ppt) for domestic water acceptability. Electrical Conductivity ranged from 84.0 – 371.0µS/cm with a mean of 188.0µS/cm. These values were within regulatory limits (250 µS/cm) for

domestic water acceptability. Concentrations of calcium (0.992 - 9.00mg/l) and Mg (0.750 – 4.78mg/l) were within regulatory requirement for domestic water acceptability. The concentrations of zinc, Iron and copper in the ground water were generally low, having concentrations below FMEnv limits for surface waters. Concentrations of Ca, Mg, Zn Fe and Cu were all within regulatory limits for domestic water acceptability

ES 4.7.2 Groundwater Microbiology

The results showed that all microbial indices (Total Heterotrophic Bacteria, Total Fungi, Hydrocarbon Utilizing Bacteria and Hydrocarbon Utilizing Fungi did not meet regulatory requirements for domestic water acceptability

ES 4.8 Land use

The proposed Quarry Plant will be sighted in a rural settlement with some existing industrial activities most quarry, within the community and hence most of the lands are left as secondary re-growth vegetation and hence farming is popular around the proposed Quarry Plant area.

ES 4.9.1 Vegetation

There are distinct classes of vegetation prevalent in the study area. These are strand vegetation, and freshwater/rainforests.

The study area lies within the lowland rain forest zone. Over a total of thirty-one (31) well known species were identified in South South Nigeria. However, more species have been recorded in previous studies in the South east region within the lowland rain forest and also in the secondary forest/bush fallow. The commonest plants within the upland rain forest include trees such as *Anthocleista vogelii, Alstonia boonei, Elaeis guineensis, Chrysophyllum albidum, Funtumia elastica, Musanga cercropioides, Baphia sp, Bambusa sp, Psydrax subcordata, and Albizia sp*. Epiphytes found within the forest include; *Diaplazium samattii* and *Asplenium africana.* The dominant plant species encountered in the oil palm and rubber plantations were; *Elaeis guineensis, Hevea brasiliensis, Selaginella sp, Dryopteris sp Hypoestes cancellata, Tecca sp and Lophira procera.*

A variety of plants were found within the secondary forest/bush fallow areas, the commonest ones being *Elaeis guineensis, Alchornea cordiflia, Anthocleista vogelii, Chromolaena odorata, Manniophyton fulvum, Harungana madagascariensis, Ficus exasperata, Rauvolfia vomitoria, Trema orientalis, Aspilia africana and Selaginella sp (Table xxxxx). Rubber trees (Hevea brasiliensis)* occurred in old plantations within this vegetation zone untended but were still being tapped. The vegetation within this secondary forest/bush fallow habitat is at various stages of development. The system of farming is land rotation in this zone with multiple cropping systems. Fast growing, light demanding species were characteristic of the fallow areas. Examples of plants characteristic of this vegetation type include *Musanga cercropioides, Ficus spp. Spondias mombin, Chromolaena odorata, Rauvolfia vomitoria, Baphia nitida, Harungana madagascariensis, Cnestis ferruginnea,* and *Bambusa vulgaris.*

Generally, because most of the selected power plant sites are built up, in some cases, completely paved, vegetation in the immediate vicinity of power plants are mostly scrubs, grasses and food crops in some cases. Usually, these food crops are planted on a subsistence basis in any available portion of land close by. However, in some cases, secondary rain forests occur close to or a little further away from the power plants.

ES 4.9.2 Plant Diseases

The growth of the vegetation in the study area is generally luxuriant and shows no sign of major pathological disorders. The leaf spot disease was observed as the main disease affecting some plants in the area.

ES 4.10.0 Wildlife

The project area contains a rich diversity of wildlife. Although vegetation type affects the distribution of wildlife, such that aquatic species occur at the coastline and close to riverbanks, while woodland species occur in farmlands, secondary forests, etc., the results presented here cover the entire project

area. Wildlife species identified in the include taxa are amphibians, reptiles, birds, and mammals. Similarly, groups of animals identified include small arthropods like crabs and insects

ES 4.11.0 Socioeconomics

The proposed Quarry is located in Obung community in Akamkpa Local Government Area, Cross River State. The Obung community speak Ejagham language. Christianity and traditional religion are the main religion. The major occupation are farming, lumbering, fishing and petty trading. The literacy level is average. Unemployment level is high in the area. The average monthly income in the area is N41, 000 - N60, 000. The wall type of the houses consisted mainly of cement blocks and mud walls that were plastered with cement. The roofing type of the houses consisted mainly of corrugated roofing sheets. The floor types were mainly of cement. Toilet system in the community was mainly water-borne system with a few pit latrines. Most of the houses were occupied by tenants (rented) while a few were occupied by the owners. Lighting source was mainly electricity from Port Harcourt Electricity Company. Liquefied Petroleum Gas was the main source of energy for cooking with a few kerosene stoves. Portable water was mainly from personal boreholes. The public water supply was epileptic. Waste disposal was by burning household garbage. Government clinics were few and most people sought treatment from medicine hawkers and medicine stores.

ES 5.0. Potential and Associated Impacts

There were positive (beneficial) and adverse (negative) significant impacts of the proposed quarry on the ecology, social and health of the people within the area.

The associated and potential significant beneficial impacts included;

- Improvement of the economic status of landlords and traditional rulers through payment of adequate compensation
- Mining and production of chippings of various sizes will contribute to revenue generation contributes to revenue to the government
- Contribute to the general economic growth of the country as it would positively affect directly or indirectly some sectors of our country
- Creation of employment opportunities for both skilled and unskilled labour that will employed at different phases of the project

- Increase in socioeconomic activities in Akamkpa due to the purchase of chippings and other associated activities
- Chippings of various sizes will be made available for construction activities in Cross Rivers State and other South States and Southeastern States.
- There will be transfer of technical knowledge in mining industry to Quarry workers
- The associated and potential significant negative impacts of the proposed project included but not limited to the following;
- Increase in the ambient noise level in the area above baseline values due to noise generated from during drilling of holes
- Vegetation cover removal leads to destruction of natural habitat of the soil flora and fauna and migration of wild life
- Security problems due to community interference and conflicts
- Injury to personnel (surveyors) due to exposure to wild bushes and animals
- Injury / death / assets damage due to accidents during dumping of materials from point of generation to the feed hopper.
- Increased traffic volume/delays due to daily movement of work trucks and personnel to site
- Negative effects on air quality due to emission of atmospheric pollutants (CO_X, NO_X, etc.) from internal combustion engines/exhausts during personnel movement
- Changes in drainage and hydrological patterns which may result in erosion and flooding in the area
- Soil compaction due to heavy vehicle movement, excavated material will affect diversity of soil fauna within the area, alteration of drainage pattern
- Increase in population leading to transmission of infectious diseases especially sexual transmission infections
- Pollution of soil and groundwater sources around the facility

ES 6.0 Mitigation of Potential and Associated Impacts

Appropriate mitigation measures have been proposed to reduce these potential and associated impacts to as low as reasonable Practicable (ALARP).

ES 7.0 Environmental Management Plan

Environmental Management and Monitoring plans were developed to ensure that the adverse (negative) environmental impacts already identified in this impact assessment are effectively remediated and continuously monitored. The plans included: Action Party, Timing of mitigation, Parameters to be Monitored, Responsible party, and Monitoring Frequency and Cost implications of the plans.

ES 8.0 Conclusion

The study revealed that the air quality indices were within regulatory limits. The noise levels were below the tolerable limit or noise (90dBA). The pH of the surface water and soil was acidic though the surface water was more acidic. The surface water showed characteristics of a freshwater habitat. The TPH of the soil, surface water and sediment was high. The heterotrophic microbial count of the surface water and sediment was normal. The Total Heterotrophic bacterial count represented the most predominant microbial group in soil, surface water and sediment. The groundwater did not meet regulatory requirements for domestic water acceptability. The biodiversity (microflora, macroflora microfauna and macrofauna life) was high. The vegetation was generally luxuriant and showed no sign of major pathological disorders. Wildlife species identified in the include taxa are amphibians, reptiles, birds, and mammals. The adherence to the EMP will ensure a reduced negative impact of the Quarry activities in this area.

CHAPTER ONE
INTRODUCTION

1.1 The proponent

Akamkpa Quarry Limited (AQL), hereby described as the proponent acquired two locations for the proposed quarry operation and production. These locations were abandoned quarry plant sites 2km apart and previously operated by China Civil Engineering Construction Company and Impresite Bakalori respectively. AQL business focus is to become one of the leading quarry companies in Nigeria within a very short time through effective management of manpower, technology and Resources. The mission is to engage in these activities profitably and responsibly for the benefit of all stakeholders within the best class Health, Safety and Environmental practices in the industry.

This report presents the Environmental Impact Assessment (EIA) for the proposed Akamkpa Quarry. The EIA of the proposed project was conducted in accordance with the statutory requirements for environmental management in Nigeria. These include the EIA Act No. 86 of 1992, the Federal Ministry of Environment (FMENV) Procedural Guidelines for industries.

1.2 Proponent's Intent

In conceptualizing the facility development of the quarry, AQL took cognizance of the rich and availability of mineral materials in the proposed project location with the good connectivity and close proximity to existing infrastructure. Putting this factors into consideration, AQL intends to mine the mineral material in large quantity to a point where it will become a major player in the quarry and construction business.

AQL have plan to design the facility infrastructure to optimum sizing, engineered to the specific application of the Quarry project and profile, with proven standard equipment, cost effective and easy to operate.

1.3 Project Location

The proposed Akamkpa Quarry project comprises of two site Quarry I and II located in Obung Community of Akamkpa Local Government area of Cross Rivers State. The geographical coordinates of Quarry I is 5°20"30''N and 8°24'00"E., while that of Quarry II is 5°20"45''N and 8°24'45"E (Figures 1.1 and 1.2). The land take are 80 and 40 hectares respectively for Quarry I and II.

1.4 Objectives of the EIA

The specific objectives of the study are to:

i. Determine the baseline environmental, social and health conditions of the project area;
ii. Assess the potential environmental, social and health impacts of the proposed project on the biophysical, social and health components of the environment;
iii. Determine and document the sources of impact from the project activities around the proposed site and identify the environmental, social and health components, which are critical to the impacts;
iv. Proffer appropriate mitigation measures for negative impacts and make recommendations to sustain beneficial impacts of the projects on the environment;
v. Develop cost effective Environmental Management Plan (EMP)
vi. Provide recommendations for monitoring and management activities;

1.5 Scope of the EIA

The general scope for the Environmental Impact Assessment is to identify and evaluate the baseline environmental, social and health conditions of the project on the immediate and impact zone of these proposed facilities, particularly around the proposed Akamkpa Quarry Plant. The scope will basically outline the techniques and methodology to be used in generating data including the description of the data sources. The proposed study work scope includes the following:

- Review of national and international environmental regulations, standards, codes and convention relevant to the proposed project activities.
- Review of existing literature on the study area, including study reports (EIA, EER, PIA, etc.) in order to characterise the baseline conditions
- Comprehensive field sampling/testing at the proposed project area.
- Consultation with all stakeholders and regulatory agencies.
- Assessment and Prediction of Potential Impacts
- Determination of and development of cost effective and Appropriate mitigation/ameliorative measures, monitoring programmes and Environmental Management Plan covering the project life cycle.
- Environmental Management Plan

- Preparation of draft and final EIA reports that meet regulatory requirements

Figure 1.1: Political Map of Nigeria Showing Cross Rivers State

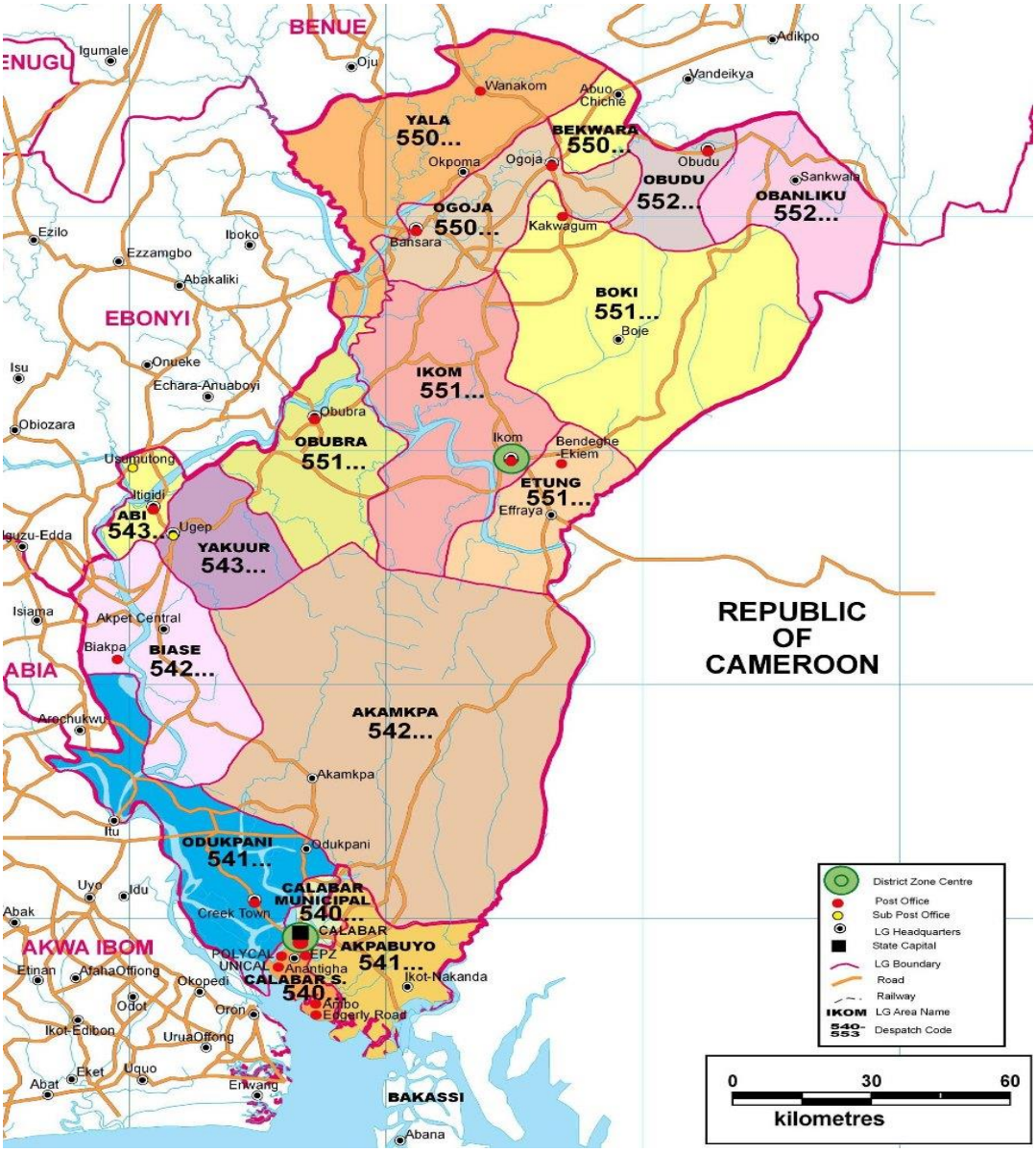

Figure 1.2: Map of Cross Rivers State with Arrow Pointing to Akamkpa LGA the Project Location

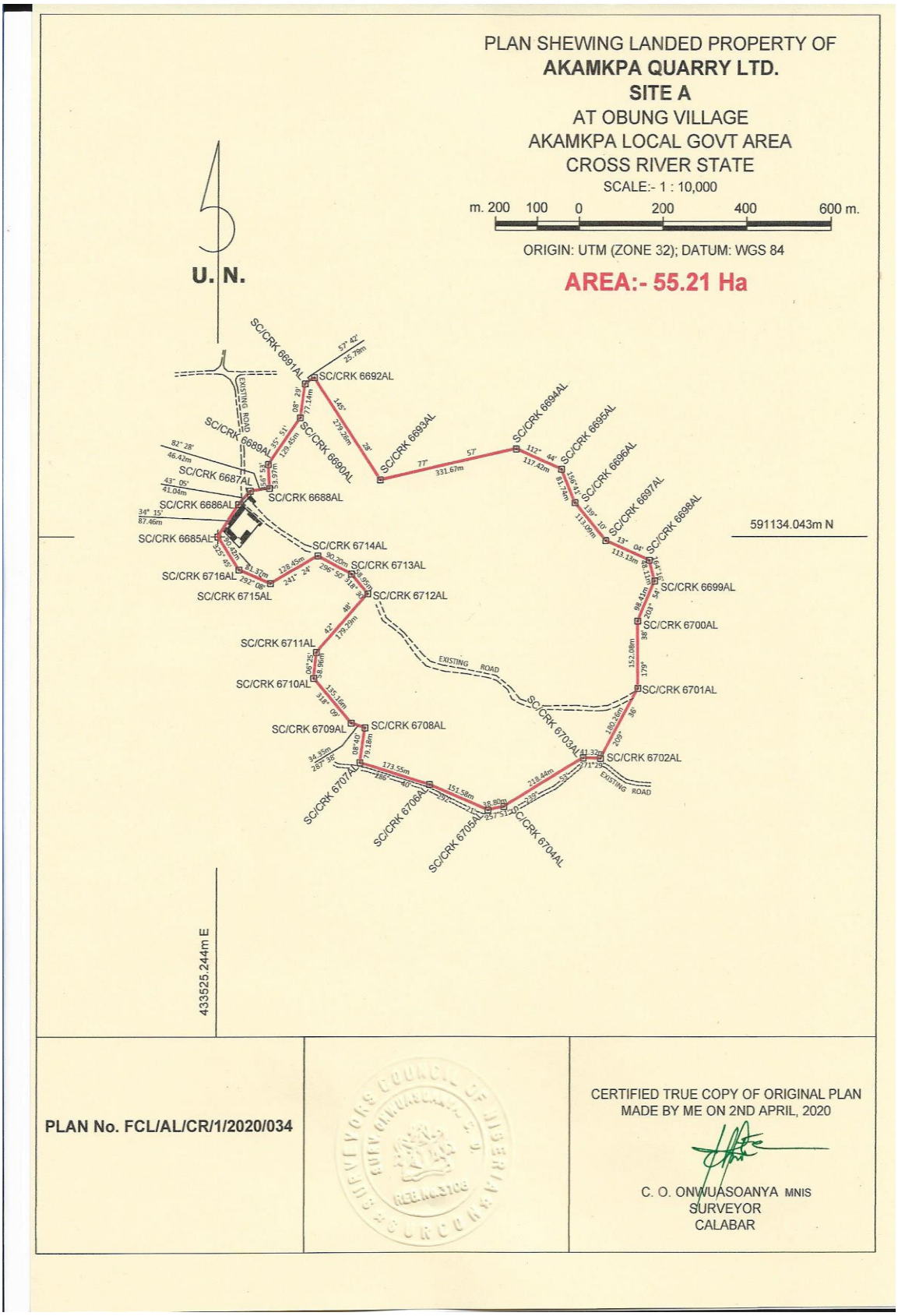

Figure 1.3: Location Map of Quarry Site I

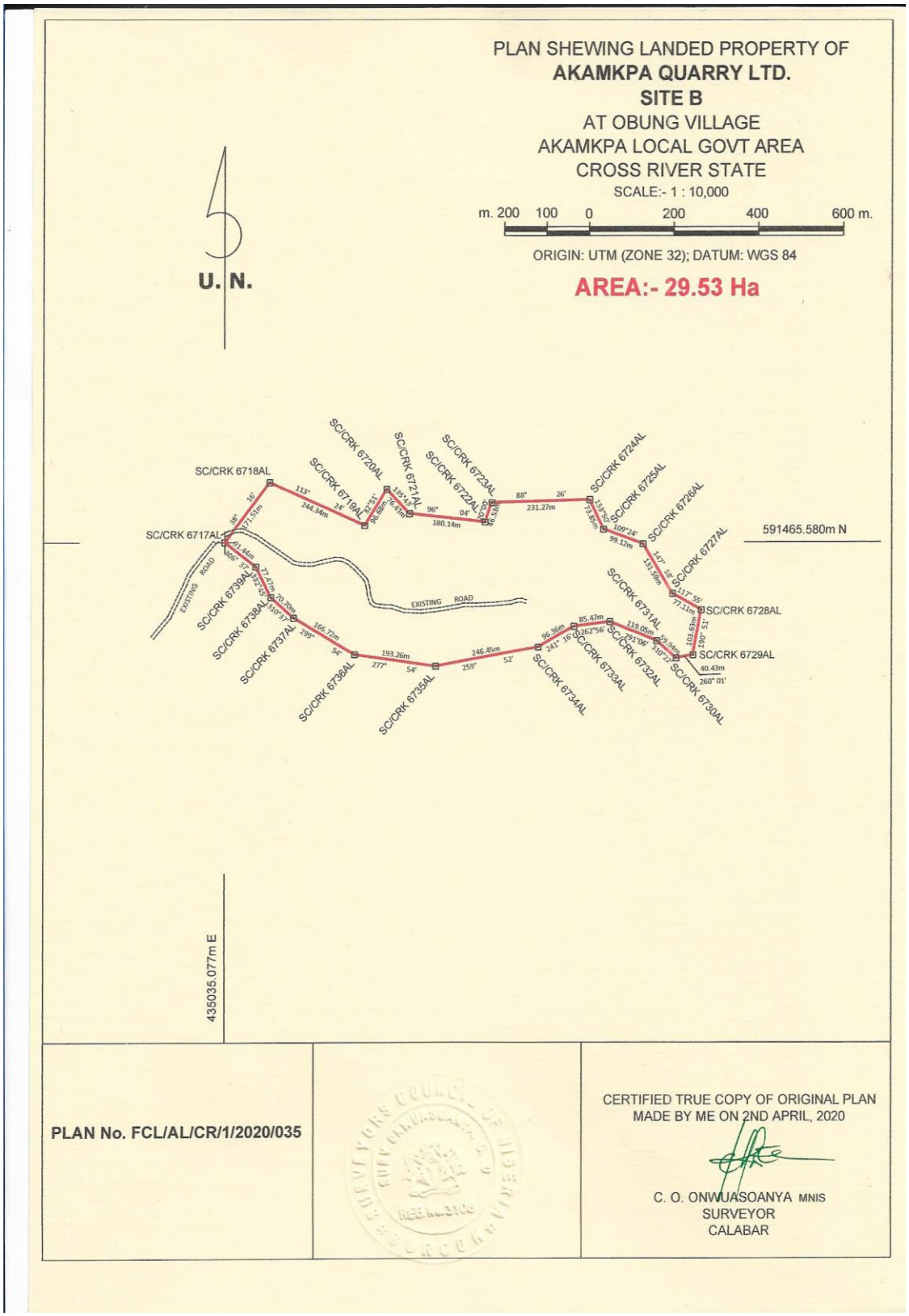

Figure 1.4: Location Map of Quarry Site II

1.6 Legislative and Regulatory Framework

The legal and regulatory frame work for the execution of the Environmental Impact Assessment (EIA) of the proposed facilities shall be based on the regulations, Guidelines, and standards as provided by the Federal Government, State Governments and International Authorities or Conventions.

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1.6.1The Federal Ministry of Environment and other Relevant Regulations

The Federal Environmental Protection Agency (FEPA) [presently subsumed into the Federal Ministry of Environment (FMEnv)] was inaugurated in 1988 by Act 58 of 1988 and subsequently amended through Act 59 of 1992. The body is charged/empowered with the overall responsibility of environmental matters in Nigeria. It has developed instruments of intervention to halt environmental degradation in form of policies, standard, guidelines and regulations and programmes. With the initiation of these instruments, enforcement by FMEnv has become the most effective tool to bring industries and regulated community into compliance through compliance promotions. The relevant policies, guidelines and regulations of the ministry regarding the proposed project are outlined below.

1.6.2FMEnv Sectorial and Procedural Guidelines for Industries (1992)

In compliance with its mandate, FEPA issued the EIA Procedural Guidelines and Sectorial Guidelines for Industrial Projects in 1992. The Procedural Guidelines also indicate the steps to be followed (in the EIA process) from project conception to commissioning in order to ensure that the project is executed with adequate consideration for the environment. Annex C contains the EIA writing format as required by FMEnv. The guidelines are intended to assist in the proper and detailed execution of EIA studies of projects in consonance with the EIA Act.

1.6.3 National Environmental Protection Management of Solid and Hazardous Wastes Regulation (1991) (FMEnv).

This provides that the objective of solid and hazardous waste management shall be to:

- Identify solid, toxic and extremely hazardous wastes dangerous to public health and environment,
- Provide for surveillance and monitoring of dangerous and extremely hazardous wastes and substances until they are detoxified and safely disposed,
- Provide guidelines necessary to establish a system of proper record keeping, sampling and labelling of dangerous and extremely hazardous wastes,
- Establish suitable and provide necessary requirements to facilitate the disposal of hazardous wastes;
- Research into possible re-use and recycling of hazardous wastes.

1.6.4 Environmental Impact Assessment Act No. 86, 1992 (FMEnv)

This Act provides guidelines for activities of development projects for which EIA is mandatory in Nigeria. The Act also stipulates the minimum content of an EIA as well as a schedule of projects, which require mandatory EIAs.

1.6.5 FEPA (FMEnv) National Guidelines for Spilled Oil Fingerprinting (Act 14 of 1999)

This provides guidelines for spilled oil fingerprinting applicable throughout Nigeria, in order to improve the quality of the environment and to free it from pollutants and other environmental and health hazards.

1.6.6 FEPA (FMEnv) National Guidelines on Waste Disposal through Underground Injection (1999)

These Guidelines and Standards on waste disposal through underground injection provide the '*modus operandi*' for the most viable options for disposal of these wastes in a tropical environment as Nigeria.

1.6.7FEPA (FMEnv) Nigeria's National Agenda 21 (1999)

Nigeria's National Agenda 21 was developed to:

- Integrate environment into development planning at all levels of government and the private sector,

- Intensify the transition to sustainable development,
- Address sectoral priorities, plans, policies and strategies for the major sectors of the economy and,
- Simultaneously foster regional and global partnerships.

1.6.8 FEPA (FMEnv) National Policy on the Environment (1989)

This gave the policy goals, conceptual framework and strategies for implementation.

1.6.9National Policy on Environment

The National Policy on Environment, 1989 provides for "a viable national mechanism for co-operation, co-ordination and regular consultation, as well as harmonious management of the policy formulation and implementation process which requires the establishment of effective institutions and linkages within and among the various tiers of government – Federal, State and Local Governments". Prior to the launching of this policy, there was no unified co-ordination of activities of the 3-tiers of Government responsible for the environment.

The thrust of the policy is the achievement of sustainable development in Nigeria. Guidelines and strategies are therefore defined for:

- securing for all Nigerians a quality of environment adequate for their health and well-being;
- conserving and using the natural resources for the benefit of present and future generations;
- restoring, maintaining and enhancing the ecosystem and ecological processes essential for the preservation of biological diversity;
- raising public awareness and promoting understanding of the essential linkages between the environment, resources and development; and
- Co-operation with other countries, international organisations and agencies to achieve optimal use of trans-boundary in order to prevent environmental recourses.

Further, the defined guidelines and strategies provide for the effective management of the environment in the following 14 major sectors of the nation's economy:

- Human population;
- Landuse and soil conservation;

- Water resources management;
- Forestry, wildlife and protected areas;
- Marine and coastal area resources;
- Toxic and hazardous substances;
- Mining and mineral resources;
- Agricultural chemicals;
- Energy production and use;
- Air pollution;
- Noise pollution;
- Working environment (occupational health and safety); and
- Settlements, recreational space, greenbelts monuments and cultural property.

National Guidelines and Standards for Environmental Pollution Control in Nigeria

In line with the strategic thrust of the National Policy on the Environment, the National Guidelines and Standards for Environmental Pollution Control in Nigeria was published in March 1991 to serve as a basic instrument for monitoring and controlling industrial and urban pollution. The main thrusts of these guidelines are:

- Effluent limitations;
- Pollution abatement in industries;
- Water quality or industrial water uses at point of intake;
- Noise exposure limitations;
- Industrial emission limitations; and
- Management of solid and hazardous wastes;

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 to install anti-pollution and pollution abatement equipment on site based on best available technology (BAT) for detoxification of effluent and chemical discharges. The regulation is specific to each category of waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem. Appropriate penalties for contravention are also specified 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; for environmental audit (or environmental impact assessment for new industries) and penalty for contravention.

Management of Hazardous and Solid Wastes Regulation

The management of hazardous and solid waste regulation, S.I.15 of 1991 (No. 102, Vol. 78, August, 1991) defines the requirements for groundwater protection, surface impoundment, land treatment, waste piles, landfills, incinerators etc. It also describes the hazardous substances tracking programme with a comprehensive list of acutely hazardous chemical products and dangerous waste constituent. It also states the requirements and procedure for inspection, enforcement and penalty.

1.6.10Environmental Impact Assessment Act

The Act No. 86 of 1992 makes EIA mandatory for all new major public and private projects in Nigeria. The EIA Act sets out to:

- Consider the likely impacts, and the extent of these impacts on the environment before embarking on any project or activity.
- Promote the implementation of appropriate policy in all Federal Lands consistent with all laws and decision-making processes through which the goal of this Act may be realised.
- Encourage the development of procedures for information exchange, notification and consultation between organizations and persons when the proposed activities are likely to have significant environmental effects on boundary or trans-state or on the environment of bordering towns and villages.

The Act gives specific powers to the FMEnv to facilitate environmental assessment of projects.

Federal Land Use Act

The laws of the Federation of Nigeria (1990) Federal Ministry of Justice, Land Use Act (Chapter 202), Part ll, Section 11 (Power of Governor or Public Officer to enter and inspect

land and improvements) "the Governor or any public officer duly authorised by the Governor in that behalf, shall have the power to enter upon and inspect the land comprised in any statutory right of occupancy or any improvements effected thereon, at any reasonable hours in the day time and the occupier shall permit and give free access to the Governor or any such officer to enter and inspect".

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 6 months of imprisonment, to cut down trees over 2ft in girth or to set fire to the forest except under special circumstances. Nigeria is at present a wood deficit nation. In order to ameliorate the situation, the policy on forest resources management and sustainable use is aimed at achieving self-sufficiency in all aspects of forest production through the use of sound forest management techniques as well as the mobilization of human and material resources. The overall objectives of forest policy are to prevent further deforestation and to recreate forest cover, either for productive or for protective purposes, on already deforested fragile land. Specifically, the National Agricultural Policy of 1988 in which the Forestry Policy is subsumed, provides for:

- Consolidation and expansion of the forest estate in Nigeria and its management for sustained yield.
- Regeneration of the forests at rates higher than exploitation.
- Conservation and protection of the environment viz: forest, soil, water, flora, fauna and the protection of the forest resources from fires, cattle grazers and illegal encroachment.
- Development of Forestry industry through the harvesting and utilization of timber its derivatives and the reduction of wastes.
- Wildlife conservation, management and development through the creation and effective management of national parks, game reserves, tourist and recreational facilities, etc.

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 on endangered species.

Criminal Code Act

The Nigerian Criminal Code Act (Chapter 77) laws of the Federation of Nigeria 1990. The provisions of the Criminal Code shall apply in relation to any offence against any Order, Act, Law, or Statute and to all persons charge with any such offence. Section 245 of Chapter 23 of the Act makes it a punishable offence for any person who:

- Fouls the water of any spring, stream, well, tank, reservoir, or place, so as to render it less fit for the purpose for which it is ordinarily used, is guilty of a misdemeanour, and is liable to imprisonment for six months.

National Environmental Standards Regulatory and Enforcement Agency (NESREA), 2007

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established as a parastatal of the Federal Ministry of Environment. NESREA is charged with the responsibility of enforcing all environmental laws, guidelines, policies, standards and regulations in Nigeria.

1.6.11International Guidelines and Convention

In addition to the national laws/regulations, Nigeria is signatory or party to several international conventions and treaties that support the use of EIA as the key tool for achieving sustainable development. Some of these include:

World Bank Operational Directive

The World Bank Operational Directive 4.01: ‘’Environmental Assessment’’ of 1991, classifies projects according to the nature and extent of their environmental impacts, and supports the use of EIA as the key tool for achieving sustainable development.

World Heritage Convention

The World Heritage Convention (1978), which seeks to set aside areas of cultural and natural heritage, the latter defined as areas with outstanding universal value from the aesthetic, scientific and conservation points of view.

Convention on International Trade in Endangered Species of Wild Fauna and Flora

This convention was signed into law in 1973 during the Washington summit but in force in 1975 and restricts the trade of fauna and flora species termed as endangered organisms. It establishes

list of endangered species for which international commercial trade is prohibited or via permit system, regulated to combat illegal trade and over exploitation.

Vienna Convention for the Protection of the Ozone Layer

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

Ramsar Convention on Wetlands

This international convention (RAMSAR Convention of 1971) signed by Nigeria in 2001, seeks to protect and encourage wise use of coastal wetlands of international significance.

United Nations Guiding Principles on the Human Environment

These guiding principles are formal declarations that express the basis on which an environmental policy can be built and which provide a foundation for action. The United Nations has been concerned about negative environmental trends since they were formed. As a result of this, they published two major concept documents, the United Nations Guiding Principles on the Human Environment in 1972, and the Rio Declaration on Environment and Development. The principles applicable to this project include:

Principle 2

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

Principle 4

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

Declaration on Environment and Development – Rio Summit (1992)

The Rio Earth Summit (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 to technologies. The principles adopted include:

Principle 1

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

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.

1.6.12Cross River State Policy on Environment

The applicable Cross River State regulations guiding environmental management include but not limited to the following:

- Public Health Law – CAP 103 of the Laws of Eastern Nigeria 1963;
- Cross Rivers State Environmental Protection Agency Law;
- Cross Rivers State Private Health and Allied Establishments Authority Law;
- Cross Rivers State Public Health Law,
- Cross Rivers State Noise Pollution Control Law.

The Ministry of the Environment is charged with the responsibility of providing decent, orderly and reasonable conducive environment for habitable society, as contained in the assignments of Ministerial responsibilities. In line with the State Government's 10-point development Agenda, the need to restructure the Ministry for efficiency and effectiveness became apparent. Hence the existing six departments were increased to include three additional departments. Similarly, the former World Bank Assisted Projects Department was renamed Multi-Lateral Projects department for wider coverage.

The three new departments were established to achieve the following responsibilities:

- Conservation of soil and natural resources;

- Environmental sanitation and protection services;
- Control of Environment Pollution, e.g., noise, water, land and illegal trading;
- Supervision of Cross River State Waste Management Authority;
- Supervision of ESEU (Environmental Sanitation and Enforcement Unit);
- Supervision of Cross River State Environmental Protection Agency;
- Evaluation of Environmental Impact Assessment (EIA) and Environment Audit Report (EAR);
- Ecological matters; and Monitoring, co-ordination and evaluation of all World Bank Assisted Projects.
- Cross River State Ministry of Lands and Housing

The Responsibilities of the Ministry are;

- Land Use and Allocation Matter;
- Land Policy and Land Matters;
- Acquisition of Land for State Purposes;
- Issuance and Revocation of Certificate of Occupancy;
- Survey Services;
- Lands Registry (Administration and Control);
- Subsequent Transactions including Assignment Mortgages, Leases and Power of Attorney;
- Mapping Matters;
- Resolving land disputes between individuals;
- Servicing and Monitoring of Land Use and Allocation Committee; and
- Construction of Economic housing units;
- Supervision of Cross River State Development Property Corporation; Matters relating to forfeiture of properties;
- Resettlement of displaced people;
- Compensation for acquired properties;
- Valuation of all types of interest in properties; and
- Identification of abandoned properties

1.7 Akamkpa Quarry Limited HSE Policy

Akamkpa Quarry Limited, believes and pursues a primary and continuing policy of total commitment to environmental protection, resource conservation and safety of its personnel and others in the conduct of its operations. This objective shall be achieved by maintaining

compatibility between all of its operations and the environment in which its operations are carried out. The company also strives to achieve the most efficient use of its resources, high safety standards and environmentally acceptable practices in compliance with all national and international laws and regulations.

This is not limited however, to regulatory compliance but is a total commitment to environmental protection including the rapid response to any contingencies that may arise as a result of its operations.

The management of AQL recognises that environmental protection is a fundamental goal and responsibility of the company and therefore commits the resources necessary to pursue this goal and conduct its business in line with the following objectives, namely to:

- ensure the application of policies within the framework of an efficient environmental management system;
- strive to make all operations even more environmentally acceptable;
- motivate operating policy to increase complete environmental awareness;
- develop staff training programs to raise environmental consciousness at all levels;
- encourage research and the exchange of ideas, technology and information between all parties to enhance the conduct of an environmentally safe business; and
- give priority to environmental considerations when designing or modifying new or existing facilities

In line with its policies therefore and to ensure continual compliance with regulatory and other applicable requirements, Akamkpa Quarry Limited adopts the use of EIA as an environmental management tool in all its activities.

1.8 Declaration

Akamkpa Quarry Limited (AQL) declares that it has prepared the Environmental Impact Assessment report using the best available expertise in personnel, equipment and internationally acceptable methods.

1.9 Structure of the Report

All findings relating to this study has been documented in the report, after management review. The Environmental Impact Assessment report has followed the approved format laid down by the Department of Petroleum Resources, as outlined below:

- Title Page
- Table of Contents
- List of Tables
- List of Figures
- List of Plates
- List of Acronyms and Abbreviations
- List of Preparers
- Acknowledgement
- Executive Summary

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 Project Scope

The proposed Quarry Plant is designed to crush large piece of rock in to smaller fragments as sand, granite and stone. When functional, the plant shall crush large piece of rocks using different heavy equipment like, Drill machine, Excavator, Bulldozer to achieve its finally products which includes sand, granite, gravel, stone and other related products. This will be of great economic benefit to the country in addition to other benefits such as employment, sustainable development.

2.2 Aim of the Project

In a bid to contribute to the economic and technological development of Nigeria, AQL intends to set up a quarry plant that will produce materials such as granite, gravel, sand and other related products for construction

2.3 Project Objectives

The objectives for the proposed AQL Quarry Plant include;

- Extraction of mineral material from the earth through drilling and blasting of rocks into smaller units
- Breaking or disintegrated rock fragments
- Conveying of materials by the dump truck to the crushing machine
- Screening and dropping of standard graded sizes that are the end products of the processing stage

2.4 Significance of the Project

On operation, the benefits of the quarry plant are numerous and cannot be over-emphasized. Some of the benefits of the project include:

- Conversion of natural resources into material usable by man.
- Production of sand, stones, gravel, granites and other related products.
- Provision of employment opportunities for many skilled and unskilled Nigerians, especially those from the host communities.
- Enhancement of the provision of basic social amenities to the host communities.
- Poverty alleviation through increased derivation fund to local and state governments.
- Promotion of good relationship between Akamkpa Quarry Limited and the host community through increased socio-economic assistance.

2.5 Envisaged Sustainability of the Proposed Akamkpa Quarry Plant

2.5.1 Economic and Commercial Sustainability

Quarry activities is a core area of Nigeria's economy, as the country is still a developing country, the need for quarry product will be on a high demand for the construction of roads, erecting of structures and maintenance of existing ones and hence conferring economic sustainability on the facility. The project may employ directly over 100 persons during the operation. Priority will be given to qualified persons from the host community followed by the nearby communities before the others. The mining activities will create avenues for many business and employment opportunities thus greatly enriching the financial capacity of the project host communities in particular. This will be achieved through the involvement of contractors, suppliers, employment, provision of public facilities and services, increased social capital in the host communities, provision of microcredit schemes etc. The project will contribute economically to the Akamkpa LGA, Cross Rivers State and Nigeria.

2.5.2 Technical Sustainability

Akamkpa Quarry Limited has a team of professional who have vast knowledge in the area. AQL shall ensure strict adherence to internationally and nationally acceptable standards, innovative technologies that are economically viable and environmentally friendly, all through the period of project execution.

2.5.3 Environmental Sustainability

The project shall be environmentally sustainable because of the adoption of national FMEnv and international environmental regulatory processes as well as the development and deployment of an adequate Environmental Management Plan (EMP) throughout the projects life span. There will be strict adherence to the HSE policy of AQL during and after construction of the proposed quarry plant. AQL will also ensure good house- keeping practice. The choice of equipment within the perimeter of land will be reduce to the barest minimum environmental impacts on biodiversity, soil and agricultural resources. However, strict compliance to best industry practice will increase the environmental sustainability of the proposed Akamkpa quarry projects

2.6 Project Development Options

During the Project planning phase which was a major component of the EIA process three project development options were considered

2.6.1 Option 1 (Do Nothing or No Development Option)

This amounts to cancellation of the construction of the proposed quarry project. In this case no impact associated with the project will occur. The disadvantages of adoption this option include;

- The rock deposits will not be mined and thus its economic value cannot be assessed and utilized profitably.
- Loss of revenue paid to the Government to obtain the mining license lease and other logistic expenses.
- The risk of forfeiting the right over the mine fields after the stipulated years of non-development.
- Loss of revenue to the Local, State and Federal Government and the host community.
- Loss of job opportunities that the project execution would have afforded some indigenous inhabitants of Akamkpa.
- Loss of commercial and economic benefits to Akamkpa Local Government Area

This option was rejected.

2.6.2 Option 2: (Delayed Option)

This means the manifest and associated benefits of the project will be delayed, so this option was also rejected.

2.6.3 Option 3 (Implement Option)

This option involves going ahead to implement the project. This will make the Government and Akamkpa Quarry Limited (AQL) achieve their goal of harnessing the rock deposits thus contributing to the national economy and the revenue profile of the company. The option would also be beneficial to members of the project host community, Cross Rivers State and Nigeria in general. This was the reccommended option in view of its importance in providing rock aggregates for different aspects of construction and building industry in the Nigerian economy. This option was accepted.

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Introduction

The Akamkpa Quarry project entails the construction, installation and commissioning/start-up of the quarry plant. The facility infrastuctures are designed to have optimum sizing, standard equipments that are cost effective and easy to operate. Figure 3.1 Shows the proejct design for the proposed Quarry Plant.

3.2 Project Concept

The AQL took cognizance of the availability of the mineral material during the acquisition of the project location. Hence the site for the proposed quarry is rich in the mineral material and have good connectivity and close proximity to existing infrastructure. The rock aggregates to be extracted finds diverse usage and application in infrastructural products mainly in concreting, stone masonry, drainage construction and road building. Depending on the size of aggregate material, these aggregates are classified as coarse, fine and dust or powder which is the resultant of crushing rock materials, (table 3.1).

Table 3.1: Rock Texture

S/N	AGGREGATES(mm)	TEXTURE	USES
1	0 – 5	Coarse	Mixed material used for road sub-base.
2	15 – 22	Coarse	Concrete works
3	22 – 30	Coarse	Concrete works
4	5 – 10	Fine	Asphalting of road
5	0 – 5	Powder	Fillers for asphalts
6	100 – 300	Hard Core	Stone pinching and soil stabilization jobs

The rock deposit of interest for the proposed quarrying project is situated in Obung community in Akamkpa Local Government Area of Cross River State. The deposit falls within the following geographical coordinates as established. The rocks physical characteristics show that it is suitably hard for diverse engineering construction purposes.

The rock type is granite as can be observed in the mineral associations ranging from quartz, biotite and feldspar. In brief, the Obung rock deposits fall within the basement complex rocks of South Eastern Nigeria and predominantly older granite of the Precambrian era. Reserve estimation method used was basically the random drilling of pilot holes across the stretch of the rock deposit. Drilling information gathered was used to ascertain average overburden depth and rock volume. Average overburden depth is 3m while rock reserve volume indicates that over 5, 475, 000 tons of viable rock is insitu. Estimated reserve life span at a production rate of 1, 500 tons per day stands at 9 – 10 years.

3.3 Project Activities

The key activities for the proposed installation of the Quarry Plant are:

Pre-Mobilization
Mobilization and Pre-Construction activities

- Project Development
- Commissioning
- Demobilization

3.3.1 Pre-Mobilization

During this phase, AQL shall carry out pre-mobilization inspection of all items/personnel to be mobilized to site. All equipment and personnel mobilized to site shall be certified fit for purpose and approved by AQL before deployment to site.

Other activities that will be carried at this stage are:

Stakeholder's Engagements

AQL will engage the community and stakeholders on the proposed project to ensure there are aware and there are no obstructions to the project kick off.

Land Acquisition and Survey

The approximate area that was acquired for the quarry plants are 80 hectares and 60 hectares respectively for Quarry I and II.

Surveying

The boundaries of the sites shall be indicated by means of coloured survey pillars. The Contractor shall re-open the site boundaries and stay within the boundary lines and avoid

causing any damage to, or placing any obstruction upon the survey pillars and third party property outside the boundaries.

Bush Clearing

Bush clearing and de-stumping shall be limited to the area, which is absolutely necessary. Bush clearing involves the felling of all trees and clearing bush within the pegged areas and the removal of all stumps. Debris shall be piled next to, but within, the boundaries of the area of each site cleared. Appropriate construction equipment, namely - bulldozer, crawler/swamp buggy-excavator, pay-loader, excavator, and or any other AQL approved equipment shall be used for bush cutting and de-stumping.

3.3.2 Mobilization and Pre-Construction Activities

The AQL shall mobilize all personnel, equipment and materials to the site, ready to start work after completion of all necessary pre-mobilization requirements (equipment, personnel certifications and HSE documentation) necessary for commencement of site construction activities. The equipment to be mobilized are survey equipment (theodolite. Levelling instrument, echo sounder usually mounted on a boat). Construction equipment (dredger, bulldozers, excavators, graders, rollers, pay loaders, self-loaders, tippers, trailers).

Pre-Construction Activities

The following are the activities at the pre-construction activities:

Accommodation/Labour Camp

Prior to the commencement of construction activities, temporary, fully serviced accommodation with sewage systems shall be provided by the contractor on site, within AQL acquired area. This will limit human traffic significantly, thus minimizing accident potential.

Power Generation and Distribution

Diesel generating set(s) of adequate capacity shall be installed, to provide required electricity/energy during construction. Noise and emissions shall be managed to stay within

the allowable regulatory limit and ensure contractor's compliance, through effective supervision and audits.

Supplies to the Construction Site

Supplies of food, materials, consumables, fuel, water etc. to the project location shall be by road before and during construction.

3.3.3 Project Development

In the proposed quarrying project, spatial consideration and planning will essentially be done to reflect local mining regulations, aesthetics and overall efficiency. Distance and location chosen within the quarry site for the construction of explosive storage facility shall conform to the stipulations of the law. The rock process facility shall be situated at a reasonable distance that guarantees efficient work flow from extraction pit to the crushing plant. Other structural units like the office building, workshop, main entrance gate, diesel dump, weighing bridge, roads and work ways within the premises shall be positioned in a well-organized manner to make the site have an appealing look**.** The quarry plant shall be sited within the confines of the land acquired (80 and 40 hectares respectively for Quarry I and II) by Akamkpa Quarry Limited. The shelter will be big enough to accommodate the various heavy machineries and its other supporting facilities

The timing and rate of progression through the stages associated with the pit development will be defined by market conditions and demand but the quarry will have an operational life of at least 40 years. During the establishment, construction and development stages, the proposed quarry will operate with mobile plant(s), and be replaced with a permanent fixed plant as soon as Practicable after the plant site infrastructure area and initial pit have been established (estimated to occur between 5 to 6 years of the development approval).

The detailed of the project development activities are presented below:

Blasting Zone

This is the area where blasting of the granite outcrop occurs. It is set at great distance from the production one. Equipment used in the blasting zone includes drilling machine, compressors and dump trucks.

Removal of Overburden

This involves removal of the waste material that often overlies pit or quarry site by the use of large earth moving equipment such as excavators, pail loaders and dump trucks. Deposits within the waste (Spoils) are removed before excavation of the construction materials lying below.

Drilling and Blasting

Drilling cores are carried out at the desired burden to facilitate the insertion of explosives (dynamite) which is to be detonated to blast the rock materials into large boulders. This is followed by hauling of the rocks to the production zone for crushing and grinding.

Production Zone

In this area the boulders derived from the quarry are broken down into rocks and chippings of varying sizes. A network of conveyor belts transports the crushed and grinded stones to a stacking areas, segregated according to the dimensions of the chippings. The finished product is then transported off site by pail loaders and trucks.

Construction of Ancillary Facilities

Earthworks

This will involve the stripping of top soil and sinking of foundational materials to support the plant and filling with appropriate materials to the recommended level shall be carried out using excavators, bulldozers, tipper trucks etc.

Plant House

This shall involve the construction of the plant house with approved materials. The house shall be constructed in a way that will allow for proper ventilation. There shall be an emergency exit and the floors shall be sufficiently concreted to support the quarry as well as the vibrations from the plant operations.

Plant Shelter Entrance

This shall be constructed using foldable steel doors and shall be sufficiently raised for easy access of vehicles which transport the materials for the plant.

All site preparation and related activities shall be carried out within the limits of acquired land and in accordance to Akamkpa Quarry Limited Facility contractor specifications and in line with regulatory requirements.

3.4 Proposed Crushing and Power Machinery

A crushing plant capable of producing between 200-250tph is considered. Plant will

Primary section of plant will be made of:

- 200-250 tons per hour
- Primary feeder of 60m^3
- Waste and discharge conveyors

Secondary section of plants will be made of:

- 48" cone crusher
- 36" cone crusher
- Screening Machines
- Assorted sizes of conveyors.

3.4.1 Power Plant

The power generating plant of 500-800 kva is considered to power the entire crushing plant.

3.2 Proposed Infrastructure

S/N	INFRASTRUCTURE	PURPOSE
1	Explosive Magazines	Explosive material storage
2	Rock crushing facility	Process of rock boulders to standard aggregate sizes
3	Workshop	For maintenance and repairs of quarry machines
4	Offices	For administration of site
5	Stores	Safe keeping of spare parts and other items
6	Weighing bridge	For determination of weights of crushed materials
7	Fuel dump	For storage of diesel and other fuels
8	Entrance gate	To control movement of persons and material as well as

3.3 Equipment Selection

S/N	EQUIPMENT	USES
1	Air drill machine	For drilling of blast holes into rock
2	Air compressor	To power air drill machine
3	Excavators	For loading blasted rocks into trucks, digging earth etc.
4	Wheel loaders	For loading crushed rock into trucks, cleaning of yard.
5	Dump trucks	For conveying blasted and crushed rock to crushing plants
6	Hydraulic Hammer	For breaking of boulder rock to crushable sizes
7	Bulldozer	For clearing site

Figure 3.1 Drilling Machine

Figure 3.2 Excavator

Figure 3.3 Wheel Loader

Figure 3.4 Bulldozer

Figure 3.5 Dump Truck

3.5 Commissioning Plan

Commissioning comprises of a series of checks and tests equipment. The various tests are highlighted below:

- **Completion Check**- the responsible technician will inspect the plant for Completion of Plant Construction-ensuring that all parts are properly installed.
- **Finishing of the Work**-confirm that all installation works have been finished Safety aspects-confirm that all protection equipment has been properly installed.
- **Site Preparedness**-confirm the site is clean of debris and safe for work.
- **Mechanical Test** - All mechanical parts of the plant will be started and the responsible technician will inspect the plant for:

Quarry shall be started and the responsible technician shall inspect the quarry for:

- Proper function of the quarry
- Smooth throughput of materials through the various machinery

The quarry commissioning process will extend across many days as individual components, subsystems and systems are checked for correct functionality.

3.6 Decommissioning

The FMEnv guidelines for decommissioning of quarry plants shall be employed to decommission the quarry plant. All mechanical, electrical and civil works shall be effectively demobilized and the unit properly uninstalled and securely sealed. All supporting infrastructures shall be demobilized from site.

Appropriate warning signs shall be put in place in order to caution people from tampering with the sealed unit and its infrastructures. There shall be re-vegetation of necessary areas with indigenous plant species. There shall be regular inspection of the abandoned plant to ensure compliance of decommissioning and abandonment plan.

3.7 Project Schedule

This project is scheduled to commence immediately the quarry lease is issued by the Federal Ministry of Mines and Steel Development, Abuja. However, the schedule from the period of site clearing, development and construction of facilities duration of operations is established as shown below;

Table 3.4 Project Schedule

S/N	Year	Schedule
1.	2020-2021	Site Preparation
3	2020-2023	Development and construction stages, the proposed Akamkpa Quarry will operate with mobile plant(s), and be replaced with a permanent fixed plant as soon as practicable after the plant site infrastructure area and initial pit have been established
4	2023-2064	Operational life span

3.8 Quarry Waste and Proposed Management Method

The type of waste that will be generated in the Akamkpa Quarry site and the proposed management methods are as follows:

Table 3.5 Waste Types, Management & Quantities – Pre-Operational Stage

WASTE TYPE	SOURCE(S)	MANAGEMENT METHOD	ESTIMATED QUANTITY
Cleared vegetation	Clearing necessary for quarry, roads and site infrastructure	Reuse vegetation waste on site for rehabilitation, landscaping and erosion control where possible.	Vegetation generated from all cleared and designated areas
Excavated waste (soil and overburden)	Excavation necessary for quarry, roads and site infrastructure	Spread any excess soil over the nearby area and vegetate. Overburden used as fill on site or transported to another Boral site for use as fill.	Expected to be on average 6 to 10 metres deep across the site
Concrete	Site infrastructure area	Minimise waste by producing or procuring only the amount required. All excess concrete will be returned to the point of supply.	Less than 5 m^3
Scrap metal	Site infrastructure area	Segregation and collection on site. Transportation off site by a waste contractor for off-site recycling.	Variable.

Paints and resins **(Regulated Waste)**	Site infrastructure area and workshop	Minimise waste by procuring only the amount required. Paint off site where possible. Collect on site and store in a segregated covered area. Transport from site by a licensed regulated waste transporter for disposal at a licensed facility.	Variable
Waste oil and containers **(Regulated Waste)**	Workshop	Collected, labelled and stored separately on site in a bunded tank. Transported from site by a licensed waste transporter to a licensed facility for recycling.	Variable
General wastes – putrescible and organic	Workshop and offices	To minimise the attraction of vermin and pests, putrescible waste will be stored in a sealed and covered bin and disposed of off-site on a weekly basis.	Less than 1 m^3 bin per week
General waste including plastics, packaging and materials	All site operations	General waste will be taken off site for disposal at a GCCC waste facility. Collection and segregation of recyclable waste on site. Transportation from site by a licensed waste transporter to a licensed facility for recycling.	Approx. one $3m^3$ bin per week
Sewage treatment sludge **(Regulated Waste)**	All site operations	Wastes will be treated in an on-site Package Treatment Plant with the produced waste sludge transported and disposed of at a landfill facility. Portable toilets are proposed prior to construction of the Package Treatment Plant. – waste removed from site by licensed contractor.	Variable depending on work force

Table 3.6 Waste Types, Management & Quantities – Operational Stage

WASTE TYPE	SOURCE(S)	MANAGEMENT METHOD	ESTIMATED QUANTITY
Pre-coat emulsions **(Regulated Waste)**	Stockpile areas	Blend material into a useable product. If re-use is not possible the material must be disposed of as regulated waste. Oil Water separators on site to control run-off from stockpiles.	Variable
Pre-coated aggregates **(Regulated Waste)**	Stockpile areas	Blend material into a useable product. Pre-coated aggregates may be bio-remediated. Significant quantities must be disposed of as regulated waste. Oil / water separators on site to control run-off from stockpiles. ***Note: If only bitumen is left on the aggregates then it is not a regulated waste***	Variable
Oily sludge, absorbent, degreaser, grease, oily rags and oil filters **(Regulated Waste)**	Workshop	Collected on site then transported off site by a licensed regulated waste transporter to a licensed facility for recycling or treatment and disposal.	Variable
Waste oil and containers	Workshop	Drained on site with collection drums transported off site by waste contractor for off-site re-use, recycling or disposal.	Approx. 20,000 litres per year
Scrap metal	Site infrastructure areas	Segregation and storage on site in open storage bins. Transportation off site by a waste contractor for off-site recycling	Variable

WASTE TYPE	SOURCE(S)	MANAGEMENT METHOD	ESTIMATED QUANTITY
General wastes – putrescible and organic	Workshop and offices	To minimise the attraction of vermin and pests, putrescible waste will be stored in a sealed and covered bin and disposed of off-site on a weekly basis.	Approx. one 3 m^3 bin per week
General wastes - plastics	Workshop and offices	Collection on site and stored in a segregated area. Transportation from site to a GCCC waste facility.	Less than 1 m^3 per week
Explosives	Quarry Pit	No waste explosive produced on site.	Nil (all used on site)
Recyclable waste - paper, cardboard, plastics, glass and aluminium cans	Workshop and offices	Collect recyclable products segregated according to Gold Coast City Council recyclable material collection arrangements in appropriate containers.	Variable
Diesel & solvents **(Regulated Waste)**	Workshop	Recycle through an approved licensed waste collection agency.	Variable

Hazardous waste paints and resins **(Regulated Waste)**	Workshop	Collection on site and stored in a segregated area. Transported off site by a licensed regulated waste transporter to a licensed facility for treatment and disposal	Variable
Tyres **(Regulated Waste)**	Workshop	Generally, but not always, truck tyres can be re-treaded. Earthmover tyres can be re-used as bunding around the site. Light vehicle tyres will be stored on site and transported from site by the original supplier or a licensed regulated waste transporter to a licensed facility for recycling or disposal.	Variable
Vehicle batteries **(Regulated Waste)**	Workshop	Dead batteries shall be removed from site by the battery supplier. Batteries not removed by the supplier shall be stored on site for collection and disposed of as regulated waste by a certified regulated waste contractor.	Approx. 20 per year
Sewage waste and sludge **(Regulated Waste)**	Workshop and offices	Wastes will be treated in an on-site Package Treatment Plant with the produced waste sludge transported and disposed of at a landfill facility.	Approx. 3,200 litres per day
Crusher lubricants **(Regulated Waste)**	METSO C160 Jaw Crusher METSO GP500S (EC) METSO GP550 (MF) METSO B9100 VSI (Barmac)	Collected on site then transported off site by a licensed regulated waste transporter to a licensed facility for recycling or treatment and disposal.	Approx. 2,750 litres per year

Heavy Mobile Equipment (HME) Lubricants **(Regulated Waste)**	Atlas Copco F9 CAT D10T CAT 992, 990, 988, 980, 777, 775, 773, 390 & 374 CAT740 (ADT)	Collected on site then transported off site by a licensed regulated waste transporter to a licensed facility for recycling or treatment and disposal.	Approx. 18,000 litres per year
Crusher wear liners (cast manganese steel) **(Regulated Waste)**	METSO C160 Jaw Crusher METSO GP500S (EC) METSO GP550 (MF) METSO B9100 VSI (Barmac)	Collected on site then transported off site by a licensed regulated waste transporter to a licensed facility for recycling or treatment and disposal.	Approx. 36 tonnes per year

CHAPTER FOUR
DESCRIPTION OF THE ENVIRONMENT

4.1 Introduction

The existing environmental baseline (physical, chemical, biological, socio-economic and health) characteristics of the proposed project area is presented in this chapter. The environmental characteristics are required to establish the existing environmental status of the proposed project area and also to serve as a reference data for future studies and environmental monitoring. It will also be used as a basis for which the anticipated impacts of the project would be determined for appropriate mitigation measures to be put in place.

The environmental baseline data of the proposed project area was obtained through survey of existing literature, field observation, sampling and *in situ* measurements as well as laboratory analyses of biological, physico-chemical characteristics of sampled environmental components of the project area.

4.2 Baseline Data Acquisition Method

A multi-disciplinary approach was employed in the acquisition of baseline data from terrestrial ecosystems in the area as well as socio-economics and health information concerning the residents around the project area. The various methods employed in the baseline data acquisition are discussed in the subsequent subsections.

4.2.1 Review of Literature

Literature search involved consulting of relevant textbooks, research publications, articles, previous study reports and technical presentations on the geological, meteorological and geographical features of the area.

4.2.2 Field Sampling/In situ Measurements

One season sampling was approved by the Federal Ministry of Environment (FMEnv). The fieldwork, which was witnessed by representative of the FMEnv took place on 12th March, 2020 during the wet season. Sampling covered the proposed Quarry Plant Facility site I, II and the adjoining areas, so as to have comprehensive data of the environmental characteristics of the area.

The environmental components sampled include soil, sediment, biodiversity, ground water, air, noise and meteorology. Socioeconomic and Health Impact study was conducted around the proposed facility area. On the whole, sampling was accomplished with twenty-four soil sampling points, three ground water sampling points with two control, two surface water sampling points with one control, two sediment sampling points with one control and twenty two air quality, meteorology/noise sampling points with 2 control. The samples were preserved prior to physical, chemical and biological characteristics analyses.

The sampling points and their geographic co-ordinates as well as the sampling procedures/methodology and equipment are presented Figure 4.2.1

4.2.3 Positioning

Positioning at each sampling station during the fieldwork activities was carried out with the aid of an Etrex 30x model Global Positioning Systems (GPS) which was hand carried by the study team. At each sampling points, coordinates at which sampling took place were marked with the GPS and subsequently transferred into a field notebook. Sampling stations and the GPS are presented in the appendix. 2

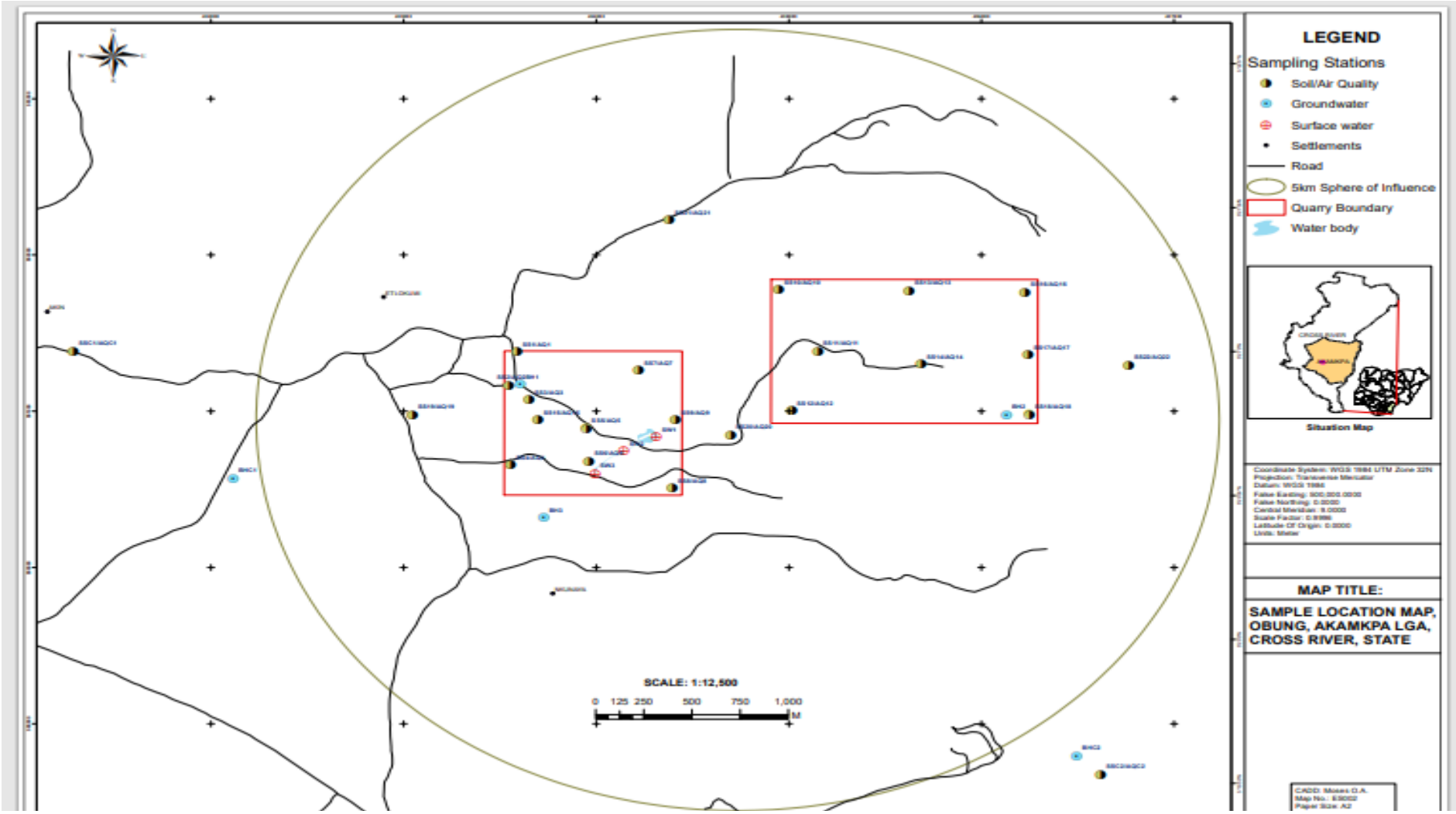

Figure 4.2.1 Sample Location Map of the Study Area, in Obung Cross River State

4.2.4 Quality Assurance

Prior to mobilisation, each member of the study team was briefed on all aspects of the fieldwork. The guidelines covered sample collection, preservation, storage and transportation. The reports were confirmed and endorsed by the team leader in order to ensure the accuracy of the documentation.

4.2.5 Laboratory Analysis

Samples collected from the field were analysed at Geospectra Engineering Services & Consultant Ltd in Port Harcourt using standard analytical methods and it was witnessed by representatives of the FMEnv. The descriptions of the laboratory analytical methods and procedures employed for the various physical, chemical and biological parameters as well as the detection limits are contained in the appendix. Also documented are the QAQC and HSE plan adopted in both field data collection and laboratory analysis.

4.2 Description of Ecological Baseline Conditions

An in-depth description of the baseline ecological status of the Akampa Quarry Limited Facility and immediate environment studied are discussed in the following subsections.

4.3.1 Climate and Meteorology

The climate of the area was studied through both literature and micro-climatic on-the-spot data collecting during the field works. The climate of the study is tropical and marked by two distinct seasons, the dry season (November - March) and the wet season (April - October). The wet season is usually interrupted by a short dry spell in August.

The climatic data obtained during the field sampling exercises are presented in Table 4.3.1. Temperature is high throughout the year, with very little difference between the minimum and maximum. The mean ambient temperature recorded is 30.2^{o}C. The temperature range seems to reflect the West North prevailing wind that dominates the entire study area during the time of measurement.

Relative Humidity, which is the amount of water vapor contained in the atmosphere, was also measured. On the whole, values were in the range of 76.45 – 93.9%. The values in all the station were statistically similar. The West-North (WNW) wind was the dominant wind direction in the study area. It is a calm gentle breeze. The wind speed was in the range of 0.0 – 3.7 mph.

Table 4.3.1: Climate Characteristic

Sampling Point ID	Wind direction	Wind speed (mph)	Temperature	Relative Humidity (%)
			(ºC)	
SP1	WNW 173º	0.8	29.8	81.6
SP2	SSE 149º	1.2	29.6	81.5
SP3	SSE 150º	0	30.6	82.6
SP4	SSE 149º	0.8	30.6	85.6
SP5	WSW 247º	0.8	31.7	79.3
SP6	WSW 240º	1.5	30.1	93.9
SP7	WSW 182º	0	30.9	80.9
SP8	WNW 192º	2.6	28.9	85.1
SP9	WNW 226º	1	28.9	85.9
SP10	WNW 253º	1.3	30.1	81.4
SP11	WNW 243º	1.7	29.5	85.3
SP12	WSW 079º	0	31.4	86.7
SP13	WNW 220º	0.2	29.31	80.42
SP14	WNW 253º	0.4	28.63	77.46
SP15	WNW 251º	1	30.21	84.32
SP16	WNW 079º	0.2	29.23	80.07
SP17	WNW 220º	1.1	30.37	84.98
SP18	WNW 233º	0.5	29.61	81.72
SP19	WNW 253º	0.1	29.15	79.73
SP20	WNW 073º	0.6	28.4	76.45
SP21	WNW 220º	1.2	30.45	85.33
SP22	WNW 250º	0.7	29.84	82.68
Mean		**0.80**	**29.87**	**82.86**
Control I	WNW 0260º	1.6	30.94	87.44
Control II	ESE 114º	3.7	30.6	76.7
Max.		3.7	31.7	93.9
Min.		0	28.4	76.45

4.3.2 Air Quality

The air quality results are presented in Table 4.3.2. All the air quality indices studied were within regulatory limits. The concentrations of NO_2 ranged between 0.010-0.094ppm with a mean of 0.04ppm. The concentrations of SO_2 ranged between 0.01–0.04 ppm mean of 0.01ppm. Volatile organic carbon (VOC) ranged between 1.06-5 ppm with a mean of 2.33 ppm. Carbon dioxide ranged between 515-721 ppm with a mean of 591.18ppm. Carbon monoxide· was not detected in all the sampling points monitored. The mean concentrations of suspended particulate matter (SPM) measured in all the sampling points ranged between

19.0 – 24.6 µg/m^3 with a mean of 20.64µg/m^3 The main sources of SO_2 are the combustion of Sulphur containing fossil fuels, smelting of Sulphur containing compounds and such related industrial processes (WHO, 1987). Although there are some natural sources of SO_2, man –made contributions are of prime concern in relation to human exposures. Due to the low levels of the air pollutants, no possible health effects are expected from them as per the world health organization classification Table 4.3.3.

Table 4.3.3 also shows that the levels of pollutants were below standards recommended by WHO (1987).

Table 4.3.2: Air Quality

SN	SAMPLE	VOC	SO2 (ppm)	NO2	CO	CO2	Suspended Particulate Matter
				(ppm)	(ppm)		(µg/m3)
		-	260	75.0 - 113	22.8	-	250
1	SP1	2	0.01	0.094	0	621	19.9
2	SP2	3	0.01	0.049	0	591	19.3
3	SP3	4	0.02	0.043	0	531	21.5
4	SP4	3	0.03	0.091	0	721	21.4
5	SP5	4	0.02	0.05	0	631	19.2
6	SP6	5	0.02	0.089	0	659	18
7	SP7	5	0.03	0.008	0	564	19.7
8	SP8	4	0.02	0.051	0	591	20.7
9	SP9	0.04	0.02	0.031	0	562	21.8
10	SP10	0.02	0.01	0.052	0	515	20.1
11	SP11	0.04	0.04	0.078	0	610	24.6
12	SP12	0.02	0.02	0.048	0	521	22.1
13	SP13	0.04	0.01	0.03	0	595	20.7
14	SP14	2.06	0.02	0.01	0	579	20.3
15	SP15	3.4	0.02	0.05	0	620	21.5
16	SP16	1.06	0.01	0.02	0	549	19.4
17	SP17	3.36	0.02	0.05	0	619	21.4
18	SP18	3.06	0.02	0.04	0	610	21.2
19	SP19	3.18	0.02	0.04	0	613	21.3
20	SP20	0.54	0.01	0.03	0	534	19
21	SP21	1.31	0.02	0.01	0	557	19.7
22	SP22	3.18	0.02	0.04	0	613	21.3
	Mean	**2.33**	**0.01**	**0.04**	**0**	**591.18**	**20.64**
23	Control I	0.54	0.01	0.03	0	534	19
24	Control II	1	0.03	0.044	0	538	29.8
	Range	1.06-5.00	0.01-0.04	0.010-0.094	0	515-721	19.0-24.6
	FMEnv	1.9	0.04-0.06	–0.08	10	-	60-90

Table 4.3.3: World Health Organization (WHO) Guidelines for Maximum Exposure to Major pollutants and possible effects if limits are exceeded.

Polluant	Possible Effects	WHO Guidelines
Sulphur dioxide (SO_2)	Worsening respiratory illness from short term exposure, increased respiratory symptoms, including chronic bronchitis, from long-term exposures	40-50 mg/m^3 (annual mean); 100-150 mg/m^3 (Daily average)
Suspended Particulate Matter (SPM)	Pulmonary effects are associated with the combined exposure to SPM and SO_2	Black: 40-60 mg/m^3 (Annual mean). 100-150 mg/m^3 (Daily average) Total SPM: 60-150 mg/m^3 (Annual mean); 150-230 mg/m^3 (Daily average)
Nitrogen dioxide (NO_2)	Effects on lung function in persons suffering from asthma from short-term exposures	150 mg/m^3 for 24 hr mean; 400 mg/m^3: Not to be exceeded
Carbon Monoxide (CO)	Reduced oxygen - carrying capacity of blood	10 mg/m^3 (for 8 hr); not to be exceeded.

Source: WHO Air Quality Guidelines (1987)

4.3.3 Noise levels

The frequency of occurrence of noise levels emanating from the study area was measured and presented in Table 4.3.5. In all the sampling points, noise levels measured were below the tolerable limit or noise level zone that could cause annoyance and they are within the values of 90dBA stipulated by the FMENV and WHO.

Table 4.3.5 Noise Level Measured During the Rainy and Dry Season

S/N	SAMPLE ID	Noise (dB)
		40.5 – 61.4
1	SP1	50.2
2	SP2	61.4
3	SP3	44.5
4	SP4	40.5
5	SP5	53.5
6	SP6	47.5
7	SP7	54.5
8	SP8	51.6
9	SP9	47.5
10	SP10	47.8
11	SP11	47.5
12	SP12	45.3
13	SP13	44.6
14	SP14	44.8
15	SP15	46.1
16	SP16	45.5
17	SP17	44.5
18	SP18	50.3
19	SP19	52.2
20	SP20	48.4
21	SP21	48.8
22	SP22	46.6
	Mean	**46.2**
23	Control I	45.2
24	Control II	47.18
	Range	40.5 – 61.4
	FMEnv	90dBA

4.4. Surface Water

4.4.1 Surface Water Physico-Chemistry

Table 4.4.1 showed the physicochemical quality of the surface water in the study area and control station. The pH of the surface water samples ranged from moderately acidic to slightly acidic. The pH ranged from 5.62 – 6.10 with a mean of 5.86. The pH of the control station was slightly acidic (6.63). The values for total dissolved solid (TDS) ranged from 12.0 – 19.0 mg/l and the mean TDS, 15.5mg/L. The TDS for the control station was 73.0 mg/l.

The salinity of the study area was low (0.01ppt) indicating freshwater. The salinity of the control station was 0.06ppt. Electrical Conductivity 19.0 – 30.0µS/cm while that of the

control station was 121. 0µS/cm. The results showed that the control station had a higher ionic concentration than the study area. The surface water was freshwater

The metal (exchangeable cations and heavy metals) content of the surface water in the study area and control are presented in Table 4.4.2. Calcium (Ca) and Magnesium (Mg), the earth metal in solution constitute the exchangeable cations. Calcium (0.214-0.448 mg/l) and Mg (0.162 – 0.178mg/l). The Ca and Mg concentrations in the study area was lower than in the control stations supporting the initial observation of higher ionic concentration of the control station compared with the study area.

Heavy Metals

Natural waters contain very small quantities of several essential metals including zinc (Zn), copper (Cu), iron (Fe), These metals, also called trace are required by plants and animal in minute quantities and are toxic in relatively high concentrations and are easily assimilated and bio accumulated in the protoplasm of aquatic organisms. The concentrations of zinc and copper in the surface water were low and similar to that of the control station. The concentration of Iron was low and ranged from 1.61 – 2.01mg/l this was similar to that of the control which was1.42mg/l.

Organics

Table 4.4.3 showed the organic (TPH and Oil and Grease) content of the surface water of the study area and control stations. The results suggest high concentrations of Total Petroleum Hydrocarbons (315-700mg/l) and absence of oil and grease (<0.01mg/l) in the study area. Higher concentrations of TPH was observed in the control stations (1,217mg/l) than in the study area. This suggests hydrocarbon contamination in the study area and pollution in the control station. The sources of hydrocarbons in the surface water may result from inputs from watercrafts such as flying boats etc.

Biochemical Oxygen Demand in the study stations were high and ranged from 91-100mg/l. The BOD of the control station was also high (77mg/l). The Chemical Oxygen Demand (COD) from the study area ranged from 130 to 143mg/l while the control station was 111mg/l. These high BOD and COD values confirmed the presence of organic matter in the surface water supporting the results of high TPH observed in the surface water.

Table 4.4.1: Physicochemical Quality of the Surface Water

S/N	STATION	Temp (^{0}C)	pH	DO (mg/l)	Colour (CU)	Sal (ppt)	TDS (mg/l)	TSS (mg/l)	EC (µS/cm)	Ammonia (mg/l)	COD (mg/l)	BOD (mg/l)
1	SP 2	21.5	6.10	7.99	10.0	0.01	12.0	<0.01	19.0	3.26	130	**91.0**
2	SP 4	22.5	5.62	6.29	5.00	0.01	19.0	<0.01	30.0	1.91	143	**100**
	Mean	**22**	**5.86**	**7.14**	**7.5**	**0.01**	**15.5**	**<0.01**	**24.5**	**2.58**	**136.5**	**95.5**
3	CONTROL	22.6	6.63	5.39	5.00	0.06	73.0	<0.01	121	1.21	111	**77.7**

Table 4.4.2: Metal Content of the Surface Water

S/N	STATION	PARAMETERS				
		Magnesium (mg/l)	Calcium (mg/l)	Zinc (mg/l)	Iron (mg/l)	Copper (mg/l)
1	SP 2	0.162	0.214	<0.003	1.61	<0.004
2	SP 4	0.178	0.448	<0.003	2.01	<0.004
	Mean	**0.17**	**0.331**	**<0.003**	**1.81**	**<0.004**
3	CONTROL	2.58	10.6	<0.003	1.42	<0.004

Table 4.4.3: Organic Content of the Surface Water

S/N	STATION	PARAMETERS	
		TPH (mg/l)	Oil and Grease (mg/l)
1	SP 2	700	<0.01
2	SP 4	315	<0.01
3	Mean	507.5	<0.01
\4	CONTROL	1,217	<0.01

4.4.2 Surface water Microbiology

Table 4.4.9 showed the microbial population of the surface water samples in the study area. The microbial populations are normal for freshwater aquatic systems. The heterotrophic bacterial populations represented the highest microbial group of organisms in the water samples. The percentage hydrocarbon utilising bacterial and fungal populations were low suggesting low levels of exposure of resident microbial populations to hydrocarbons. However, high concentrations of TPH was observed in the study area and control. These results suggest that the hydrocarbon contamination/pollution may be temporal and may result from inputs from the watercraft used for sampling or the infrequent discharge of hydrocarbon containing materials into the aquatic system hence low percentage HUB and HUF of water samples in both control and study area. The study samples supported higher microbial counts compared to the control samples indicating that microorganisms at the study stations were exposed to more nutrients in these areas than the control station**.** Faecal coliform counts of both study area (7.8-540MPN/100ml) and control (540MPN/100ml) were high suggesting human faecal contamination of the surface water

Table 4.4.4: Microbiological Quality of Surface Water

S/N	Station	PARAMETERS						
		HUB (cfu/ml)	HUF (cfu/ml)	THB (cfu/ml)	TF (cfu/ml)	%HUB	%HUF	Faecal Coliform (MPN/ 100ml)
1	SP 2	3.00×10^2	$<1.00 \times 10$	5.10×10^3	$<1.00 \times 10$	5.8	0	-
2	SP 4	1.00×10^2	$<1.00 \times 10$	6.50×10^2	$<1.00 \times 10$	15.3	0	7.8
5	**Mean**	**1.5×10^3**	**$<1.0 \times 10$**	**5.8×10^3**	**$<1.0 \times 10$**	**10.55**	**0**	**-**
6	CONTROL	$<1.00 \times 10$	$<1.00 \times 10$	$<1.00 \times 10$	$<1.00 \times 10$	0	0	540

4. 5 Sediment Studies

4.5.1 Sediment Physico-Chemistry

The physico chemical quality of the sediment samples are presented in Table 4.5.1

The sediment within the study stations was slightly acidic with a pH, ranging from 6.14 – 7.31 and a mean value of 6.42. The control station was neutral with a pH of 7.31. The concentration of Na was lower in the study stations when compared with the control station supporting the observation of higher ionic concentrations of the control when compared with the study stations. However, other the concentration of other exchangeable cations in the study station were similar with that of the control. These results indicate that the control station showed tidal influences (nearer to the ocean). The sulphate concentration of the control station was higher than that of the study stations. Phosphate and nitrate concentrations of the study area were similar to that of the control stations.

Heavy Metals

Table 4.5.2 showed the heavy metal content of the sediment. Some heavy metals are pollutants with harmful influences on natural ecosystems and human health e.g. mercury (Hg), lead (Pb), while others are essential nutrients (e.g. zinc (Zn), copper (Cu), iron (Fe), etc). However, even these micronutrients can become harmful if present in excessive amounts. The copper, chromium and lead values of the sediments was less than the equipment detection limit except for one sediment which had lead values of 1.79mg/kg. The concentrations of Fe and Pb was higher in the study stations than in the control station while

Zn recorded higher concentration in the control than in the study stations. The values of other heavy metals were similar for both control and study stations.

Organics

The organic (TPH and Oil and Grease) content of the sediment is presented in Table 4.5.3. The total petroleum hydrocarbons in the sediment in the study area were slightly high. Compared with the control station. The values ranged from 314 - 351mg/kg with a mean value of 489.5 mg/kg, while the oil and grease values for the sediment in both the study area and control was <0.01mg/kg.

Table 4.5.1: Physicochemical Quality of the Sediments

S/N	STATION	PARAMETERS							
		pH	Na (mg/kg	Ca (mg/kg)	K (mg/kg)	Mg (mg/kg)	PO_4 (mg/kg)	SO_4 (mg/kg)	$N0_3$ (mg/kg)
1	SP 2	6.71	7.61	1,197	398	1,995	1.18	92.7	16.8
2	SP 4	6.14	1.21	1,230	381	1,882	1.34	39.8	15.3
3	**Mean**	**6.42**	**5.04**	**1,213.5**	**389.5**	**1,916**	**1.26**	**66.25**	**16.05**
4	CONTROL	7.31	256	1,129	531	1,872	2.62	306	12.5

Table 4.5.2: Heavy Metal Content of the Sediments

S/N	STATION	PARAMETERS												
		Mn (mg/kg)	Cd (mg/kg)	Zn (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Cr (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	V (mg/kg)	As (mg/kg)	Ba (mg/kg)	Co (mg/kg)	Hg (mg/kg)
1	SP 2	<0.002	<0.0028	20.1	14,239	<0.004	<0.005	38.2	1.79	<0.12	<0.16	<0.09	<0.01	<0.01
2	SP 4	<0.002	<0.0028	13.6	9,312	<0.004	<0.005	35.7	<0.012	<0.12	<0.16	<0.09	<0.01	<0.01
3	**Mean**	**<0.002**	**<0.001**	**16.85**	**11,775.5**	**<0.04**	**<0.005**	**36.05**	**0.895**	**<0.12**	**<0.16**	**<0.09**	**<0.01**	**<0.01**
4	CONTROL	<0.002	<0.0028	47.3	4,882	<0.004	<0.005	45.4	<0.012	<0.12	<0.16	<0.09	<0.01	<0.01

Table 4.5.3: Organic Content of the Sediments

S/N	STATION	PARAMETERS	
		TPH (mg/kg)	Oil and Grease (mg/kg)
1	SP 2	314	<0.01
2	SP 4	351	<0.01
3	**Mean**	**489.5**	**<0.01**
4	CONTROL	71.3	<0.01

4.5.2 Sediment Microbiology

Table 4.5.4 showed the microbial population of the sediments. The heterotrophic bacterial and fungal populations in the study station were similar to that of the control station. The percentage (%) hydrocarbon utilising bacterial and fungal populations of both the study area and the control station were high and suggestive of exposure of resident microbial populations to hydrocarbons. This results supports the high TPH concentrations obtained in the sediment. The fungal populations were very low suggesting unsuitable environmental conditions for the growth of fungi in both study area and control.

Table 4.5.4: Microbial Population of the Sediments

S/N	STATION	PARAMETERS					
		HUB (cfu/g)	HUF (cfu/g)	THB (cfu/g)	TF (cfu/g)	%HUB	%HUF
1	SP 2	8.00×10^3	$<1.00 \times 10$	5.85×10^4	$<1.00 \times 10$	13.6	0
2	SP 4	1.00×10^2	$<1.00 \times 10$	4.00×10^3	$<1.00 \times 10$	2.5	0
3	**Mean**	$\mathbf{4.05 \times 10^2}$	$\mathbf{<1.00 \times 10}$	$\mathbf{3.12 \times 10^4}$	$\mathbf{1.00 \times 10}$	**8.05**	**0**
4	CONTROL	6.40×10^3	$<1.00 \times 10$	2.40×10^4	$<1.00 \times 10$	26.6	0

4.6 Soils

The physical and chemical properties of the soil samples of the project area are summarized in Tables 4.6.1 and 4.6.4 in relation to the sampling location.

4.6.1 Soil Physicochemical Quality

The chemical characteristics of the project area are presented in in Table 4.6.1 in relation to the sites where the samples were collected. The soils of the study area were varied from moderately acidic to slightly acidic with a mean pH for top soil (0-15cm) of 6.4 and 6.86 for subsoil (15-30cm). The acidity could be attributed to leaching loss of exchangeable bases. Aroh (2003) reported pH range of 3.8 - 4.0 (1 mol/L KCl) for most soils of Niger Delta which Foth (1984) observed was not good for crop production as most essential nutrients become available at pH 5.5 -7.3. Alberta (2010) reported favourable pH range of 6 to 8.5 in industrial

and natural areas. Severe acidification can cause non reversible clay mineral dissolution and a reduction in cation exchange capacity, accompanied by structural deterioration (Goulding, 2016). The soil pH in this area was good for agriculture activity. There was no significant difference between the temperature of the top soil (24 ^{o}C) and that of the bottom soil (24^{o}C).

Nitrogen is one of the essential elements necessary for plant growth, especially vigour and is listed among the fertilizer key elements in soils of Nigeria. In the study area mean values 213mg/kg and 137.6mg/kg were recorded in the top and bottom soils of the study area. There was decrease in total Nitrogen with depth. In Nigeria, both soils are classified high in total N. The higher N content could be due to litter decomposition and mineralization of organic materials High total N stimulate microbial growth and subsequently increases soil productivity.

Total phosphorus was very low in both soils and far below the critical limit of 15 mg/kg especially in the study area; mean values recorded were 0.728 mg/kg in top soil and 0.914 for bottom soil in the study area. The low P could be attributed to the low content of the parent materials. Higher organic carbon, nitrogen also contributes to higher P. This therefore justify the kind of parent material that could be low P bearing.

Chloride is an essential micronutrient and all crops require Chloride in small quantities. However, it is often associated with salinity damage and toxicity. Chloride ions are derived from chlorine, which is a halogen. Chloride is not a structural element but they play vital roles in plant metabolism (Campbell, 1979). Furthermore, chloride ions are very soluble and are not easily obtained in food crop analysis because of their ionization. Mean chloride concentrations of 64.0 and 37.3 mg/kg were recorded in the top and sub soil of the study area. More commonly, chloride is associated with detrimental effects on *soil salinity*. Based on the threshold of 200 mg/kg (WHO 1983), the soils in the study area were polluted with chloride. SFM (2018) reported that moderately tolerant plants show injury when Cl is within the range of 141 – 350 mg/kg. The soil was suitable for plant growth.

Heavy Metals

The metal content of the soil is presented in Table 4.6.2. Exchangeable K, Mg and Ca were high in the study Ca values ranged from 1,197mg/kg to 2,747mg/kg. Magnesium values ranged from 818mg/kg to 1,573mg/kg. The exchangeable bases decreased slightly with increasing depth in both the study area. The concentrations of these cations improves soil fertility. The relatively higher levels of iron, magnesium and Calcium are not necessarily due to pollution, but rather as a result of the genesis of soil formation. Generally high concentrations of Fe were recorded in both top and sub soils of the study area. Spatial variations were observed in some locations. In some stations there was an increase in concentration of Fe with depth while in some others there was a decrease.in concentration. The spatial variation is probably due to differences in moisture content, clay content, cation exchange capacity, organic matter content and pH of the different sites. The concentrations of the micronutrients/heavy metals (Zn, Cu, Cr, Cd, Mn, V and Ni) were within the permissible limits in the soil as given by and WHO/FAO (2001). The concentrations of the above heavy metals in the study area showed no significant differences though spatial variations were observed. The soils are therefore free from heavy metals contamination.

Organics

Table 4.6.3 showed the organic content (TPH and Oil and Grease) of the soil within the study area. Total Petroleum Hydrocarbon (TPH) of the soil in the study area was high (107 to 362mg/kg). In some locations top soil concentrations were higher than subsoil concentrations in some locations the converse was the case. The study revealed that the soils have been contaminate with hydrocarbons of mineral oil origin. Oil and grease contents were very low in the soil (0.01mg/kg);

Table 4.6.1: Physicochemical Quality of the Soil

S/N	STATION	PARAMETER							
		pH	Temp (^{0}C)	HARDNESS (mg/kg)	ALKALINITY (mg/kg)	CHLORIDE (mg/kg)	TOTAL PHOSPHORUS (mg/kg)	TOTAL NITROGEN (mg/kg)	POTASSIUM (mg/kg)
1	SP 1 0 - 15CM	6.23	26.2	328	216	52.2	0.383	135	234
2	SP 1 15 – 30CM	5.57	25.2	288	184	40.4	1.42	152	254
3	SP 2 0 - 15CM	6.10	25.0	288	184	84.1	1.42	175	222
4	SP 2 15 – 30CM	5.92	24.9	240	152	68.7	0.622	147	173
5	SP 3 0 - 15CM	6.27	24.6	248	160	40.2	1.10	159	63.8
6	SP 3 15 – 30CM	5.74	24.6	280	184	60.8	1.18	155	49.9
7	SP 4 0 - 15CM	5.92	24.3	272	216	80.9	1.34	241	140.6
8	SP 4 15 – 30CM	5.76	24.3	264	184	68.2	0.463	161	216
9	SP 5 0 - 15CM	5.95	24.5	272	168	60.5	1.66	186	168
10	SP 5 15 – 30CM	5.63	24.3	320	232	36.3	0.463	157	92.6
11	SP 6 0 - 15CM	6.18	24.4	240	216	56.0	0.542	181	94.6
12	SP 6 15 – 30CM	5.94	24.3	208	184	36.2	0.702	135	66.2
13	SP 7 0 - 15CM	5.91	24.1	288	192	68.7	0.861	222	69.28
14	SP 7 15 – 30CM	5.79	24.0	240	168	44.3	1.10	93.8	41.2
15	SP 8 0 - 15CM	6.25	23.8	296	232	44.5	0.941	228	364
16	SP 8 15 – 30CM	5.90	24.1	280	200	32.3	0.941	184	117
17	SP 9 0 - 15CM	6.78	23.8	240	216	80.7	0.383	191	101
18	SP 9 15 – 30CM	5.80	24.0	208	184	68.8	1.10	155	91.2
19	SP 10 0 - 15CM	5.96	24.2	224	168	60.9	0.383	226	145
20	SP 10 5 – 30CM	5.87	24.0	192	120	36.2	0.622	219	201
21	SP 11 0 - 15CM	6.42	24.2	328	216	56.4	0.722	167	353
22	SP 11 15 - 30CM	6.52	24.1	248	168	40.6	2.14	226	179
23	SP 12 0 - 15CM	6.49	24.2	216	152	41.4	0.941	111	226
24	SP 12 15 - 30CM	6.60	24.2	176	120	28.6	0.463	92.8	75.8
25	SP 13 0 - 15CM	6.72	26.3	222	112	23.7	0.181	277	112
26	SP 13 15 - 30CM	6.43	25.2	248	106	33.4	0.344	167	56.8
27	SP 14 0 - 15CM	6.49	25.6	260	132	37.8	0.267	154	99.3

28	SP 14 15 - 30CM	6.88	25.9	218	144	39.0	0.442	127	112
29	SP 15 0 - 15CM	5.62	26.1	214	172	29.8	0.654	134	165
30	SP 15 15 - 30CM	6.60	26.2	180	166	25.6	0.523	124	88.7
31	SP 16 0 - 15CM	5.81	24.8	198	208	23.3	0.432	225	75.4
32	SP 16 15 - 30CM	6.73	25.3	174	212	26.4	0.333	147	157
33	SP 17 0 - 15CM	6.48	25.7	220	200	26.0	0.512	209	47.9
34	SP 17 15 - 30CM	6.77	25.9	340	178	26.8	0.412	216	62.8
35	SP 18 0 - 15CM	6.34	25.9	288	140	43.5	0.217	184	132
36	SP 18 15 - 30CM	6.58	26.0	268	154	37.5	0.333	163	112
37	SP 19 0 - 15CM	6.72	26.1	226	162	31.6	0.342	144	106
38	SP 19 15 - 30CM	6.62	26.2	244	172	44.2	0.525	152	88.3
39	SP 20 0 - 15CM	6.49	25.7	204	122	20.9	0.467	173	67.4
40	SP 20 15 - 30CM	6.37	25.9	260	140	34.6	0.213	163	65.2
41	SP 21 0 - 15CM	6.22	26.1	256	152	45.6	0.435	112	135
42	SP 21 15 - 30CM	5.65	26.2	312	144	32.0	0.298	134	152
43	SP 22 0 - 15CM	6.40	26.4	182	216	34.4	0.347	122	123
44	SP 22 15 - 30CM	6.55	26.3	194	206	27.5	0.634	172	67.2
45	SP 23 0 - 15CM	6.73	26.3	192	188	31.0	0.436	132	162
46	SP 23 15 - 30CM	6.92	26.2	236	196	33.9	0.413	126	58.3
	Mean 0-15cm	6.24	25.1	246	174	43.6	0.672	167	132
	Mean 15-30cm	6.25	25.1	244	174	43.3	0.673	167	128
47	Control 0-15cn	7.12	26.5	132	114	20.1	0.156	79.5	54.3
48	Control 15-30cm	6.98	26.2	108	96.0	23.4	0.341	95.8	88.1

Table 4.6.2: Metal Content of the Soil

S/N	STATION	PARAMETERS													
		Fe (mg/kg)	Cd (mg/kg)	Zn (mg/kg)	Ca (mg/kg)	Cu (mg/kg)	Cr (mg/kg)	Mg (mg/kg)	Pb (mg/kg)	V (mg/kg)	As (mg/kg)	Ni (mg/kg)	Co (mg/kg)	Hg (mg/kg)	Ba (mg/kg)
1	SP 1 0 - 15CM	8,401	<0.0028	9.79	2,730	<0.004	<0.005	1,116	<0.012	<0.12	<0.16	37.6	<0.01	<0.001	<0.09
2	SP 1 15 – 30CM	11,896	<0.0028	<0.003	2,747	<0.004	<0.005	1,264	<0.012	<0.12	<0.16	38.1	<0.01	<0.001	<0.09
3	SP 2 0 - 15CM	2,340	<0.0028	1.26	2,540	<0.004	<0.005	976	<0.012	<0.12	<0.16	37.2	<0.01	<0.001	<0.09
4	SP 2 15 – 30CM	3,610	<0.0028	2.23	2,596	<0.004	<0.005	1007	<0.012	<0.12	<0.16	37.2	<0.01	<0.001	<0.09
5	SP 3 0 - 15CM	2,846	<0.0028	5.59	2,528	<0.004	<0.005	818	<0.012	<0.12	<0.16	38.7	<0.01	<0.001	<0.09
6	SP 3 15 – 30CM	4,670	<0.0028	<0.003	2,410	<0.004	<0.005	976	<0.012	<0.12	<0.16	38.6	<0.01	<0.001	<0.09
7	SP 4 0 - 15CM	3,289	<0.0028	2.93	2,393	<0.004	<0.005	1,147	<0.012	<0.12	<0.16	39.8	<0.01	<0.001	<0.09
8	SP 4 15 – 30CM	6,073	<0.0028	9.52	2,376	<0.004	<0.005	1,193	<0.012	<0.12	<0.16	39.6	<0.01	<0.001	<0.09
9	SP 5 0 - 15CM	3,592	<0.0028	0.745	2,258	<0.004	<0.005	1,352	<0.012	<0.12	<0.16	39.0	<0.01	<0.001	<0.09
10	SP 5 15 – 30CM	4,932	<0.0028	<0.003	2,225	<0.004	<0.005	1,568	<0.012	<0.12	<0.16	37.4	<0.01	<0.001	<0.09
11	SP 6 0 - 15CM	1,921	<0.0028	<0.003	2,056	<0.004	<0.005	1,289	<0.012	<0.12	<0.16	37.4	<0.01	<0.001	<0.09
12	SP 6 15 – 30CM	3,424	<0.0028	<0.003	2,106	<0.004	<0.005	1,540	<0.012	<0.12	<0.16	36.0	<0.01	<0.001	<0.09
13	SP 7 0 - 15CM	3,417	<0.0028	0.532	2,073	<0.004	<0.005	1,454	<0.012	<0.12	<0.16	35.7	<0.01	<0.001	<0.09
14	SP 7 15 – 30CM	82.2	<0.0028	<0.003	1,517	<0.004	<0.005	264	<0.012	<0.12	<0.16	30.6	<0.01	<0.001	<0.09
15	SP 8 0 - 15CM	7,162	<0.0028	16.2	1,904	<0.004	<0.005	1,573	<0.012	<0.12	<0.16	39.3	<0.01	<0.001	<0.09
16	SP 8 15 – 30CM	9,618	<0.0028	5.64	1,888	<0.004	<0.005	1,341	<0.012	<0.12	<0.16	37.3	<0.01	<0.001	<0.09
17	SP 9 0 - 15CM	4,515	<0.0028	15.5	1,871	<0.004	<0.005	1,354	<0.012	<0.12	<0.16	35.2	<0.01	<0.001	<0.09
18	SP 9 15 – 30CM	10,247	<0.0028	<0.003	1,820	<0.004	<0.005	1,591	<0.012	<0.12	<0.16	36.8	<0.01	<0.001	<0.09
19	SP 10 0 - 15CM	6,744	<0.0028	46.2	1,803	<0.004	<0.005	2,016	<0.012	<0.12	<0.16	36.2	<0.01	<0.001	<0.09
20	SP 10 5 – 30CM	10,066	<0.0028	<0.003	1,719	<0.004	<0.005	1,714	<0.012	<0.12	<0.16	36.7	<0.01	<0.001	<0.09
21	SP 11 0 - 15CM	5,304	<0.0028	142	1,854	<0.004	<0.005	1,541	<0.012	<0.12	<0.16	36.4	<0.01	<0.001	<0.09
22	SP 11 15 - 30CM	4,461	<0.0028	<0.003	1,197	<0.004	<0.005	1,839	<0.012	<0.12	<0.16	34.8	<0.01	<0.001	<0.09
23	SP 12 0 - 15CM	8,338	<0.0028	<0.003	1,264	<0.004	<0.005	1,634	<0.012	<0.12	<0.16	35.9	<0.01	<0.001	<0.09
24	SP 12 15 - 30CM	5,488	<0.0028	30.2	1,298	<0.004	<0.005	1,635	<0.012	<0.12	<0.16	<0.01	<0.01	<0.001	<0.09
25	SP 13 0 - 15CM	6,213	<0.0028	12.5	1,674	<0.004	<0.005	800	<0.012	<0.12	<0.16	16.4	<0.01	<0.001	<0.09
26	SP 13 15 - 30CM	4,322	<0.0028	<0.003	1,434	<0.004	<0.005	874	<0.012	<0.12	<0.16	33.5	<0.01	<0.001	<0.09
27	SP 14 0 - 15CM	5,123	<0.0028	23.5	1,253	<0.004	<0.005	650	<0.012	<0.12	<0.16	23.6	<0.01	<0.001	<0.09
28	SP 14 15 - 30CM	6,543	<0.0028	<0.003	1,424	<0.004	<0.005	734	<0.012	<0.12	<0.16	34.5	<0.01	<0.001	<0.09

29	SP 15 0 - 15CM	6,161	<0.0028	43.6	1,898	<0.004	<0.005	1,200	<0.012	<0.12	<0.16	12.5	<0.01	<0.001	<0.09
30	SP 15 15 - 30CM	7,345	<0.0028	23.4	2,034	<0.004	<0.005	1,123	<0.012	<0.12	<0.16	54.2	<0.01	<0.001	<0.09
31	SP 16 0 - 15CM	9,191	<0.0028	16.7	1,454	<0.004	<0.005	989	<0.012	<0.12	<0.16	22.5	<0.01	<0.001	<0.09
32	SP 16 15 - 30CM	7,434	<0.0028	<0.003	1,878	<0.004	<0.005	656	<0.012	<0.12	<0.16	32.6	<0.01	<0.001	<0.09
33	SP 17 0 - 15CM	4,176	<0.0028	<0.003	1,439	<0.004	<0.005	870	<0.012	<0.12	<0.16	28.7	<0.01	<0.001	<0.09
34	SP 17 15 - 30CM	9,342	<0.0028	<0.003	1,521	<0.004	<0.005	1,233	<0.012	<0.12	<0.16	14.6	<0.01	<0.001	<0.09
35	SP 18 0 - 15CM	7,170	<0.0028	65.3	1,622	<0.004	<0.005	340	<0.012	<0.12	<0.16	23.6	<0.01	<0.001	<0.09
36	SP 18 15 - 30CM	5,323	<0.0028	23.5	1,782	<0.004	<0.005	450	<0.012	<0.12	<0.16	16.7	<0.01	<0.001	<0.09
37	SP 19 0 - 15CM	6,612	<0.0028	56.4	1,343	<0.004	<0.005	650	<0.012	<0.12	<0.16	19.7	<0.01	<0.001	<0.09
38	SP 19 15 - 30CM	8,154	<0.0028	33.5	1,877	<0.004	<0.005	676	<0.012	<0.12	<0.16	22.5	<0.01	<0.001	<0.09
39	SP 20 0 - 15CM	5,454	<0.0028	54.2	1,090	<0.004	<0.005	998	<0.012	<0.12	<0.16	27.4	<0.01	<0.001	<0.09
40	SP 20 15 - 30CM	3,878	<0.0028	44.7	1,569	<0.004	<0.005	1,548	<0.012	<0.12	<0.16	29.4	<0.01	<0.001	<0.09
41	SP 21 0 - 15CM	6,172	<0.0028	59.3	1,343	<0.004	<0.005	1,451	<0.012	<0.12	<0.16	32.8	<0.01	<0.001	<0.09
42	SP 21 15 - 30CM	4,123	<0.0028	29.0	1,290	<0.004	<0.005	1,611	<0.012	<0.12	<0.16	42.5	<0.01	<0.001	<0.09
43	SP 22 0 - 15CM	5,786	<0.0028	78.9	1,343	<0.004	<0.005	670	<0.012	<0.12	<0.16	38.4	<0.01	<0.001	<0.09
44	SP 22 15 - 30CM	4,989	<0.0028	58.3	1,458	<0.004	<0.005	758	<0.012	<0.12	<0.16	35.7	<0.01	<0.001	<0.09
45	SP 23 0 - 15CM	7,343	<0.0028	94.2	1,333	<0.004	<0.005	564	<0.012	<0.12	<0.16	42.3	<0.01	<0.001	<0.09
46	SP 23 15 - 30CM	6,323	<0.0028	66.5	1,822	<0.004	<0.005	800	<0.012	<0.12	<0.16	22.6	<0.01	<0.001	<0.09
	Mean 0-15cm	5,851	<0.0028	33.5	1,805	<0.004	<0.005	1,134	<0.012	<0.12	<0.16	33.1	<0.01	<0.001	<0.09
	Mean 15-30cm	5,805	<0.0028	35.4	1,785	<0.004	<0.005	1,127	<0.012	<0.12	<0.16	32.7	<0.01	<0.001	<0.09
47	Control 0-15cm	4,343	<0.0028	33.6	1,200	<0.004	<0.005	229	<0.012	<0.12	<0.16	8.13	<0.01	<0.001	<0.09
48	Control 15-30cm	2,121	<0.0028	20.1	1,090	<0.004	<0.005	450	<0.012	<0.12	<0.16	9.06	<0.01	<0.001	<0.09

Table 4.6.3: Organic Content of the Soil

S/N	PARAMETERS		
	STATION	TPH	TOG (mg/kg)
1	SP 1 0 - 15CM	284	403
2	SP 1 15 – 30CM	107	289
3	SP 2 0 - 15CM	188	312
4	SP 2 15 – 30CM	308	434
5	SP 3 0 - 15CM	317	486
6	SP 3 15 – 30CM	298	512
7	SP 4 0 - 15CM	286	503
8	SP 4 15 – 30CM	319	517
9	SP 5 0 - 15CM	324	532
10	SP 5 15 – 30CM	346	544
11	SP 6 0 - 15CM	321	521
12	SP 6 15 – 30CM	336	543
13	SP 7 0 - 15CM	365	564
14	SP 7 15 – 30CM	275	487
15	SP 8 0 - 15CM	250	493
16	SP 8 15 – 30CM	341	562
17	SP 9 0 - 15CM	365	592
18	SP 9 15 – 30CM	348	599
19	SP 10 0 - 15CM	348	592
20	SP 10 5 – 30CM	362	578
21	SP 11 0 - 15CM	148	322
22	SP 11 15 - 30CM	365	612
23	SP 12 0 - 15CM	398	632
24	SP 12 15 - 30CM	326	572
25	SP 13 0 - 15CM	220	540
26	SP 13 15 - 30CM	187	376
27	SP 14 0 - 15CM	267	522
28	SP 14 15 - 30CM	312	576
29	SP 15 0 - 15CM	176	387
30	SP 15 15 - 30CM	199	393
31	SP 16 0 - 15CM	206	480
32	SP 16 15 - 30CM	234	543
33	SP 17 0 - 15CM	276	487
34	SP 17 15 - 30CM	244	498
35	SP 18 0 - 15CM	256	522
36	SP 18 15 - 30CM	322	623
37	SP 19 0 - 15CM	212	534
38	SP 19 15 - 30CM	312	621
39	SP 20 0 - 15CM	215	578
40	SP 20 15 - 30CM	265	583
41	SP 21 0 - 15CM	256	534
42	SP 21 15 - 30CM	333	622
43	SP 22 0 - 15CM	206	579
44	SP 22 15 - 30CM	214	568
45	SP 23 0 - 15CM	245	572
46	SP 23 15 - 30CM	123	453
	Mean 0-15cm	277	519
	Mean 15-30cm	274	520
47	Control 0-15cm	112	278
48	Control 15-30cm	86.0	116

4.6.2 Soil Microbiology

Table 4.6.4 showed the microbial population of the soil within the study area. The bacterial population presented the microbial group with the highest population when compared with fungi. The vertical variation with depth of the microbial population was not evident. The Total Heterotrophic Bacterial. Population was low compared to soils within the Niger delta. The microbial population showed levels of stress due to high levels of hydrocarbons within the soil. Soil TPH levels were high indicating hydrocarbon contamination/pollution of the soils within the study area. The %HUB (2.7 to 71.4%) was high confirming exposure of resident heterotrophic bacterial populations to hydrocarbons of mineral oil origin.

Table 4.6.4: Microbiological Quality of the Soil

S/N	STATION	PARAMETERS					
		HUB (cfu/g)	HUF (cfu/g)	THB (cfu/g)	TF (cfu/g)	%HUB	%HUF
1	SP 1 0 - 15CM	3.60×10^3	$<1.00 \times 10^1$	5.85×10^4	$<1.00 \times 10^1$	6.2	0
2	SP 1 15 – 30CM	2.20×10^3	$<1.00 \times 10^1$	2.40×10^4	$<1.00 \times 10^1$	9.1	0
3	SP 2 0 - 15CM	9.20×10^3	$<1.00 \times 10^1$	2.90×10^4	$<1.00 \times 10^1$	31.7	0
4	SP 2 15 – 30CM	5.30×10^3	$<1.00 \times 10^1$	3.25×10^4	$<1.00 \times 10^1$	16.5	0
5	SP 3 0 - 15CM	2.30×10^3	$<1.00 \times 10^1$	2.75×10^4	$<1.00 \times 10^1$	8.3	0
6	SP 3 15 – 30CM	1.00×10^3	$<1.00 \times 10^1$	1.20×10^4	$<1.00 \times 10^1$	8.3	0
7	SP 4 0 - 15CM	8.60×10^4	$<1.00 \times 10^1$	2.95×10^5	$<1.00 \times 10^1$	29.1	0
8	SP 4 15 – 30CM	7.00×10^4	$<1.00 \times 10^1$	1.10×10^5	$<1.00 \times 10^1$	63.6	0
9	SP 5 0 - 15CM	2.00×10^4	$<1.00 \times 10^1$	1.71×10^5	$<1.00 \times 10^1$	11.7	0
10	SP 5 15 – 30CM	1.00×10^4	$<1.00 \times 10^1$	1.48×10^4	$<1.00 \times 10^1$	71.4	0
11	SP 6 0 - 15CM	2.30×10^4	$<1.00 \times 10^1$	1.31×10^5	$<1.00 \times 10^1$	17.5	0
12	SP 6 15 – 30CM	1.00×10^4	$<1.00 \times 10^1$	1.50×10^4	$<1.00 \times 10^1$	66.6	0
13	SP 7 0 - 15CM	2.00×10^4	$<1.00 \times 10^1$	3.45×10^4	$<1.00 \times 10^1$	58.8	0
14	SP 7 15 – 30CM	1.00×10^3	$<1.00 \times 10^1$	1.00×10^3	$<1.00 \times 10^1$	10.0	0
15	SP 8 0 - 15CM	4.50×10^3	$<1.00 \times 10^1$	1.83×10^4	$<1.00 \times 10^1$	7.3	0
16	SP 8 15 – 30CM	1.90×10^3	$<1.00 \times 10^1$	2.15×10^4	$<1.00 \times 10^1$	3.0	0
17	SP 9 0 - 15CM	1.70×10^3	$<1.00 \times 10^1$	6.15×10^4	$<1.00 \times 10^1$	2.7	0
18	SP 9 15 – 30CM	1.20×10^3	$<1.00 \times 10^1$	1.30×10^4	$<1.00 \times 10^1$	9.2	0
19	SP 10 0 - 15CM	6.20×10^3	$<1.00 \times 10^1$	1.10×10^5	$<1.00 \times 10^1$	5.6	0
20	SP 10 5 – 30CM	3.10×10^3	$<1.00 \times 10^1$	2.55×10^4	$<1.00 \times 10^1$	12.4	0
21	SP 11 0 - 15CM	6.40×10^3	$<1.00 \times 10^1$	2.60×10^4	$<1.00 \times 10^1$	24.6	0
22	SP 11 15 - 30CM	3.20×10^3	$<1.00 \times 10^1$	4.45×10^4	$<1.00 \times 10^1$	7.2	0
23	SP 12 0 - 15CM	1.10×10^3	$<1.00 \times 10^1$	1.10×10^5	$<1.00 \times 10^1$	1.0	0
24	SP 12 15 - 30CM	1.10×10^3	$<1.00 \times 10^1$	2.60×10^4	$<1.00 \times 10^1$	4.2	0
25	SP 13 0 - 15CM	2.39×10^3	$<1.00 \times 10^1$	1.20×10^4	$<1.00 \times 10^1$	19.9	0
26	SP 13 15 - 30CM	2.11×10^3	$<1.00 \times 10^1$	2.50×10^4	$<1.00 \times 10^1$	8.44	0
27	SP 14 0 - 15CM	1.23×10^3	$<1.00 \times 10^1$	1.17×10^4	$<1.00 \times 10^1$	10.5	0
28	SP 14 15 - 30CM	3.30×10^3	$<1.00 \times 10^1$	1.32×10^4	$<1.00 \times 10^1$	25	0
29	SP 15 0 - 15CM	2.43×10^3	$<1.00 \times 10^1$	3.45×10^4	$<1.00 \times 10^1$	7.04	0
30	SP 15 15 - 30CM	1.27×10^3	$<1.00 \times 10^1$	4.30×10^4	$<1.00 \times 10^1$	2.95	0
31	SP 16 0 - 15CM	1.44×10^3	$<1.00 \times 10^1$	3.30×10^4	$<1.00 \times 10^1$	4.36	0
32	SP 16 15 - 30CM	2.50×10^3	$<1.00 \times 10^1$	2.74×10^4	$<1.00 \times 10^1$	9.12	0
33	SP 17 0 - 15CM	2.56×10^3	$<1.00 \times 10^1$	2.12×10^4	$<1.00 \times 10^1$	12.1	0
34	SP 17 15 - 30CM	1.45×10^3	$<1.00 \times 10^1$	2.37×10^4	$<1.00 \times 10^1$	6.12	0
35	SP 18 0 - 15CM	1.40×10^3	$<1.00 \times 10^1$	3.57×10^4	$<1.00 \times 10^1$	3.92	0
36	SP 18 15 - 30CM	2.56×10^3	$<1.00 \times 10^1$	3.65×10^4	$<1.00 \times 10^1$	7.01	0
37	SP 19 0 - 15CM	2.88×10^3	$<1.00 \times 10^1$	4.45×10^4	$<1.00 \times 10^1$	6.47	0
38	SP 19 15 - 30CM	2.10×10^3	$<1.00 \times 10^1$	3.45×10^4	$<1.00 \times 10^1$	6.09	0

39	SP 20 0 - 15CM	1.88×10^3	$<1.00 \times 10^1$	6.23×10^4	$<1.00 \times 10^1$	3.02	0
40	SP 20 15 - 30CM	1.34×10^3	$<1.00 \times 10^1$	4.50×10^4	$<1.00 \times 10^1$	2.98	0
41	SP 21 0 - 15CM	2.50×10^3	$<1.00 \times 10^1$	3.45×10^4	$<1.00 \times 10^1$	7.25	0
42	SP 21 15 - 30CM	2.78×10^3	$<1.00 \times 10^1$	5.34×10^4	$<1.00 \times 10^1$	5.21	0
43	SP 22 0 - 15CM	4.23×10^3	$<1.00 \times 10^1$	6.23×10^4	$<1.00 \times 10^1$	6.79	0
44	SP 22 15 - 30CM	5.43×10^3	$<1.00 \times 10^1$	5.34×10^4	$<1.00 \times 10^1$	10.2	0
45	SP 23 0 - 15CM	4.42×10^3	$<1.00 \times 10^1$	4.23×10^4	$<1.00 \times 10^1$	10.5	0
46	SP 23 15 - 30CM	3.16×10^3	$<1.00 \times 10^1$	4.22×10^4	$<1.00 \times 10^1$	7.49	0
	Mean 0-15cm	7.69×10^3	$<1.00 \times 10^1$	4.84×10^4	$<1.00 \times 10^1$	14.7	0
	Mean 15-30cm	7.79×10^3	$<1.00 \times 10^1$	4.82×10^4	$<1.00 \times 10^1$	14.7	0
47	Control 0-15cm	2.20×10^3	$<1.00 \times 10^1$	3.20×10^3	$<1.00 \times 10^1$	68.8	0
48	Control 15-	1.23×10^3	$<1.00 \times 10^1$	2.10×10^3	$<1.00 \times 10^1$	58.6	0

Plate 4.6.1: Collecting Core Soil Samples with a Soil Auger at Study Area

4.7 Geology and Hydrogeology

4.7.1 Regional Geology/Stratigraphy

The generalized lithostratigraphy of Niger Delta is presented in Fig 4.7.1. The study area is underlain by sedimentary formations of Late Tertiary and Holocene ages. Deposits of recent alluvium and beach ridge sands occur along the coast and the estuaries of the rivers, and also along the flood plains of creeks. The area is characterized by fresh water, beach ridge sands and mangrove swamps. Erosion was noticed at some areas within the study area. This is attributable to loose soil and lack of vegetation cover in those areas.

There are three major lithostratigraphic units defined in the subsurface of the Niger Delta Basin. These units are chronostratigraphic and decrease in age basin ward reflecting the overall regression of depositional environment within the Niger Delta clastic wedge (Short and Stauble, 1967; Weber and Daukuro, 1975).

These units include:

The Benin Formation (Oligocene-Recent), a dominantly fluvial facies unit made up of approximately 90% sand and sandstone and clay. Shallow parts of the formation are composed entirely of non-marine sand deposited in alluvial or upper coastal plain environments during progradation of the delta. The formation thins basin ward and ends near the shelf edge.

The Agbada Formation (Eocene-Recent), a deltaic facies unit is made up of alternating sands, silts and shale units arranged within 10 to 100 feet successions defined by progressive upward changes in grain size and bed thickness. The top of the formation is often defined as the base of fresh water sand.

The Akata Formation (Paleocene-Pleistocene), an open marine facies unit dominated by shales is made up of dark grey shales and silts with rare streeks of sand of probable turbidite origin. Marine planktonic foraminifera make up 50% of the micro fauna assemblage and suggest shallow marine shelf deposition (Doust and Omatsola, 1990).

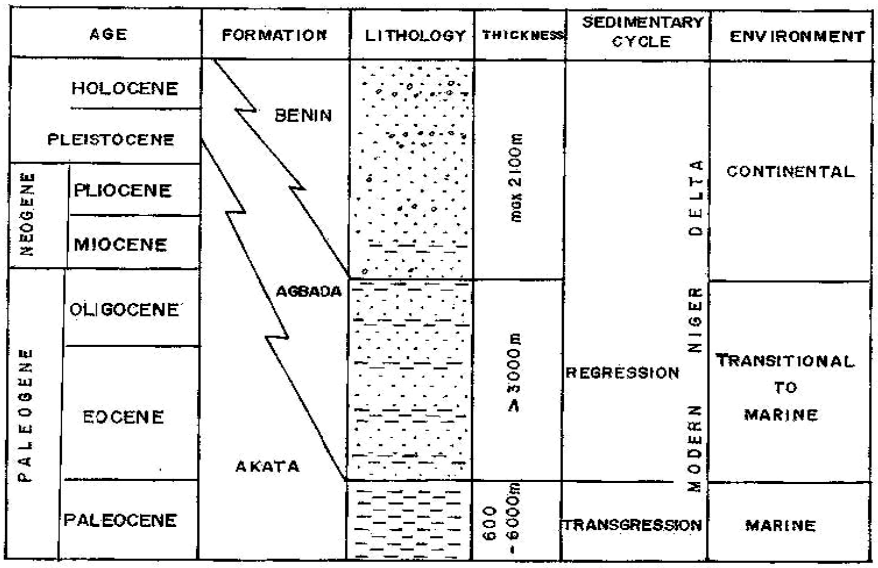

Fig. 4.7.1: Generalized lithostratigraphy of Niger Delta

The sedimentary thickness within the basin is in excess of 8000m (24000ft). These units are overlain in most parts of the delta by Quaternary deposits comprising four (4) geomorphologic units.

These are:

a. **The Deltaic Plain Belt** (Sombreiro-Warri): An extensive low-lying area, dominated by fluvial systems, some with braided characteristics, although a few meander belts are developed. The flood plains are vegetated with raffia palms while the inter-fluvial settings are characterized by oil palm trees.

b. **The Freshwater Swamps and Meander Belts:** These are represented by abandoned meander loops (ox-bow lakes) and extensive point bars. It is capped by natural levees with crevasse splay deposits typifying the flood plains. The vegetation is mainly mangrove.

c. **The Saltwater Mangrove Swamp Belt:** These areas surround the estuaries, creeks and lagoons, and are dominated by a system of interconnecting fairly rectangular meandering tidal flats in places. Thick under-growths and rich mangrove vegetation characterize this belt.

d. **Coastal Islands and Beach Ridges:** This belt includes both active and abandoned ridges facing the sea, separated laterally by the various river mouths which dissect them

into small islands, 5-47km long and approximately 12km wide. Bordering the open sea, the zone of the coastal sand and beach ridges is relatively narrow. It varies from a few hundred metres to about 16km.

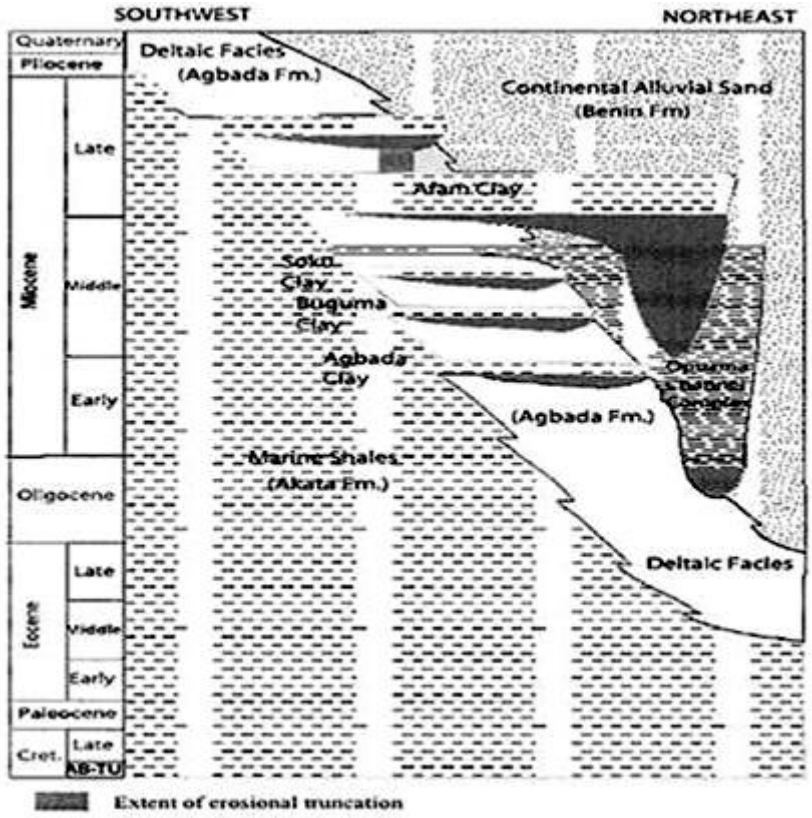

Fig. 4.7.2: Stratigraphic column showing formations of the Niger Delta. Modified from Doust and Omatsola (1990).

4.7.2 Hydrogeology

The study area is characterized by freshwater mangrove swamp. Fresh water aquifers within the deltaic terrain are much deeper, usually in excess of the estimated total thickness of the alluvial deposits. The likelihood of saline intrusion to near surface aquifers is a function of the distance of the site to the shoreline but more especially, in addition, areas affected by tidal influence between the direct contact relationships of the near-surface aquifers to surface flows. This poses a saline pollution effect on this group of aquifer systems and is the case with the aquifers near the sea in the study area. Fig. 4.7.2: Stratigraphic column showing formations of the Niger Delta.

Two stratigraphic units form the main aquifer systems in the delta region (Table 4.7.1), these are:

i. The Alluvium: The aquifer systems within the alluvial deposits, especially the near surface beds close to the shore are often saline bearing. However, the lateral extent of these shallow aquifers is very erratic, occurring as lenses of sands within less permeable beds of silts and clay.

ii. The Benin Formation: For most of the Niger Delta Basin, this chrono-stratigraphic unit forms the main aquifer system, having a total thickness of 1892m (6000ft) around Warri. Its lithologic composition is mainly (90%) sands and sandstones. The remaining 10% is made up of clay and lignitic beds that are hardly continuous over any significant distance - largely occurring as lenses. Thus, the Benin Formation is one large aquifer system with enormous storage.

Recharge to this system is mainly from rainfall, while discharge sources include run-offs from the basin and abstraction through boreholes.

Table 4.7.1: Stratigraphic sequence of the Niger Delta Basin with aquifer prospectively

	Stratigraphic Units	Lithologic Description	Aquifer Prospect
QUAT ERNARY	ALLUVIUM	Gravely sands, sands, silt and clays	Good
	MEANDER BELT DEPOSIT	Gravely sands, sands with thin clay units.	Good
	WOODED BACK SWAMPS & FRESH-WATER SWAMPS DEPOSITS	Mainly silt and silty clays with clayey intercalations	Poor

	MANGROVE SWAMPS DEPOSIT	Fine sands to silt and silty clays and clays with organic matter	Poor (Saline water)
	SOMBREIRO-DELTAIC PLAIN SEDIMENTS	Coarse to fine grained sands, silts and clays	Medium
MIOCENETO RECENT	BENIN FORMATION	Mainly coarse-medium grained sands, lenticular with clay and shaly lens	Prolific Aquifer

4.8 Ground Water Quality

4.8.1 Groundwater Physico- Chemistry

Table 4.8.1 showed the Physicochemical Characteristics of the groundwater within the study area. The ground water samples were from acidic nature. The pH values of the samples ranged from 3.60 – 3.99 with a mean of 3.73. The pH exceeded WHO limits for domestic water acceptability. The values for total dissolved solid (TDS) was 54.0 – 241.0 mg/l and the mean TDS, 123.0mg/L. These values were within international regulatory limits (500mg/l) for domestic water Acceptability. Salinity values ranged from 0.04 - 0.18ppm with a mean value of 0.09ppt. The salinity values exceeded regulatory limits (0.02ppm) for domestic water acceptability. Electrical Conductivity (EC), also called specific conductance, is a measure of the ability of a water sample to convey electrical current and it is related to the concentration of ionized substances in water. The conductivity values ranged from 84.0 – 371.0µS/cm with a mean of 188.0µS/cm. The EC values were within regulatory limits (250 µS/cm) for domestic water acceptability.

Heavy Metals

The metal content in the ground water is presented in Table 4.8.2. Calcium (Ca) and Magnesium (Mg), the earth metal in solution constitute the exchangeable cations. Calcium (0.992 - 9.00mg/l) and Mg (0.750 – 4.78mg/l). The order of dominance which is Ca > Mg. Natural waters contain very small quantities of several essential metals including zinc (Zn), copper (Cu), iron (Fe), These metals, also called trace or heavy metals are required by plants and animal in minute quantities and are toxic in relatively high concentrations and non – biodegradable as well as easily assimilated and bio – accumulated in the protoplasm of

aquatic organisms. The concentrations of zinc, Iron and copper in the ground water are generally low, having concentrations below FMEnv limits for surface waters.

Concentrations of Ca, Mg, Zn Fe and Cu were all within regulatory limits for domestic water acceptability.

Organics

Table 4.8.3 showed the organic content (TPH and Oil and Grease) of the ground water within the study area. Total Petroleum Hydrocarbon (TPH) of the soil in the study area was high (159 to 440mg/kg. The study revealed that the groundwater has been contaminate with hydrocarbons of mineral oil origin. Oil and grease contents were high in the soil (62.2 to 440mg/kg); High BOD (92.6-106mg/l) and COD (130-152mg/l) values of study stations and high BOD (94.5mg/l) and COD (135mg/l) suggest high organic content of groundwater rendering the water unsuitable for domestic use.

Table 4.8.1: Physico-Chemical Properties of Ground Water (Borehole Samples)

S/N	SAMPLE ID	Temp (^{0}C)	pH	DO (mg/l)	Color (CU)	Sal (ppt)	TDS (mg/l)	TSS (mg/l)	EC (µS/cm)	Ammonia (mg/l)	COD (mg/l)	BOD (mg/l)
1	SP 13	22.6	3.99	6.89	1.00	0.05	74.0	<0.01	110	0.377	152	106
2	SP 14	22.2	3.60	6.26	1.00	0.18	241	<0.01	371	0.269	130	92.6
3	SP 15	21.9	3.61	5.29	1.00	0.04	54.0	<0.01	84.0	0.529	135	94.5
	Mean	**22.2**	**3.73**	**6.15**	**1.00**	**0.09**	**123**	**<0.01**	**188**	**0.392**	**139**	**97.7**
	Control I	22.5	5.34	6.62	1.00	0.02	17.3	<0.01	34.6	0.111	54.6	28.2
	Control II	22.3	5.78	6.43	1.00	0.01	26.8	<0.01	54.4	0.093	48.0	21.3

Table 4.8.2: Metal Results of the Ground Water (Borehole Samples)

S/N	SAMPLE ID	Magnesium (mg/l)	Calcium (mg/l)	Zinc (mg/l)	Iron (mg/l)	Copper (mg/l)
1	SP 13	1.11	0.992	<0.003	<0.0046	<0.004
2	SP 14	4.78	9.00	<0.003	<0.0046	<0.004
3	SP 15	0.750	5.18	<0.003	<0.0046	<0.004
	Mean	**2.21**	**5.06**	**<0.003**	**<0.0046**	**<0.004**
	Control I	0.231	1.78	<0.003	<0.0046	<0.004
	Control II	0.336	1.92	<0.003	<0.0046	<0.004
	WHO/FMEnv	100	200	0.03	0.3	0.08

Table 4.8.3: Summary of the Organics Results of the Ground Water (Borehole Samples)

S/N	SAMPLE ID	TPH (mg/l)	Oil and Grease (mg/l)
1	SP 13	211	440
2	SP 14	101	180
3	SP 15	96.2	159
	Mean	**136**	**260**
	Control I	23.5	62.5
	Control II	36.2	71.7

4.8.2 Groundwater Microbiology

The microbiological quality of groundwater within the study area is presented in Table 4.8.1. The results showed that all microbial indices fell short of regulatory requirements for domestic water acceptability.

Table 4.8.4: Microbiological Quality of Ground Water (Borehole Samples)

S/N	SAMPLE ID	HUB (cfu/ml)	HUF (cfu/ml)	THB (cfu/ml)	THF (cfu/ml)
		-	-	-	-
1	SP 13	3.00×10^2	$<1.00 \times 10^1$	5.10×10^4	3.00×10^2
2	SP 14	1.00×10^2	$<1.00 \times 10^1$	6.50×10^3	1.00×10^2
3	SP 15	$<1.00 \times 10^1$	$<1.00 \times 10^1$	$<1.00 \times 10^1$	$<1.00 \times 10^1$
	Mean	**2.00×10^2**	**$<1.00 \times 10^1$**	**2.88×10^4**	**2.00×10^2**
	Control I	$<1.00 \times 10^1$	$<1.00 \times 10^1$	$<1.00 \times 10^1$	$<1.00 \times 10^1$
	Control II	$<1.00 \times 10^1$	$<1.00 \times 10^1$	$<1.00 \times 10^1$	$<1.00 \times 10^1$
	WHO limit	0	0	1.0×10^2	0

Landuse

Anderson *et al* (1976) and Vink (1975) described land use as a set of technological and biological activities engaged in for economic and social purposes. People live in areas where they find their means of subsistence and shun those areas that present difficulties to them. The ecology and physiographic nature of the terrain and the customs and traditions of the people living in the study area to a great extent dictate the land use pattern of the area. Land use is the function of the land determined by natural conditions and human intervention. It is categorized according to status and employment of the land. It is necessary to distinguish present land use

(the way in which the land is used at present) and potential land use (how it could be used with or without improvements).

The proposed quarry plant will be sighted in a rural settlement with some existing industrial activities most quarry, within the community and hence most of the lands are left as secondary re-growth vegetation and hence farming is popular around the proposed Quarry Plant area.

4.10 Vegetation

Vegetation, as a component of the terrestrial environment, serves some very useful functions that are crucial to the ecological system (ecosystem). These include protection of the fragile soils from the erosive impacts of rains and wind, maintenance of soil fertility through continuous nutrient recycling, conservation of water resources through shading, preservation of water sheds, regulation of air and soil temperatures, moisture balance, and stream flow, stabilisation of climate and provision of habitat for countless terrestrial fauna. Vegetation also helps in the purification of the environment through the consumption of carbon dioxide during photosynthesis and the release of oxygen for human and animal respiration.

Urbanisation, civilisation, agriculture, bush burning and other human related factors have immensely contributed to the depletion of vegetal cover. As such, it is difficult to almost impossible, to find entirely pristine vegetal cover in most parts of Nigeria. In the south-south and south-east zone of Nigeria, development has overtaken most of parts, such that only vestiges of natural forests remain, with a large amount of secondary regrowth forests occurring. During this study, attention was focussed on assessing the vegetal conditions around the various sites visited.

Plate 4.10.1: Cross section of vegetation within study area

Plate 4.10.2: Vegetation within the Study Area

Vegetation Physiognomy

There are various distinct classes of vegetation prevalent in the study area. These are strand vegetation, and freshwater/rainforests. The study area lies within the lowland rain forest zone. Over a total of thirty-one (31) well known species were identified in South-South Nigeria. However, more species have been recorded in previous studies in the South east region within the lowland rain forest and also in the secondary forest/bush fallow. The commonest plants within the upland rain forest include trees such as *Anthocleista vogelii, Alstonia boonei, Elaeis guineensis, Chrysophyllum albidum, Funtumia elastica, Musanga cercropioides, Baphia sp, Bambusa sp, Psydrax subcordata,* and *Albizia sp*. Epiphytes found within the forest include; *Diaplazium samattii* and *Asplenium africana.*

The dominant plant species encountered in the oil palm and rubber plantations were; *Elaeis guineensis, Hevea brasiliensis, Selaginella sp, Dryopteris sp Hypoestes cancellata, Tecca sp and Lophira procera.*

A variety of plants were found within the secondary forest/bush fallow areas, the commonest ones being Elaeis guineensis, Alchornea cordiflia, Anthocleista vogelii, Chromolaena odorata, Manniophyton fulvum, Harungana madagascariensis, Ficus exasperata, Rauvolfia vomitoria, Trema orientalis, Aspilia africana and Selaginella sp (Table 4.10.1). Rubber trees (Hevea

brasiliensis) occurred in old plantations within this vegetation zone untended but were still being tapped. The vegetation within this secondary forest/bush fallow habitat is at various stages of development. The system of farming is land rotation in this zone with multiple cropping systems. Fast growing, light demanding species were characteristic of the fallow areas. Examples of plants characteristic of this vegetation type include *Musanga cercropioides, Ficus spp. Spondias mombin, Chromolaena odorata, Rauvolfia vomitoria, Baphia nitida, Harungana madagascariensis, Cnestis ferruginnea,* and *Bambusa vulgaris.*

Generally, because most of the selected power plant sites are built up, in some cases, completely paved, vegetation in the immediate vicinity of power plants are mostly scrubs, grasses and food crops in some cases. Usually, these food crops are planted on a subsistence basis in any available portion of land close by. However, in some cases, secondary rain forests occur close to or a little further away from the power plants.

Plate 4.10.3 Consultant Sampling Vegetation within the Study Area

Plate 4.10.4: Assistant Sampling Vegetation within Study Area

Plate 4.10.5: Consultant and Assistant Sampling Vegetation within Study Area

Table 4.10.1: List of vegetation species identified in Eastern region including Akamkpa LGA

S/N	Botanical	Family	Local	Occurrence
1	*Dennettia tripetala*	*Annonaceae*	*Nmimmi (*Tree)	Medium
2	*Morinda lucida*	*Rubiaceae*	*Nne mmanu (*Tree)	Medium
3	*Alstonia boonei*	*Apocynaceae*	*Egbu (*Tree)	Medium
4	*Uvaria chamae*	*Annonaceae*	*Odu – agu (*Shrub)	High
5	*Anacardium Occidentale*	*Anacardaceae*	*Cashew (*Tree)	High
6	*Piper guineense Schum*	*Piperaceae*	*Uzuza (*Climber)	Medium
7	*Xylopia aethiopica*	*Annonaceae*	*Uda (*Tree)	High
8	*Tetrapleura tetraptrera*	*Leguminosae*	*Nkpokoro nwa ohio*	Medium
9	*Berlinia grandiflora*	*Fabaceae*	*Ububa (*Tree)	High
10	*Elaeis guineensis*	*Arecaceae*	*Nkwu (*Tree)	High
11	*Ocimum gratissmum*	*Lamiaceae*	*Nchu anwu (*Herb)	Medium
12	*Monodora tenuifolia*	*Annonaceae*	*Osisi ogiri/Ehuru*	Low
13	*Abrus precatorius*	*Leguminosae*	*Anyannunu (*Climber)	Medium
14	*Costus afer ker*	*Zingiberaceae*	*Okopto (*Shrub*)*	Medium
15	*Carica papaya*	*Caricaceae*	*Okwuru bekee (*Tree)	Low
16	*Raphia vinifera*	*Arecaceae*	*Ngwo (*Tree*)*	Medium
17	*Euphorbia heterophylla*	*Euphorbiaceae*	*Ogwu afo (*Herb*)*	Medium
18	*Annona senegalensis*	*Combretaceae*	*Nri nnunu (*Shrub)	Medium
19	*Bryophyllum pinnatum*	*Crassulaceae*	*Akwukwo ndu* (Herb*)*	Low
20	*Aichornea cordifolia*	*Euphorbiaceae*	*Ububе (*Shrub)	High
21	*Hedranthera bateri*	*Apocynaceae*	*Amu nkita* (Shrub)	Medium
22	*Pterocarpus soyauxii*	*Fabaceae*	*Oha/Ora* (Tree)	Medium
23	Ceiba pentandra	Bombacaceae	Akpu (Tree)	High
24	Bombax buonopozense	Bombacaceae	Akpu ogiri (Tree)	High

25	Pisidium guajava	Myrtaceae	Gova (Tree)	Medium
26	Mucuna pruriens	Leguminosae	Agbara ohia	Medium
27	Aspilia africana	Compositae	Oranjele (Herb)	Medium
28	Discorea bulbifera	Discoreaceae	Adu (Climber)	Medium
29	Canarium schweinfurthii	Burseraceae	Ube mgba (Tree)	High
30	Cola lepidota	Sterculiaceae	Ochichaa (Tree)	High
31	Irvinga woumbolu	Irvingaceae	Ogbono (Tree)	Medium
NB Occurrence of these species range from Medium to High				

4.10.1 Plant Health Status

The growth of the vegetation in the study area is generally luxuriant and shows no sign of major pathological disorders. The leaf spot disease was observed as the main disease affecting some plants in the area.

4.10.2 Biomass of the Herb Stratum

The biomass productivity of herbaceous layers across the zone was moderate, ranging from 150g/m2 to 475g/m2. The productivity of the herb stratum may have been enhanced by the rains, which tend to maximize weed/plant growth. Plates 1 to 4. Shows the predominant vegetation observed within the Akamkpa Project Site

Plate 4.10.6: Vegetation Enumeration by Consultant

Plate 4.10.7: Palm Tree

Plate 4.10.8: Elephant Grass and Creepers

Plate 4.10.9: Celapagonum sp, Melina sp

4.10.3 Wildlife and Endangered Species

Based on information obtained during the field surveys and from earlier studies on wildlife of the South-south and South-east zones (NDES, 1997; PTF, 2000; Conoil, 2003; ERML 2004), the project area contains a rich diversity of wildlife. Although vegetation type affects the distribution of wildlife, such that aquatic species occur at the coastline and close to riverbanks, while woodland species occur in farmlands, secondary forests, etc., the results presented here cover the entire project area. Wildlife species identified in the include taxa are amphibians, reptiles, birds, and mammals. Similarly, groups of animals identified include small arthropods like crabs and insects. Detailed description of wildlife composition in the general area is presented below.

4.10.4 Diversity and Distribution of Wild Life

Mammals: Mammals known to be present in the area (Table 4.10.2) include *Bosman's Potto, Perodicticus potto, Dwarf Galago, Galagoides demidovii*, Mona Monkey, *Cercopithecus mona*, Bush pig, *Potamochoerus porcus, Sitatunga, Tragelaphus spekei, Bushbuck, Tragelaphus scriptus, Maxwell's Duiker*, *Cephalophus maxwelli,* Tree *Pangolin, Manis tricuspis, Long-tailed Pangolin, M. tetradactyla, Brush-tailed Porcupine, Atherurus africanus, Grasscutter, Thryonomys swinderianus, Gambian Giant Rat Cricetomys gambianus and Crawshay's Hare, Lepus crawshayi*. Others include the African Civet, *Viverra civetta*, the Two-spotted Palm Civet, *Nandinia binotata*, Cape Clawless Otter, *Aonyx capensis*, Spotted-necked Otter, *Lutra maculicollis, Cusimanse* Mongoose, *Crossarchus obscurus*, Marsh

Mongoose, *Atilax paludinosus,* the Gambian Mongoose, *Mungos gambianus*, and genets, presumably the Large-spotted Forest Genet, *Genetta poensis*.

Birds: As will be seen from Table 4.10.3, the study area contains quite a few birds of the waterside and an abundance of species commonly associated with gardens, farmlands, fallows with scattered trees, and dense secondary growth. These include the Grey Heron, *Ardea cinerea*, Village Weaver, *Ploceus cuculatus*, Cattle Egret, *Bulbulcus* ibis, Black-shouldered Kite, *Elanus caeruleus*, Black Kite, *Milvus migrans*, Grey Kestrel, Falco *ardosiaceus*, Senegal Thick-knee, *Burhinus senegalensis*, African Green Pigeon, *Treron calva,* Red-billed Wood Dove, Turtur afer, Senegal Coucal, Centropus senegalensis, Pied Kingfisher, *Ceryl rudis*, the *vinaceous* dove *Streptopelia vinacea* and the African Pied Hornbill, *Tockus fasciatus*.

Reptiles: The reptilian fauna is made up of crocodiles, turtles, tortoises, snakes and lizards (Table 4.10.2). The Monitor Lizard, *Varanus niloticus*, the Nile Crocodile, *Crocodylus niloticus* and the Dwarf Crocodile ("Alligator"), *Osteolaemus tetraspis* are hunted for food. Several species of snakes are said to occur in the area including the Black Cobra, *Naja melanoleuca*, Spitting Cobra, *Naja nigicollis*, Night Adder, *Causus maculatus*, African Beauty Snake (*Psammorphis sibilans*), Royal Python, Python regius, and the Rock Python, Python sebae. Sea turtles that nest annually on the sandy shores, stretching from the Benin River Estuary to the Calabar Bar include the Green Turtle, *Chelonia mydas*, Olive Ridley Turtle, *Lepidochelys olivacea,* Hawksbill Turtle, *Eretmochelys imbricata*, and Loggerhead Turtle, *Caretta caretta.*

Amphibians: Species recorded in the area include: *Bufo regularis* (common toad), ranid frogs: *Dicroglossus occipitalis* (Bullfrog), *Ptychadena oxyrhinchus*, *P. aequplicata,* P. *taenioscelis, Aubria subsigilata,* and *Phrynobatrachs albolabris;* tree-frogs*: Afrixalus dorsalis, Hyperolius fusciventris, H. guttulatus,* and *H. concolor,* and a Clawed toad, *Xenopus tropicalis,* (Table 4.10.2).

4.10.5 Economic Significance of Wildlife

Animals are hunted both for food and for sale. Apart from consumption as food, certain parts of wild animals are also used in folk medicine. Animals kept as pets include doves, turtles, cats etc. These are bred and sold for economic purposes.

Table 4.10.2: The Mammals in the Project Area.

COMMON NAME	SPECIES	CONSERVATION STATUS		
		IUCN	Act No. 11	Project Area
Primates				
Bosman's Potto	*Perodicticus potto*	1	2	Endangered
Demidov's Galago	*Galago demidovii*	1	2	Common
Mona Monkey	*Cercopethicus mona*	2	2	Vulnerable
Pholidota (Pangolins)				
Tree Pangolin	*Manis tricuspis*		1	Vulnerable
Long-tailed Pangolin	*Manis tetradactyla*		1	Vulnerable
Lagomorpha (Hares and Rabbits)				
Crawshay's Hare	*Lepus crawshayi*			Common
Rodentia (Rodents)				
Giant Forest Squirrel	*Protoxerus stangeri*			Vulnerable
Red-legged Sun-squirrel	*Heliosciurus*			Common
Fraser's Flying Squirrel	*Anomalurus*			Endangered
Giant Rat ("Rabbit")	*Cricetomys*			Common
Cane Rat or Grasscutter	*Thryonomys*			Common
Brush-tailed Porcupine	*Atherurus africanus*		1	Common
Carnivora (Carnivores)				
Cape Clawless Otter	*Aonyx capensis*		1	Vulnerable
African Civet	*Viverra civetta*		2	Vulnerable
Two-spotted Palm Civet	*Nandinia binotata*		2	Uncommon
Large-spotted Forest Genet	*Genetta poensis*		2	Vulnerable
Cusimanse Mongoose	*Crossarchus*		2	Common
Gambian Mongoose	*Mungos gambianus*		2	Vulnerable
Marsh Mongoose ('Fox')	*Atilax paludinosus*		2	Endangered
Hyracoidea (Hyraxes)				
Tree Hyrax ("Bush dog")	*Dendrohyrax dorsalis*		2	Common
Artiodactyla				
Bushpig	*Potamochoerus*			Very rare
Maxwell's Duiker	*Cephalophus*		2	Common
Bushbuck	*Tragelaphus scriptus*		2	Uncommon
Sitatunga ("Water Deer")	*Tragelaphus spekei*	1	1	Endangered

Table 4.10.3: Birds in the Project Area

COMMON NAME	SPECIES	CONSERVATION STATUS		
		IUCN	Act No. 11	Project Area
Ardeidae (Herons and Egrets)				
Cattle Egret	*Bubulcus ibis*		2	Uncommon
Grey Heron	*Ardea cinerea*		2	Common
Accipitridae (Vultures, Hawks, Kites, Eagles, etc.)				
Black-shouldered Kite	*Elanus caeruleus*		1	Common
Shikra	*Accipiter badius*		1	Common
Lizard Buzzard	*Kaupifalco*		1	Common
Black Kite	*Milvus migrans*		1	Abundant

Falconidae (Kestrels, falcons)				
Common Kestrel	*Falco tinnunculus*		1	Common
Grey Kestrel	*Falco ardosiaceus*		1	Common
Phasianidae (Francolins & Guinea Fowls)				
Double-spurred Francolin	*Francolinus*		2	Common
Burhinidae (Thick-knees or Stone Curlews)				
Senegal Thick-knee	*Burhinus senegalensis*			Uncommon
Columbidae (Pigeons and Doves)				
Red-eyed Dove	*Streptopelia*			Common
Laughing Dove	*Streptopelia*			Common
Vinaceous Dove	*Streptopelia vinacea*			Uncommon
Red-billed Wood Dove	*Turtur afer*			Common
Tambourine Dove	*Turtur tympanistria*			Common
African Green Pigeon	*Treron calva*			Uncommon
Cuculidae (Cuckoos and Coucals)				
Senegal Coucal	*Centropus senegalensis*			Common
Alcedinidae (Kingfishers)				
Woodland Kingfisher	*Halcyon senegalensis*			Common
Grey-headed Kingfisher	*Halcyon leucocephala*			Uncommon
Shining-blue Kingfisher	*Alcedo quadribrachys*			Uncommon
Malachite Kingfisher	*Corythornis cristata*			Common
Pied Kingfisher	*Ceryl rudis*			Unommon
Meropidae (Bee-eaters)				
White-throated Bee-eater	*Merops albicollis*			Uncommon
Little Bee-eater	*Merops pusillus*			Rare
Bucerotidae (Hornbills)				
African Pied Hornbill	*Tockus fasciatus*			Common
Capitonidae (Barbets)				
Speckled *Tinkerbird*	*Pogoniulus*			Common
Hirundinidae (Swallows)				
Ethiopian Swallow	*Hirundo aethiopicus*			Common
Motacillidae (Wagtails, Pipits, Longclaws)				
African Pied Wagtail	*Motacilla aguimp*			Rare
Pycnonotidae (Bulbuls)				
Common Garden Bulbul	*Pycnonotus barbetus*			Common
Sylviidae (Warblers)				
Grey-backed *Camaroptera*	*Camaroptera*			Common
Nectariniidae (Sunbirds)				
Olive-bellied Sunbird	*Nectarinia chloropygia*			Common
Collared Sunbird	*Anthreptis collaris*			Common
Corvidae (Csite s, Magpies, etc)				
Pied Csite	*Corvus alba*			Common
Passeridae (Sparsites)				

Grey-headed *Sparsite*	*Passer griseus*			Common
Ploceidae (Weavers)				
Village Weaver	*Ploceus cucullatus*			Common
Estrildidae (Finches, Waxbills, Mannikins)				
Bronze *Mannikin*	*Lonchura cucullata*			Abundant
Red-billed Fire-Finch	*Lagonosticta senegala*			Uncommon
Viduidae (Whydahs, Indigo Birds)				

Plate 4.10.11: Vegetation of Study Area

4.11 Socio-Economic Setting of Cross River State

The socio-economic survey was embarked upon to provide baseline data on the socio-economic/health assessment status of the inhabitants around the proposed plant and investigate the perception of the inhabitants of the affected areas on the likely impacts of the project on their general socio-economic well-being.

Socio-economic information presented in this report were obtained mostly from secondary data, including Federal Office of Statistics Publications (2011) and the National Population Commission Census Report (2006). In addition, some on-site information was collected through direct discussions and interviews with people in the area, in the course of field data collection

4.11.1 Socio-Economic Status

Cross River State was created on May 27, 1967 from the Eastern Region. The state is located in the southern part of Nigeria, and its capital is located in the city of Calabar, which is also one of the biggest commercial centers in the state. The State has a land area of 23,074 square kilometres, Density: 191.8/km². The state is also referred to as 'Canaan city" and nicknamed "The People's Paradise". The state shares boundary with Cameroon in the East. Benue state in

the North. Abia and Anambra in the West, and Ebonyi in the North-West, and the Atlantic Ocean in the South. The original name for Calabar was Akwa Akpa, from the Efik language. The city is watered by the Calabar River and Great Kwa Rivers and creeks of the Cross River (from its inland delta).

4.11.2 Ethnic Composition

The State is ethnically diverse including the three major ethnic groups; the Efik, the Ejagham, and the Bekwarra inhabitants. Other minor ethnic group exist such as Yakurrs, Bettes, Yala, Igedes, Ukelles etc. Efik is widely spoken in Cross River State. Other languages spoken includes, Ekoi, Etung, Boki and Becheve.

4.11.3 Demographic Structure

4.11.3.1 Population Distribution

The 2006 census quotes Cross River State as having a total population of 2,892,988 residents (Table 4.11.1). Further information on the population structure shows. Male with 1,471,967 and Female 1,421,021 representing a percentage of 49.1% and 50.9% respectively.

Table 4.11.1: Population of Cross River State

S/N	LOCAL GOVERNMENT	MALE	FEMALE	TOTAL
1	Abi	73,077	71,240	144,317
2	Akamkpa	76,921	72,784	149,705
3	Akpabuyo	141,602	130,660	272,262
4	Bakassi	18,175	13,466	31,641
5	Bekwarra	52,914	52,583	105,497
6	Biase	85,625	82,488	168,113
7	Boki	95,154	91,457	186,611
8	Calabar Municipal	93,092	90,589	183,681
9	Calabar South	94,584	96,931	191,515
10	Etung	41,089	38,947	80,036
11	Ikom	82,646	81,045	163,691
12	Obanliku	55,998	53,635	109,633
13	Obubra	87,153	85,390	172,543
14	Obudu	81,537	79,920	161,457
15	Odukpani	100,697	92,187	192,884
16	Ogoja	86,802	84,772	171,574
17	Yakurr	99,485	96,786	196,271
18	Yala	105,416	106,141	211,557
	Total	1,471,967	1,421,021	2,892,988

Source: National Population Commission, Abuja

Breakdown of age group in the study reveals 0 - 4 years being 1,105,270, 15 - 64 years being 1,697,035, while those aged 65+ were 90,683. Table 4.11.2 shows the age distribution of residents

Table 4.11.2: Age Distribution of Residents;

AGE DISTRIBUTION (C 2006)	
0-9 years	758,791
10-19 years	679,784
20-29 years	553,631
30-39 years	357,611
40-49 years	254,441
50-59 years	142,255
60-69 years	82,052
70-79 years	38,278
80+ years	26,145

4.11.4 The People

The people of Cross River State belong to the Calabar ethnic group of South-South geographical zone in Nigeria. The people in the study area are predominantly Efik and Ejagham

4.11.5 Occupation

Agriculture and fishing is one of the major occupation of the Cross River people. However, the state is blessed with natural resources as shown in Table 4.11.3

Table 4.11.3 Raw Materials Distribution in Cross River State

S/N	LOCAL GOVERNMENT AREA	MINERAL RAW MATERIALS	AGRO RAW MATERIALS
1	ABI	Salt, Limestone	Palm Produce, Cassava, Poultry, Maize, Forestry, Fruits, Vegetables, Rice
2	AKAMKPA	Limestone, Coal, Manganese, Ilmenite, Gold, Quartz, Glass sand, Tourmaline	Timber, Palm Produce, Poultry, Forestry, Fruits, Vegetables, Rubber, Raffia Palm, Gmelina
3	AKPABUYO	Petroleum, Natural Gas	Palm Produce, Cassava, Raffia Palm, Timber, Poultry, Forestry, Fruits, Kolanut, Fishery

4	BAKASSI	Petroleum, Kaolin	Fishery, Raffia Palm, Forestry, Beniseed
5	BEKWARRA		Maize, Cassava, Groundnut, Palm Produce, Yam, Beniseed
6	BIASE	Tin Ore	Fruits, Vegetable, Plantain, Banana, Timber, Forestry, Raffia Palm
7	BOKI	Mica, Ilmenite	Plantain, Banana, Fruits, Vegetable, Livestock, Palm Produce, Raffia Palm, Cocoa, Poultry, Timber, Forestry, Cane Ropes, Coffee.
8	CALABAR MUNICIPAL	Sharp Sand, Kaolin, Limestone, Clay	Fishery, Raffia Palm, Cassava, Palm Produce, Rubber, Vegetable
9	CALABAR SOUTH	Sharp Sand, Clay, Spring Water	Fishery, Vegetable, Cassava, Palm Produce, Raffia Palm
10	ETUNG	Salt	Plantain, Banana, Cocoa, Fruits, Timber, Forestry , Palm Produce, Maize, Livestock, Cassava, Cane Ropes, Coffee
11	IKOM	Quartz, Glass Sand	Plantain, Banana, Cocoa, Fruits, Timber, Forest Produce, Livestock, Yam, Poultry, Palm Produce, Gmelina, Rubber, Maize, Coffee.
12	OBANLIKU	Talc, Mica, Ilmenite, Granite, Spring Water	Maize, Poultry, Livestock, Timber, Forestry, Palm Produce, Yam, Beniseed, Groundnut, Kolanut, Cassava, Rice, Plantain, Banana.
13	OBUBRA	Lead/Zinc, Salt, Tin Ore, Geothite, Quartz, Muscovite, Pure Quartz, Limestone, Clay	Fruits, Rice, Yam, Palm Produce, Poultry, Cassava, Timber, Forestry , Maize, Cocoa
14	OBUDU	Kaolin, Quartz, Glass Sand, Gold, Tin Ore, Mica, Ilmenite, Talc	Poultry, Livestock, Yam, Palm Produce, Beniseed, Kolanut, Groundnut, Maize, Millet, Plantain, Banana
15	ODUKPANI	Limestone	Fishery, Plantain, Banana, Fruits, Vegetable, Timber, Rubber, Palm Produce, Raffia Palm, Cassava, Maize, Kolanut
16	OGOJA	Tin Ore, Clay	Maize, Millet, Cassava, Poultry, Livestock, Sugarcane, Yam, Rice, Groundnut, Beniseed, Palm Produce
17	YAKURR	Uranium	Fruits, Rice, Rubber, Palm Produce, Poultry, Timber, Forestry, Cassava, Maize
18	YALA	Baryte, Lead/Zinc, Salt	Maize, Millet, Cassava, Palm Produce, Poultry, Livestock,

			Yam, Rice, Sugarcane, Fruits, Beniseed

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4.11.6 Religion

The main religions are Christianity and Traditional Religion. Traditional Efik religion included belief in a supreme creator god, ancestral and other supernatural beings, magic, sorcery and witchcraft. However, the publication (1868) of an Efik - language Bible - the first translation of that scripture into a Nigerian language - had a significant impact, and in the 21st century most Efik identified themselves as Christians. Below are notable religious places in Cross River State;

- Jehovah's Witnesses
- The Apostolic Church
- The Redeemed Christian Church of God
- Church of Christ
- Pentecostal Church
- Assemblies of God Church
- Church of God Mission etc.

4.11.7 Educational Facilities

Tertiary educational institutions in the State includes University of Calabar, and Cross River State University of Technology located in the state capital, Calabar. Ibrahim Babangida College of Agriculture located in Obubra Local Government Area. Cross River State College of Education located in Awi – Akamkpa Local Government Area. College of Health Technology, Iboko Okpoma, Federal College of Education located in Obudu and Technical College Ugep located in Yakurr Local Government Area.

Some notable secondary schools (both government and private) in Cross River state includes;

- Access High School - Calabar
- Federal Government Girls College - Calabar
- Marygold International School, Calabar Campus
- Aunty Margaret Group of Schools - Calabar
- University of Calabar Int'l Demonstration Secondary School - Calabar
- FAAN Schools Calabar - Calabar
- Lightway Secondary School
- Treasure Child Comprehensive Secondary School- Akamkpa
- Apostolic Trinity Nursery and Primary School – Akamkpa

- Excel Group of Schools – Akamkpa
- Government Secondary School - Akamkpa
- Uyanga Model High School - Akamkpa
- Institute of Basic Studies, Awi – Akamkpa etc

The National Youth Service Corps (NYSC) Permanent Orientation Camp is located at Obubra Local Government area of the state.

4.11.8 Health Facilities

The state has major government and private hospitals such as: The Health care centre and University of Calabar Teaching Hospital in Calabar etc. However, there is a huge presence of clinics as well as emergency ambulatory services across the state

4.11.9 Cultural Heritage

The Efik-speaking people live mainly in the Southern senatorial districts of Cross River, or as it is commonly referred to the Greater Calabar district, which includes Calabar Municipality, Calabar South, Bakassi, Biase, Akpabuyo, Odukpani, and Akamkpa LGAs. There is also the Qua community in Calabar, which speaks Ejagham. The main Ejagham group occupies mostly the Greater Calabar areas of Calabar Municipality, Odukpani, Biase and Akamkpa sections of Cross River State

There are also the Yakurr/Agoi/Bahumono ethnic groups in Yakurr and Abi LGA, while the Mbembe are predominantly found in Obubra LGA. Further up the core northern part of the state are several sub-dialectical groups, among which are Etung, Olulumo, Ofutop, Nkim/Nkum, Abanajum, Nseke and Boki in both Ikom, Etung and Boki LGAs. Also, the Yala/Yache, Igede, Ukelle, Ekajuk, Mbube, Bette, Bekwarra and Utugwanga people are found in Ogoja, Yala, Obudu and Obanliku and Bekwarra LGA's. The Yala are a subgroup of the Idoma nation, part of the Yala LGA's sub-groups are the Igede speaking people believed to have migrated from the Oju part of Benue State, who migrated from Ora, in Edo North. In Cross River North, Bekwarra is the most widely spoken language. It is understood by other tribes in the district. This language along with Efik and Ejagham is used for news broadcast in the state owned radio and TV stations.

The Efik culture draws from different ethnic groups, i.e., groups from which ancestors of the present-day Efik originated: chiefly from the Orient. Hope Waddell recorded the elaborate funeral rites that marked the death and burial of Efik kings as those he found to be in perfect cultural alignment with corresponding rites in the Orient. In corroborating Waddell, Aye wrote:

…the origin of the Efik people points to the Orient; this is evidenced by the fact that in most of their habits and tradition they are different from their immediate neighbours in many respects, but have strong similarities with early oriental peoples.

4.11.10 Ethical Culture

The Efik ethical culture, which is part of its social culture, emphasizes respect of seniority. Juniors are taught to respect their seniors in all aspects of interpersonal activity both in private and public spaces. It is a necessary condition of greeting for a junior male to use both of his hands to shake a senior male, but the latter must initiate the greeting. Unlike their male counter parts women seldom shake hands but would embrace themselves, their husbands, and close male relatives. Cross River State epitomises the nation's linguistic and cultural plurality and it is important to note that, in spite of the diversity of dialects, all the indigenous languages in the state have common linguistic roots as Niger-Congo languages.

4.11.11 Tourism

Cross River State boasts of being the venue of the largest carnival in Africa. From the soaring plateaus of the mountain tops of Obanliku to the rain forests of Afi, from the Waterfalls of Agbokim and Kwa to the spiralling ox-bow Calabar River which provides sights and images of the Tinapa Business Resort, Calabar Marina, Calabar Residency Museum and the Calabar Slave Park along its course, there is always a thrilling adventure awaiting the eco-tourist visiting Cross River State.

The major tourism attractions of Cross River state includes;

- Agbokim Waterfalls - Located some 17 kilometers from Ikom and about 315 kilometers from Calabar, Agbokim Waterfalls is not far from the Nigeria-Cameroon border. The fall consists of seven streams, each cascading over steep cliff which provides seven - faced falls. located close to Nigeria-Cameroon border,
- Kwa Falls in the Oban division of the Cross River National Park.

- Slave History Museum - located on the site of 15th century slave trading warehouse in Marina Resort, Calabar,
- Obudu Mountain Resort - Located in the highlands of Cross River State (in Obudu, Obanliku LGA.), only 45 miles from the border with Cameroon. It possesses a temperate climate due to its high altitude.
- Tinapa Business Resort (an integrated business and leisure resort) situated in Calabar Municipality. It is a four phased development promoted by the Government of Cross River State, under a Private Public Partnership (PPP), and very close to Calabar Free Trade Zone.
- Visit Drill Ranch (Pandrillus) in Boki – a conservation area at the feet of Afi mountain, a wildlife sanctuary where Drill monkeys, chimpanzees and gorrillas are rehabilitated and reintroduced into the wild.
- Cross River National Park – this park has two sections: Okwangwo (established 1991) and Oban (established 1988). The park is known as the Pride of Nigeria and for good reason, it is home to endangered species of animals and plants and has been listed as a biodiversity hotspot.
- Mary Slessor House – She was a Christian missionary that arrived Nigerian shores in 1876. She settled in Akpap Okoyong, Odukpani Local Government Area of Cross River State and built the two-bedroom mud house with a veranda, a store and a parlour which she called a “Caravan”. This was where she kept the children and twins she saved from death, from the community.
- Torutuga Island - Torutuga Island is an area comprising of three popular plantation-style bars overlooking the nearby Calabar River. It is located in beautiful gardens in Calabar Marina Resort.
- Other tourist attractions are the Ikom Monoliths (a series of volcanic-stone monoliths of unknown age. Cross River State can be accessed by air through the Margaret Ekpo International Airport at Calabar.

4.11.12 Festivals

Cross River state celebrates diverse traditional festivals. Most of these festivals have their roots in traditional religions of the people. Some of these festivals attracts international attention which enjoys state government support.

- Calabar Carnival - The Calabar Carnival is the peak of tourism in Cross River, and perhaps the whole of Nigeria. Every December, tourists from all over the world gather for a month-long (December 1 – December 31) procession and display of culture and heritage from Cross River and different parts of Nigeria.
- New Yam Festival - Bekwarra, Obudu, Obanliku celebrate new yam festival which is held every 1st Saturday of September yearly.
- Cross River State Carnival Float – This takes place every 26 and 27 December yearly.
- Yakurr Leboku Yam festival – This is celebrated every 28 August annually.
- Anong Bahumono – This festival which is held in Anong Village, during which different cultural dances are showcased, including Ikpobin (acclaimed to be the most entertaining dance in the state).
- The Calabar Boat Regata

However, there are daily flights to Calabar from Lagos and Abuja serviced by airlines such as Arik Airlines and Aero Contractors.

4.11.13 Social Organisation and Traditional Governance – Power and Hierarchy Structure

The Efik social structure is strong and organizes under three major rubrics: Esien (clan), ufok (house) and iman (family). To paraphrase Akak,the efik house system is based on the patriarchal character of the Efik social system. Social units which had formed themselves into becoming members of various habitats had first formed themselves into family groups, bearing in mind the shared paternity with one another prior to arriving at their present habitats.

The obong, or paramount leader, elected from among the heads of various Houses, traditionally exercised his authority as head of the Ekpe (Egbo), or Leopard, society. In addition to ritual propitiation of forest spirits to ensure the well-being of the community, this graded secret male society made and enforced laws by fines, capital punishment, or boycotts; judged cases; maintained internal peace; and served as the executive government of Efik society. The Ekpe was composed of the leading men of the community, and its higher grades were open only to those who could pay the heavy entrance fees. It also functioned as a force for tribal unity, as society members from one village were accepted by members in another village. The Ekpe continues to exist, but its dominant role in legislative, judicial, and economic affairs has been taken over by the state. Its putative supernatural powers also have waned.

4.11.14 Political Significance

Calabar once was the seat of Government of the Niger Coast protectorate, Southern Nigeria Protectorate and Oil River Protectorate, and the first Nigerian Capital City. Akak recorded that it was through their Ekpe Confederation that the Efik initiated what is believed to be the African approach to a democratic system of government which later became the model of democracy organization believed to have diffused into Europe where it was modified and passed onto other parts of the world. If we take language to be a political force and press the symbol of civilization, it would be necessary to parlay the political importance of the Efik by virtue of the Efik language being the first African language in print in Africa beginning in 1862.

Below, are the premiers from Cross River State.

- Late Chief [Dr.] Bassey James Ikpeme (first indigenous Surgeon General of Nigeria)
- Late Chief [Mr.] Ekanem Bassey Ikpeme (first female pharmacist in West Africa)
- Professor Lawrence Eyo Ita (first indigenous Nigerian professor and first premier of the former Eastern Region of Nigeria)
- Chief Ita Ekanem (former Registrar of the University of Ibadan)
- Late T. W. Ikpeme (founder and proprietor of St. Georges School in Aba)
- Late Hogan "Kid" Bassey (first Nigerian to win the world feather-weight boxing title)
- Late Etubom Oyo Orok Oyo-Ita (the first Nigerian to represent Africa in FIFA)
- Late Chief [Dr.] James Ene Richard Henshaw was Nigeria's foremost literary artist
- Late Hon Richard Henshaw the first indigenous member of legislature in Lord Lugard's administration.
- Late Chief [Mrs.] Ekei Esien Oku (the first female librarian in West Africa)
- Late Chief Afiong E. Idem Ekeng (the first female Ophthalmic Optician in Nigeria).
- Former Governor Donald Duke (the first Cross River State Governor and visionary who turned local Efik Christmas festivity into international carnival). He is also internationally acclaimed for establishing the Tinapa Holiday Resort.

Furthermore, the first photographic studio in West Africa was established in Calabar in 1876. Willy Eyo Honesty 1 was the first in West Africa to compile a dictionary of an African language in 1812, although the compilation was not completed. The first medical college in Nigeria began in Calabar, so was the first Nigeria's School of Pharmacy in Calabar which

relocated to Lagos in 1924; the first church wedding in Nigeria occurred in Creek Town Presbyterian Church on April 15, 1850.

4.11.15 Infrastructure and Utilities

4.11.16 Water Supply

There was a great difference in ease of access to potable water between the Calabar Metropolis and the rest of the state. In Calabar, 59% of the population had easy access to piped water and 76% had access to borehole water. Yet, in most rural LGAs, citizens had little or no access to either piped or borehole water.

The Scorecard showed that in 2008, 70% of people in the State sourced their water from rivers and streams while only 4.7% and 13.2% of the population used piped and borehole water respectively. Of the communities with piped water supply, 66% had supply less than 3 times a week, 16% had a supply more than 3 times a week and only 18% had a continuous supply.

Recent surveys conducted by RUWATSSA and RUDA indicate that on average access to acceptable water sources across the state is 41% with relatively good access in the Calabar Municipality, Calabar South and Bakassi.

The major source of water in the area remains rainwater, surface water, sub-surfaced water, borehole and pipe-borne water. Studies previous made shows that abundant water can be drawn from surface and sub-surface sources. It maintained that groundwater potential is very good as it is tapped from sandy aquifers. Generally, water resource development the sub-surface is encouraging.

4.11.17 Sanitation

Toilets: Flush-toilet and pit-latrines were commonly used in Akamkpa LGA. Yet around 40% of the focus groups in the rural areas reported that they use bush/field/rivers and not latrines. It is currently estimated that overall access to sanitation facilities across the state between 35% and 40%.

Refuse Disposal: Some 54% of the groups surveyed in Akamkpa LGA have access to a government refuse collection service. However, there was minimal or no refuse collection service in the rural areas of the state.

4.11.18 Road Network

The state enjoys good road network inter-connecting the major towns in the state. Areas like Calabar, Akamkpa, Ugep, Ikom, Akpabuyo and Ogoja and are well inter-connected. For instance, major towns in Cross River like Odukpani and Akpabuyo do not have good road networks causing perenious traffic situation in such areas.

4.11.20 Socio-Economic Characteristics of Respondents

This section examined the sex, age, marital status, educational qualification, household size, employment status, income level, health assessment of respondents. A summary of the main findings of socio-economic variables which are peculiar to Obung community in Akamkpa LGA in Cross River State is presented below (Figure 4.11.20). A set of questionnaires was administered to population size of thirty (30) respondents within close proximity of the proposed Akamkpa Quarry Limited site in Obung, Akamkpa Local Government Area in Cross River State (See sample in Appendix 4.1) and the settlement where inhabitants reside. The questionnaires were designed mainly to collect information on socio-economic variables which are peculiar to the local government.

4.11.21 Sex of Respondents

Table 4.11.4 numerically compares the sex of respondents. It thus, reveals that of the 30 responses from the questionnaires administered, 21 were male, amounting to 70%, while the female were 9%, amounting to 30%.

Table 4.11.4 Sex of Respondents

SEX	NUMBERS	PERCENTAGE (%)
Male	21	70
Female	9	30
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.22 Age of Respondents

The various age range of respondents is shown in Table 4.11.5. The age range below 20 were 3(10%) respondents, 6(20%) respondents were under the ages of 21 – 30, 5(16.7%) respondents within the ages of 31 – 40 were 10 (33.3%), while those who are 51 and above were 6(20%) respondents.

Table 4.11.5 Age of Respondents

SEX	NUMBERS	PERCENTAGE (%)
Below 20	3	10
21 – 30	6	20
31 – 40	5	16.7
41 – 50	10	33.3
51 and above	6	20
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.23 Marital Status of Respondents

Table 4.11.6 shows the marital status of the respondents. It shows that 3(10%) respondents were single. Constituting the highest ranking in the marital status was married showing 23(76.7%). 3 (10%) were widowed while 1(3.3%) were divorced.

Table 4.11.6 Marital Status of Respondents

MARITAL STATUS	NUMBERS	PERCENTAGE (%)
Single	3	10
Married	23	76.7
Widowed	3	10
Divorced	1	3.3

TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.24 Educational Background of Respondents

Table 4.11.7 shows the educational background of the respondents. A total of 3(10%) respondents had attained primary education, more so, 8(26.7%) respondents had attained secondary education while 3(10%) and no respondents had attained tertiary and no-formal education respectively.

Table 4.11.7 Educational Background of Respondents

EDUCATIONAL LEVEL	NUMBERS	PERCENTAGE (%)
Primary	3	10
Secondary	8	26.7
Vocational	3	10
Tertiary	16	53.3
No Formal Education	-	-
TOTAL	**30**	**100**

Source: Geospectra Field work 2020

4.11.25 Religion of Respondents

Table 4.11.8 shows the varied religious denominations of the respondents. The details have it that Christians were 26(86.7%), there were no Muslims, Traditionalist were 3(10%) and others accounted for 1(3.3%) of the population size.

Table 4.11.8 Religion of Respondents

RELIGION	NUMBERS	PERCENTAGE (%)
Christian	26	86.7
Muslim	-	-

Traditional	3	10
Others	1	3.3
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.26. Employment Status of Respondents

Table 4.11.9 shows the employment status of the respondents as revealed in the table below; shows that out of the sampled size, students were 3 (10%), unemployment level is high in the area as 17 respondents (56.7%) were sampled. Employed status shows 9(30%), other categories of employment not listed in the questionnaire accounted for 1(3.3%).

Table 4.11.9 Employment Status of Respondents

EMPLOYMENT STATUS	NUMBERS	PERCENTAGE (%)
Student	3	10
Unemployed	17	56.7
Employed	9	30
Others	1	3.3
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.27 Monthly Income of Respondents

Table 4.11.10 shows the income range of the respondents is shown in the table below. Respondents with ranges between ₦21,001 to ₦40,000 were 5(16.7%) respondents likewise the range between ₦41,000 to ₦60,000 were 10(33.3%), the ranges between ₦61,000 to ₦80,000 were 9(30%), ₦81,000 to ₦100,000 were 3(10%) respondents,3(10%) while 3(10%) respondents were within the range of ₦100,000 and above.

Table 4.11.10 Monthly Income of Respondents

MONTHLY INCOME DISTRIBUTION	NUMBERS	PERCENTAGE (%)
₦ 1,000 – ₦20,000	-	-
₦21,000 - ₦40,000	5	16.7
₦41,000 - ₦60,000	10	33.3
₦61,000 - ₦80,000	9	30
₦81,000 - ₦100,OOO	3	10

Above ₦100,000	3	10
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.28 Residential Status of Respondents;

Wall Type

Table 4.11.11 shows the residential status of respondents based on the construction materials used in the walls of their building. It indicates that the respondents living in mud houses were 1(3.3%), those living in houses with plastered mud were 5(16.7), while those living in houses with cemented walls were 24(80%). There was no recording for those living in wooden walls and other types of wall.

Table 4.11.11 Residential Status of Respondents - Mud

CONSTRUCTION MATERIAL – WALL TYPE	NUMBERS	PERCENTAGE (%)
Mud	1	3.3
Plastered Mud	5	16.7
Cement Blocks	24	80
Wood	-	-
Others (specify)	-	-
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.29 Roofing Type

Table 4.11.12 shows the residential status of respondents based on the construction materials used in the roofing of their building. It indicates that the residents living in houses with roof made of corrugated sheets were 24(80%), those living in roof made of asbestos were 3(10%), those living in houses roofed with tiles were 3(10%), there was no indication for those living in houses with thatch and other types roof.

Table 4.11.12 Residential Status of Respondents - Roofing

CONSTRUCTION MATERIAL – ROOFING	NUMBERS	PERCENTAGE (%)
Corrugated Sheets	24	80
Asbestos	3	10
Tile	3	10
Thatch	-	-
Others (specify)	-	-
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.30 Floor Type

Table 4.11.13 shows the residential status of respondents based on the construction materials used in the flooring of their house. It indicates the residents living in houses with cemented floor were 21(70%), those living in tiled houses were 6(20%). Those living in houses with floor made of terrazzo were 3(10%). No respondent indicated living in earthen and other types of floor.

Table 4.11.13 Residential Status of Respondents - Floor

CONSTRUCTION MATERIAL –	NUMBERS	PERCENTAGE (%)
Earthen	-	-
Cement	21	70
Tile	6	20
Terrazzo	3	10-
Others (specify)	-	-
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.31 Toilet Facility

Table 4.11.14 shows the residential status of respondents based on the construction materials used in the toilet of their house. It indicates the residents using pit latrines were 8(26.7%), those using water-borne system as toilet were 19(63.3%). Those using bush for their toilet needs were 3(10%). No respondent indicated using any other toilet type in their home.

Table 4.11.14 Residential Status of Respondents - Toilet

TOILET FACILITY	NUMBERS	PERCENTAGE (%)
Pit Latrine	8	26.7
Water-borne System	19	63.3

Bush Use	3	10
Others (specify)	-	-
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.32 Tenure of Housing

This shows the residential status of respondents based on their tenure/ status of residence (table 4.11.15). It indicates the residents as owners of the house they are living were 6(20%), those living as tenants with paid rent/lease were 23(76.7%). Those living as tenants with non-rent payment occupiers were 1(3.3%). No respondent indicated using any other type of residency.

Table 4.11.15 Tenure of Housing

TENURE OF HOUSING	NUMBERS	PERCENTAGE (%)
Owner Occupier	6	20
Rent/Lease	23	76.7
Non-Rent Payment Occupier	1	3.3
Others (specify)	-	-
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.33 Lighting Source of Respondents

Table 4.11.16 provides information on the existing condition of lighting being used by the respondents' household. It indicates the respondents using PHEDC, torchlight and batteries were 9(30%). A total number of respondents that relied on PHEDC and Kerosene Lamp for their lighting were 3(10%), those relying only on PHEDC were 1(3.3%), while those with PHEDC and Generator were 17(56.7%). No respondent indicated using any other lighting source.

Table 4.11.16 Lighting Source of Respondents

LIGHTING SOURCE	NUMBERS	PERCENTAGE (%)
PHEDC, Torchlight and Batteries	9	30
PHEDC and Kerosene Lamp	3	10

PHEDC	1	3.3
PHEDC and Generator	17	56.7
Others (Specify)	-	-
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.34 Energy Source (Cooking) of Respondents

Table 4.11.17 provides information on existing condition of energy source for respondents' cooking needs. It indicates the respondents using Charcoal, Firewood and Kerosene were 3(10%). A total number of respondents that relied on Kerosene Stove as their energy source for cooking were 6(20%), those that relied on LPG stove were 17(56.7%), Those that use Electricity/Generator Hot Plate for their cooking needs were 3(10%). Respondents that rely on other energy source for their cooking was 1(3.3%).

Table 4.11.17 Energy Source of Respondent

ENERGY SOURCE	NUMBERS	PERCENTAGE (%)
Charcoal, Firewood and Kerosene	3	10
Kerosene Stove	6	20
LPG Stove	17	56.7
Electricity/Generator (Hot Plate)	3	10
Other (Specify)	1	3.3
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.35 Source of Portable Water

Table 4.11.18 reveals the numbers of respondents whose source of portable water for drinking /other needs. It indicates the respondents sourcing for water from well for daily needs were 1(3.3%). A total number of respondents that relied on personal sunk borehole as their water source were 17(56.7%), those that relied on public water supply were 5(16.7%). Those that rely on water vendor/tanked water for their water needs were 2(6.7%). Respondents that rely on rain harvesting were 3(10%). Other source(s) for their water needs was 1(3.3%).

Table 4.11. 18 Sources of Portable Water

SOURCE OF PORTABLE WATER	NUMBERS	PERCENTAGE (%)

Well	1	3.3
Borehole(Personal)	17	56.7
Public Water Supply	5	16.7
Stream/River	1	3.3
Water vendor/Tanked Water	2	6.7
Rain Harvesting	3	10
Others (Specify)	1	3.3
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.36 Waste Disposal Method of Respondents

This section is directed at assessing existing condition of waste disposal method for respondents. There were no respondents indicating throwing their waste in the drain/gutter. A total number of respondents that relied on private cart pushers for their waste disposal were 2(6.7%), those that burned their waste outside/backyard were 22(73.3%). Those that preferred to bury their waste were 3(10%). While respondents that rely on other disposal source(s) were 3(10%).

Table 4.11.19 Waste Disposal Method of Respondents

WASTE DISPOSAL METHOD	NUMBERS	PERCENTAGE (%)
Through in the drains/gutter	-	-
Private Cart Pushers	2	6.7
Burning Outside/Backyard	22	73.3
Burying	3	10
Other (Specify)	3	10
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.37 Health Status of Respondents

Table 4.11.20 showed the health status of the respondents. A total of 23(76.7%) respondents indicated their health status were good. A respondent indicated his/her health status to be poor with 1 (3.3%) in the health status sector.

4.11.20 Health Status of Respondents

HEALTH STATUS	NUMBERS	PERCENTAGE (%)
Excellent	23	76.7
Good	6	20
Poor	1	3.3

TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.38 Source of Treatment for Sickness

Table 4.11.21 reveals the numbers of respondents for their preferred source of treatment in case of sickness. No respondents relied on self-medication/stay at home to rest. A total number of respondents that relied on buying drugs from medicine hawkers were 17(56.7%), those that relied on going to the chemist were 6(20%). Those that rely on attending government clinic/public hospital for their health needs were 3(10%). Respondents that relied on attending private clinic/hospital were 3(10%). A respondent indicated relying on Trado-medical/Natural medicine for his/her health needs was 1(3.3%).

4.11.21 Source of Treatment for Sickness

SOURCE OF TREATMENT FOR SICKNESS	NUMBERS	PERCENTAGE (%)
Self-medication/Stay at home to rest	-	-
Buy drugs from medicine Hawker	17	56.7
Go to the chemist for Treatment	6	20
Attend Government Clinic/Public Hospital	3	10
Attend private clinic/hospital	3	10
Attend Trado-medical/Natural Medicine home	1	3.3
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.39 Frequency in Accessing Clinic/Hospital

This section is directed at showcasing the frequency of respondents accessing clinic/hospital in case of sickness (Table 4.11.22). It reveals the respondents visiting the clinic/hospital in the last 6 months were 3(10%). A total number of respondents that visited the clinic/hospital were 6(20%), those that visited in the last 5 years were 17(56.7%), and those that visited more than 5 years ago were 3 (10%). Respondents that never visited was 1(3.3%).

Table 4.11.22Frequency in Accessing Clinic/Hospital

FREQUENCY IN ACCESSING	NUMBERS	PERCENTAGE (%)
Last 6 months	3	10
Last 1 year	6	20
Last 5 years	17	56.7
More than 5 years	3	10
Never visited one	1	3.3

TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.40 Type of Ailment/ Disease Experienced in the Last 6 Months

This section is directed at highlighting the kind of ailment/sickness experienced by respondents in the last 6 months (Table 4.11.23). It shows the respondents experiencing headache were 10 (33.3%). A total number of respondents that had fever were 5(16.7%), those that had skin irritation/rashes were 2 (6.7%). Those that that had cough were 5(16.7%). Those with asthma/Nasal Issues were 1 (3.3%). Those with complaints of hypertension were 4(13 %), while respondents with complaints of eye-related problems were 3 (10%). There was no indication for watery tool/diarrhoea, vomiting, sleep disorder/insomnia, chest pain/pneumonia and impaired hearing/partial deafness by respondents.

Table 4.11.23 Type of Ailment/ Disease Experienced In the Last 6 Months

AILMENT/DISEASE	NUMBERS	PERCENTAGE (%)
Headache	10	33.3
Fever	5	16.7
Skin irritation/rashes	2	6.7
-Watery stool/diarrhoea	-	-
Vomiting	-	-
Cough	5	16.7
Sleep disorder/insomnia	-	
Asthma/Nasal Issues	1	3.3
Hypertension	4	13.3
Chest pains/pneumonia	-	-
Burns	-	-
Eye conditions	3	10
Impaired hearing/ partial Deafness	-	
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

4.11.41 Health Risk Living Near a Stone Quarry Site

Table 4.11.24 compares the awareness of respondents on health risk associated with living near a stone quarry site. It thus, reveals that out of the 30 responses from the questionnaires administered, 21 indicated no knowledge of any risk associated living near a stone quarry site amounting to 70% of the population size, while those with a yes knowledge were 9%, amounting to 30% of the population size.

4.11.24 Health Risk Living Near a Stone Quarry Site

AWARENESS	NUMBERS	PERCENTAGE (%)
Yes	9	30
No	21	70
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

Respondents Assessment of Ailment/Disease caused by staying close to Stone Quarry

Table 4.11.25 indicates the respondents' assessment of health risk that inhabitants can suffer associated with living near a stone quarry site. It indicated severe headache constituting 3(10%) of the responses. There was a 6(20%) indication for cough, Asthma/nasal issues accounted for the highest score of 17(56.7). Responses on Impaired eye condition resulting from living within close proximity to site was 1(3.3%), while impaired hearing constituted for 3(10%) of responses from the administered.

Table 4.11.25 Assessment of Ailment/Disease Caused by Staying Close to Stone Quarry

AILMENT/DISEASE	NUMBERS	PERCENTAGE (%)
Severe Headache	3	10
Cough	6	20
Asthma/Nasal Issues	17	56.7
Impaired Eye condition	1	3.3
Impaired hearing/ partial	3	10
TOTAL	**30**	**100**

Source: *Geospectra Field work 2020*

People were generally positively disposed to the planned project, for several reasons but primarily in anticipation of possible employment opportunities. For instance, some youths discussed with in Obung, Community were of the opinion that some employment will be available during construction, while others see the project to bring about improved security and general improvement in the economic activities of the area.

CHAPTER FIVE

POTENTIAL AND ASSOCIATED IMPACT ASSESSMENT

5.1 Introduction

The results of assessment for the potential and associated environmental impacts studies of the proposed Akamkpa Quarry I and II by Akamkpa Quarry Limited is presented in this chapter. The assessment covered impacts on the biophysical environment as well as human health and safety. The objectives of the impact assessment are:

- To identify the potential and associated environmental, social and health impacts of the proposed project project/activities,
- To evaluate the likelihood of occurrence
- To evaluate magnitude and significance of identified impacts.

The impact assessment approach therefore entailed matching the different onsite activities and project phases described in Chapter 3 with the baseline components of the project environment, which is presented in Chapter 4. The onsite activities described in Chapter 3 include:

- Pre-mobilization
- Mobilization
- Project Development
- Commissioning
- Demobilization and Abandonment

5.2 Impact identification and Evaluation

A modified ISO 14000 approach for assessing environmental aspects and impacts was used in the systematic assessment of the potential and associated impacts of the proposed project. The method entailed the identification/assessment/evaluation of the potential and associated impacts of the proposed project using a three-stage approach as illustrated in **Figures 5.1a, b** and **c**.

According to Figure 5.1a below, the process involved firstly, the extraction of specific project tasks that have environmental undertones, then identifying the environmental aspects (elements of the project activities that interacts with the environment either positively or negatively) through the use of a screening criteria. The checklist of identified aspects was evaluated for significance using set environmental criteria, which included stakeholder expectations, regulatory requirements, public perception, industry best practices, abatement costs, relative contribution, scientific evidence, and sensitivity of receiving environment. Following this, the identified significant aspects were recorded.

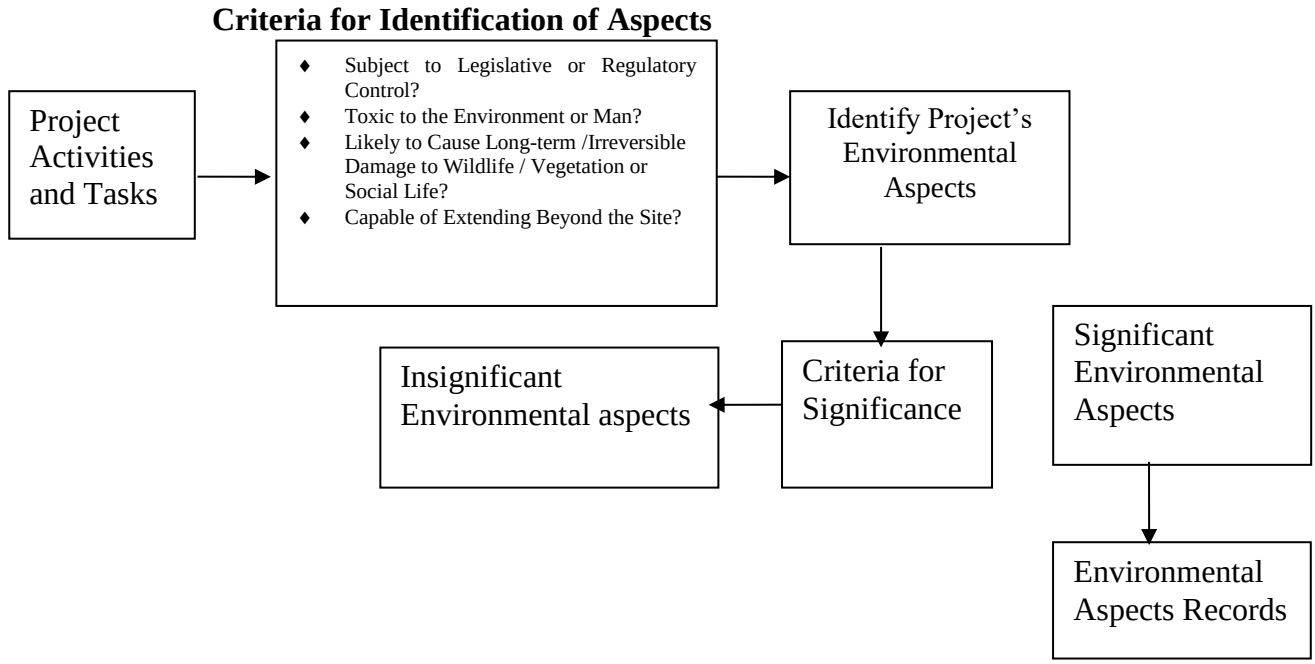


Figure 5.1a: Stage 1: Process of Identifying / Evaluating Environmental Aspects

The output (environmental aspects records) from **Figure 5.1a** was fed into **Figure 5.1b** and used in conjunction with various source reference materials to identify and characterise the potential and associated impacts of the proposed project. The identified impacts were then evaluated and mitigation measures proffered for significant negative impacts as described in **Figure 5.1c**

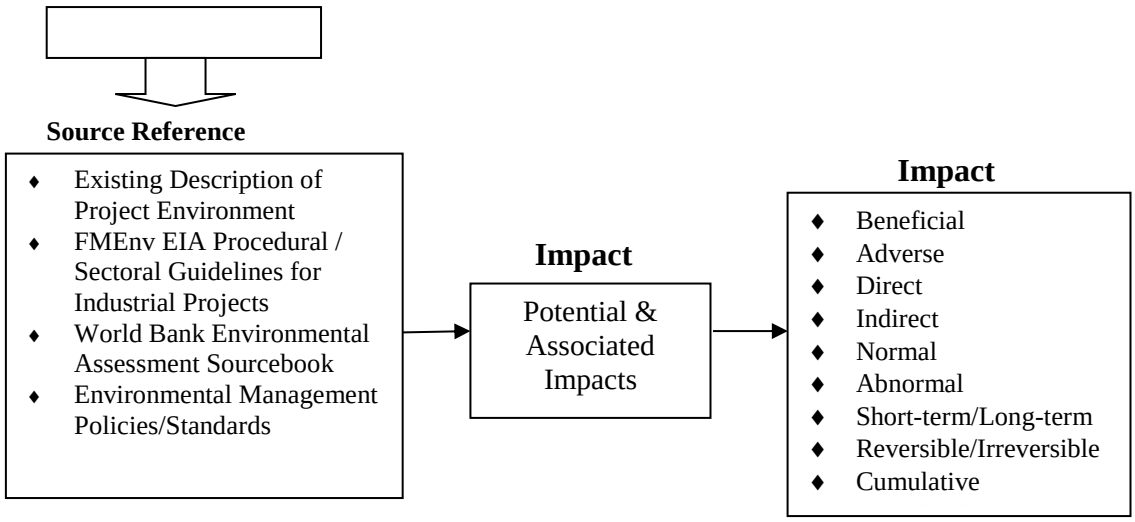


Figure 5.1b: Stage 2: Process of Identifying/Characterising Environmental

The output (environmental aspects records) from **Figure 5.1a** was fed into **Figure 5.1b** and used in conjunction with various source reference materials to identify and characterise the potential and associated impacts of the proposed projects. The identified impacts were then evaluated and mitigation measures proffered as described in **Figure 5.1c**

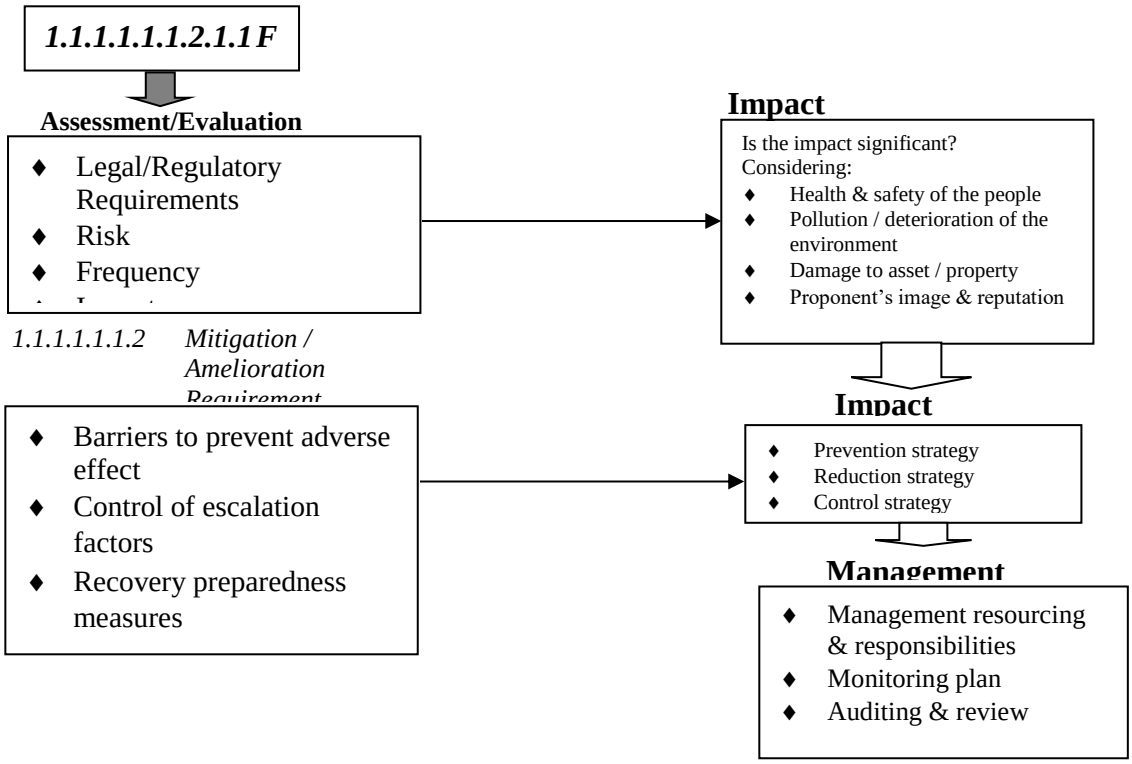


Figure 5.1c: Stage 3: Impact Evaluation, Mitigation and Management

Mitigation measures, which are means to prevent, reduce or control adverse environmental effects of a project were developed for the adverse significant potential impacts through review of industry experience, consultations and expert discussions with multi-disciplinary team of engineers and scientists. Details of the process are discussed in sub-section 5.2.1 to Section 5.3 while the results are presented thereafter in Tables 5.1.

5.2.1 Impact Identification

The environmental aspects of the proposed projects were obtained from the planned project activities. These aspects were then matched with the existing baseline description of the project environment and used to develop a checklist of cumulative, potential and associated impacts of the proposed projects (see Table 5.1). The development of the checklist was carried out using the FMEnv EIA Sectorial Guidelines and the World Bank Environmental Assessment Source Book, Volume III (Guidelines for Environmental Assessment of Energy and Industry Projects, 1991).

5.2.2 Impact Characterisation

The identified impacts of the proposed projects were further characterised as explained in the items listed below. The characterisation was based on the nature, characteristics and estimated duration of the various project activities on the ecological components of the project environment as well as human health and safety.

- **Beneficial Impacts**: These are impacts that creates positive and substantial effect on the environment. The primary benefits of the proposed projects are highlighted in chapter 2 of this report.
- **Adverse Impacts**: These are impacts that may result in: irreversible and undesirable change(s) in the biophysical environment; decrease in the quality of the biophysical environment; limitation, restriction or denial of access to or use of any component of the environment to others, including future generations; and sacrifice of long term environmental viability or integrity for short term economic goals.

- **Direct Impacts**: Direct impact occur through direct interaction of an activity with an environmental, social, or economic component.

- **Indirect Impacts**: Indirect impacts on the environment are impacts that are not a direct result of the project or that are at least one step removed from a project activity. They do not follow directly from a project activity.
- **Normal Impacts**: These are impacts that will usually be expected to follow a particular project activity.
- **Abnormal Impacts**: An impact is considered to be abnormal when it follows a project activity as against sound predictions based on experience.
- **Short-term Impacts**: These are defined as impacts that will last only within the period of a specific project activity.
- **Long-term Impacts**: These are impacts whose effects remain even after a specific project activity.
- **Reversible Impacts**: These are impacts whose effects can be addressed on application of adequate mitigation measures.
- **Irreversible Impacts**: 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 Impacts**: Cumulative impacts consists of an impact that is created as a result of the combination of the project evaluated in the EIA together with other projects causing related impacts these are impacts resulting from interaction between ongoing project activities with other activities, taking place simultaneously.
- **Incremental Impacts**: These are impacts that progress with time or as the project activity advances.
- **Residual Impacts**: These are impacts that would still remain after mitigation measures have been applied.

5.2.3 Impact Evaluation

Impact evaluation assesses the changes that can be attributed to a particular intervention. At this stage, the potential and associated impacts identified and characterised at the previous stage of the assessment process (**see Sections 5.2.1 – 5.2.2**) were evaluated. The evaluation which was based on clearly defined criteria (legal/regulatory requirement, risk, impact frequency, importance and public interest/concern) was used to determine the significance or otherwise of each impact. The criteria and weighting scale adopted for the evaluation are described below.

Legal/Regulatory Requirements (L)

The project activities that resulted in impacts were weighted 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 1 of this report as well as those guidelines in the source references relating to the proposed project activity as presented in Section 5.2 and subsection 5.2.1.

Table 5.1: The weighting scale used was as follows:

Condition	**Rating**
No legal / regulatory requirement attached to environmental impact	1 = Low
Legal / regulatory requirement associated with environmental impact	3 = Medium
A permit is required prior to carrying out project activity with environmental aspects, which may result in impact on the environment	5 = High

Risk Posed by Impact (R)

The criteria used to categorize the risk posed by the impacts of the proposed projects address both the consequence severity and probability or likelihood of occurrence. In determining the likelihood of occurrence, reference was made to historical records of accidents/incidents in AQL operations and in this instance, with special reference to AQL operational areas and facilities. The consequence criterion considers the environmental and socio-economic (workers/public health and safety) attributes of the project area as shown below.

Table 5.2: Consequence Criterion

Consequence	Severity Rating	Attribute – Environmental	Attribute – Workers/Public Health and Safety
Negligible	1	Minor/Little or No Response Needed	>Slight injury (no medical/first aid treatment required)
Minor	2	Moderate/Limited Response of Short Duration	>Minor injury (no lost time) >No impact on public
Moderate	3	Serious/Significant Resources Commitment	>Major injury (lost time) >Limited impact on public

Major	4	Major/Extended Duration/Full Scale Response	>Single fatality >Multiple major injuries >Serious impact on public
Severe	5	Multiple Occurrences/Elongated Duration/Larger Scale Response	>Multiple Fatalities

These consequence criteria are combined with the probability of occurrence to evaluate and categorize the risks posed by impacts into “high = 5”, “medium = 3”, and “low = 1” risk as summarized below in **Figure 5.3**.

Table 5.3: Risk Rating

Risk	**Attribute**
1 = Low	This means that no further mitigation may be required
3 = Medium	This means that the impact can be mitigated with additional controls and modification
5 = High	This means that the impact require avoidance or major control/mitigation

Consequence Rating			Likelihood of Occurrence				
			A	B	C	D	E
			No Known Occurrence in AKAMKPA QUARRY Facility (> 1000 Equipment Years)	Has occurred in AKAMKPA QUARRY Facility (1000 – 100 Equipment years)	Has occurred at AKAMKPA QUARRY Facility locations	Happens several times/year at export terminals (10 – 1 Equipment Years)	Happens several times/year at export terminals
	1	Negligible					
	2	Minor					
	3	Moderate					
	4	Major					
	5	Severe					

Low Risk Medium Risk High Risk

Figure 5.2: Matrix used for assessing Risks posed by impacts

Magnitude of Occurrence of Impacts (F)

Evaluation of the magnitude (anticipated nature, duration and frequency) of occurrence of each impact was also carried out. Magnitude of occurrence was rated as "high", "medium" or "low" based on the historical records of accidents/incidents, consultation with experts (in the industrial operations) and professional judgment. The magnitude criterion is summarised below.

Table 5.4: Magnitude Criterion

Magnitude	Attribute – Environmental, Human Health and Safety
5 = High	♦ 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 (2 months) ♦ Geographic extent of impact
3 = Medium	♦ 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
1 = Low	♦ 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 Environmental Component (I)

The importance of target 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/scientist and other stakeholders of the proposed project. The importance criterion is summarised below.

Table 5.5: Importance Criterion

Importance	Attribute – Environmental
5 = High	• 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 statute
3 = Medium	• Negative outcome • Measurable reduction or disruption in value, function or service of impacted resource • Potential for non-compliance with international best practices
1 = Low	• Imperceptible outcome • Insignificant alteration in value, function or service of impacted resource • Within compliance, no controls required

- **Public Interest/Perception (P)**

  The interest/perception of the public on the proposed projects and the identified potential/associated impact were determined through consultation with the 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 summarised below.

Table 5.6: Public Perception / Interest Criterion

Public Perception	Attribute – Human Health and Safety
5 = High	• Elevated incremental risk to human health, acute and / or chronic • Possibility of life endangered for on-site personnel and nearby residents • Major reduction in social, cultural, economic value • Continuous non-compliance with statute • Any major public concern among population in the project area
3 = Medium	• Limited incremental risk to human health, acute and / or chronic • Unlikely life endangered for on-site personnel and local residents • Some reduction in social, cultural, economic value • Possibility of adverse perception among population • Potential for non-compliance
1 = Low	• No risk to human health, acute and / or chronic • No possibility of life endangered for on-site personnel and local residents • Minor reduction in social, cultural, economic value • Unlikely adverse perception among population

5.2.4 Overall Significance Ranking

The overall significance rating (Level of Significance) assigned to each evaluated impact as presented in Table 5.12, are without consideration for mitigation measures including those controls built into project design. The ratings were based on the following considerations:

High Significance

- (L+R+F+I+P) ≥ 15 or
- (F+I) > 6 or
- P = 5

Impacts with this category are adverse impacts and would require avoidance or major Control/mitigation.

Medium Significance

- (L+R+F+I+P) ≥ 8 but < 15

Impacts in this category are adverse impacts and can be mitigated with additional controls and modifications.

Low Significance

- (L+R+F+I+P) < 8

Impacts in this category may require no further modification

Table 5.7 Phases of Project Development Activities and Source of Impact

S/N	Project Phases	Activities/Source of Impact
1	Mobilisation	Road traffic, Influx of Persons
2	Site Preparation	Road traffic, bush clearing, waste disposal, dust
3	Quarry Plant Construction	Blasting/Excavation, Pilling, Welding, Painting, Waste disposal, Road traffic, Noise

4	Operation and Maintenance	Blasting, Noise, Waste generation, Influx of Persons, Dust emissions, traffic generation
5	Decommissioning and abandonment	Dismantling and Removal of equipment and structures, waste disposal, residual contamination, road traffic

5.3. Beneficial Impact

- Improvement of the economic status of landlords and traditional rulers through payment of adequate compensation
- Mining and production of chippings of various sizes will contribute to revenue generation contributes to revenue to the government
- Contribute to the general economic growth of the country as it would positively affect directly or indirectly some sectors of our country
- Creation of employment opportunities for both skilled and unskilled labour that will employed at different phases of the project
- Increase in socioeconomic activities in Akamkpa due to the purchase of chippings and other associated activities
- Chippings of various sizes will be made available for construction activities in Cross Rivers State and other South States and Southeastern States.
- There will be transfer of technical knowledge in mining industry to Quarry workers

5.8 Table Associated and Potential Impacts of the Project

Project Phase	Project Activities	Environmental /Social/Health Component	Potential /Associated Impacts
Premobilization /Mobilization /Preconstruction	Land take/Site acquisition /Land Survey	Vegetation, soil, wildlife, land use	Vegetation cover removal leads to destruction of natural habitat of the soil flora and fauna and migration of wild life
		Socioeconomic	Improvement of the economic status of landlords and traditional rulers through payment of adequate compensation
		Socioeconomic (Personal Safety)	Security problems due to community interference and conflicts
		Health of workers	Injury to personnel (surveyors) due to exposure to wild bushes and animals
	Transportation of equipment / materials / personnel to worksite	Air quality, and Personal Safety	Increased traffic volume/delays due to daily movement of work trucks and personnel to site
		Health of workers	Injury / death / assets damage due to road traffic accidents and incidents e.g., collision

		Air Quality	Negative effects on air quality due to emission of atmospheric pollutants (CO_X, NO_X, etc.) from internal combustion engines/exhausts during personnel movement
Construction of Quarry Plant (Quarry, Offices, Base camps) Rock Processing Stage	Site Preparation / Site clearing to remove vegetation	Vegetation	De-vegetation of the proposed project area and loss of local flora
		Vegetation, Soil	Changes in drainage and hydrological patterns which may result in erosion and flooding in the area
		Air Quality	Negative effects on air quality due to emission of atmospheric pollutants (CO_X, NO_X, etc.) from earth moving equipment and localized increase in background noise level
		Socioeconomic	Creation of jobs and job opportunities
	Rock Quarrying	Air Quality	Negative effects on air quality due to emission of atmospheric pollutants (CO_X, NO_X, etc.) from earth moving equipment and localized increase in background noise level
		Health of workers	Increase in the ambient noise level in the area above baseline values due to noise generated from during drilling of holes
		Health of workers	Injury / death / asset damage due to work place accidents/incidents during crushing/installation

	Excavation and Overburden Removal	Soil	Soil compaction due to heavy vehicle movement, excavated material will affect diversity of soil fauna within the area, alteration of drainage pattern.
	Dumping of the material conveyed by the dump truck to the crushing machine into the feed	Soil, Rocks	Injury / death / assets damage due to accidents during dumping of materials from point of generation to the feed hopper
	Installation of crushers and conveyor belts	Health(Radiation and Heat) of workers	Welders exposed to heat and light radiation, heat rashes, welding flashes leading to eye diseases
		Socioeconomic health	Increase in population leading to transmission of infectious diseases especially sexual transmission infections
		Soil	Reduction in cases of dumping of materials within and around crushing locations
		Socioeconomic	Community conflicts resulting from labour and recruitment issues, and compensation leading to security problems
		Soil	Pollution of soil and groundwater sources around the facility from improper management of wastes meant for incineration and ash residue
	Levelling compaction	Soil, water	Exposure of soil organisms to weather conditions Pollution of soil and groundwater sources around the facility from

			improper management of wastes meant for incineration and ash residue
Operational and Maintenance	Aggregate crushing and sorting	Air quality/ noise	Increase in exhaust gases, increase in ambient noise levels
	Rock blasting	Air quality/ noise	Increase in exhaust gases, increase in ambient noise levels
		Social	Significant noise, cracks in houses, shock and injuries
	Transportation of produced quarry aggregates	Socioeconomic/Health	Increase in income of workers Road traffic accidents Increased noise and vibrations
Decommissioning / abandonment	Decommissioning / abandonment and ancillary facilities	Soil and groundwater	Soil and groundwater contamination from wastes abandoned at the site
		Land use, soil, vegetation and socioeconomics	Possible use of abandoned quarry as landfill Soil contamination stagnant pools of water, explosives chemicals etc

5.4 Result of Impact Assessment

The results of the impact assessment exercise as discussed in the previous sections are presented in Table 5.10. The table presents the various project phases, planned project activities, the environmental aspects of the proposed project as well as the identified associated and potential impacts. Also included in the table are the impact significance evaluation criteria: legal/regulatory requirements (L), risk posed by the impact (R), and magnitude of occurrence (M), Importance of affected environmental component (I) and Public Perception (P). In addition, the overall ratings of impact significance (High, Medium or Low) of each impact considered have been included. These were based on the summations already described.

Table 5.9: Potential and Associated Impact Assessment of the Proposed Project

Project Phase	• Project Activity / Environmental Aspect	Potential and Associated Impact	Impact Characterisation	• Impact Significance Evaluation					Sum	Overall Significance Rating
				L	R	M	I	P		
Site Acquisition	Land take	Restriction of access to the proposed facility area (60hectares) for as long as the facility exist	Adverse, direct, long-term, normal	0	1	3	3	3	11	Medium
		Improvement of the economic status of landlords and traditional rulers through payment of adequate compensation	Beneficial, direct, normal, short-term, incremental	-	-	-	-	-	-	Beneficial
		Security problems due to community interference and conflicts	Adverse, indirect, abnormal, short term	0	3	3	3	5	14	High
	Site Survey	Injury to personnel (surveyors) due to exposure to wild bushes and animals	Adverse, direct, abnormal, short-term, residual	0	1	3	3	3	9	Medium

• Mobilisation / Demobilisation (Movement of vehicles and personnel**)**	Transportation of equipment / materials / personnel to worksite	Increased traffic volume/delays due to daily movement of work trucks and personnel to site	Adverse, direct, normal, short-term, reversible,	0	1	1	1	3	6	Low
		Injury / death / assets damage due to road traffic accidents and incidents e.g., collision	Adverse, direct, abnormal, short-term or long term, Residual	3	5	1	1	5	15	High
		Negative effects on air quality due to emission of atmospheric pollutants (CO_X, NO_X, etc.) from internal combustion engines/exhausts during personnel movement	Adverse, direct, normal, Short-term	3	1	1	1	1	7	Low
		Noise nuisance from increased vehicular movement / use of internal combustion engines	Adverse, direct, normal, short-term, incremental, residual	3	1	1	3	1	9	Medium
Site Preparation / Site clearing to remove vegetation	Vegetation clearing within the	De-vegetation of the proposed project area and loss of local flora	Adverse, direct, normal, long-term	3	1	3	3	3	13	Medium

	proposed facility area									
	• Stripping of topsoil and compaction of same with earth moving equipment within the proposed project location	Changes in drainage and hydrological patterns which may result in erosion and flooding in the area	Adverse, direct, short-term, abnormal,	0	3	3	3	3	12	Medium
		Negative effects on air quality due to emission of atmospheric pollutants (CO_X, NO_X, etc.) from earth moving equipment and localized increase in background noise level	Adverse, direct, normal, Short-term	3	1	1	3	1	9	Medium
	• General site preparation activities	Creation of jobs and job opportunities	Beneficial, direct, normal, short-term, incremental	-	-	-	-	-		Beneficial

Impact Significance Criteria
L = Legal/Regulatory requirement P = Public Perception/Interest
R = Risk posed by impact
M = Envisaged magnitude of impact

Significance Rating Criteria
High = (L+R+M+I+P) = ≥ 15 or (M+I) > 6 or P = 5
Medium = (L+R+M+I+P) ≥ 8 but < 15
Low = (L+R+M+I+P) < 8

Project Phase	Project Activity/Environmental Aspect	Potential and Associated Impact	Impact Characterisation	• Impact Significance Evaluation					Sum	Overall Significance Rating
				L	R	M	I	P		
Rock Quarrying extraction process	Overburden removal to expose rock	Increase in the ambient noise level in the area above baseline values due to noise generated from during drilling of holes.	Adverse, direct, normal, short-term, incremental, cumulative	3	1	1	1	1	7	Low
	Rock drilling for pit development / holes with the use of air or hydraulically powered drilling machine.	Injury / death / asset damage due to work place accidents/incidents during crushing/installation	Adverse, direct, abnormal, long-term, irreversible, residual	3	5	1	5	5	19	High
	Crushing plant installation / Loading of broken or disintegrated	Localised increase (above baseline values) in ambient concentrations of air pollutants (NO_x, SO_x, CO_x, C_xH_y, H_2S, & SPM) from drilling machines used for drilling of blast holes into rock.	Adverse, direct, normal, short-term, cumulative, residual	3	3	1	3	1	11	Medium

	rock fragments with excavators into dump trucks and conveyed to the crushing machines.	Damage to ecological resources, and environmental degradation by minor spillages during fuelling of drilling machines	Adverse, direct, abnormal, short-term	0	1	1	3	1	6	Low
		Indiscriminate disposal of sanitary and domestic wastes during drilling of holes	Adverse, direct, abnormal, short-term, reversible	0	1	1	1	1	4	Low
		Wildlife migration, exposure of soil to weather conditions, fauna habitat loss injury to wild animals	Adverse, direct, long term, reversible	0	5	5	3	5	18	High

Project Phase	**Project Activity/Environmental Aspect**	**Potential and Associated Impact**	**Impact Characterisation**	• Impact Significance Evaluation					**Sum**	**Overall Significance Rating**
				L	**R**	**M**	**I**	**P**		
Rock Processing Stage		Injury / death / assets damage due to accidents during dumping of materials from point of generation to the feed hopper	Adverse, direct, abnormal, short-term or long term, Residual	3	5	1	5	5	19	High

	• Dumping of the material conveyed by the dump truck to the crushing machine into the feed hopper of the primary jaw crusher.	Reduction in cases of dumping of materials within and around crushing locations	Beneficial, direct, normal, long-term, cumulative	-	-	-	-	-	-	Beneficial
		Community conflicts resulting from labour and recruitment issues, and compensation leading to security problems	Adverse, indirect, abnormal, short – or long- term	0	3	3	3	5	14	High
	Screening of the materials leaving the cone crushing stage.	Pollution of soil and groundwater sources around the facility from improper management of wastes meant for incineration and ash residue	Adverse, direct, abnormal, short – or long-term, reversible	3	3	3	3	3	15	High
		Fire outbreak, destruction of facility, loss of life of personnel due to malfunctioning of facility or operators fault	Adverse, direct, abnormal, long-term, irreversible	3	5	5	1	5	19	High
	Maintenance and general operations of the facility	Health related hazards on operational staff due to constant inhalation of crushing materials	Adverse, direct, short-or long-term, reversible	3	3	1	3	1	11	Medium

		Kidnap/forceful abduction of operation staff	Adverse, direct, abnormal, short-term, reversible	3	5	1	5	5	19	High

Project Phase	Project Activity/Environmental Aspect	Potential and Associated Impact	Impact Characterisation	• Impact Significance Evaluation					Sum	Overall Significance Rating
				L	R	M	I	P		
Decommissioning / Abandonment	• Decommissioning / abandonment and ancillary facilities	Soil and groundwater contamination from wastes abandoned at the site	Adverse, direct, abnormal, long-term	3	3	1	3	3	13	Medium
		Risk of poor management of decommissioned facilities	Adverse, direct, abnormal, long-term	0	3	1	3	3	10	Medium
		Availability of land for alternative uses	Beneficial, direct, normal, long-term	-	-	-	-	-		Beneficial

Impact Significance Criteria

L = Legal/Regulatory requirement P = Public Perception/Interest
R = Risk posed by impact
M = Envisaged magnitude of impact

Significance Rating Criteria

High = (L+R+M+I+P) = ≥ 15 or (M+I) > 6 or P = 5
Medium = (L+R+M+I+P) ≥ 8 but < 15
Low = (L+R+M+I+P) < 8

5.5 Summary of Impact Significance Ranking

The Impact Assessment of the proposed project (i.e. interaction of different Project Phases and Project Activities/Environmental Aspects) resulted in Twenty-Seven (27) impacts with different impact significance ratings as follows: Beneficial, Low, Medium and High. The summary is presented in Table 5.10 below.

Table 5.10: Summary of Impact Significance Ranking

Project Phase	Project Activity/Environmental Aspect	Number of Identified Impacts	Impact Significance Ranking			
			Beneficial	Low	Medium	High
Site Acquisition	Land Take / site survey	4	1	-	2	1
Site preparation	Vegetation Clearing and general site prep; Stripping and compaction of topsoil with earth moving equipment	4	1	-	3	-
Mobilization/Demobilization	Transportation of equipment and personnel to and from site	4	-	2	1	1

Rock Quarrying extraction process	Overburden removal to expose rock / Rock drilling for pit development / holes with the use of air or hydraulically powered drilling machine. Crushing plant installation / Loading of broken or disintegrated rock fragments with excavators into dump trucks and conveyed to the crushing machines.	5	-	3	1	1
Rock Processing Stage	• Dumping of the material conveyed by the dump truck to the crushing machine into the feed hopper of the primary jaw crusher. Screening of the materials leaving the cone crushing stage. Maintenance and general operations of the facility	7	1	-	1	5
Abandonment/Decommissioning	Decommissioning/abandonment of Quarry Plant and other ancillary facilities	3	1	-	2	-
Summary (Total Number of Impacts)		27	4	13	10	8
% Significance			14.81	48.15	27.04	29.63

The summary of Impact Significance Rating above shows that approximately 62.96% of the identified impacts fall within the category of Beneficial and Low Impacts; approximately 56.67% fall within the Medium and High Significance Impact category that requires mitigation. It is noteworthy that the percentage that fell within the High Significance category is 29.63%. The impacts that resulted in the 29.63% high significance rating does not require concept modification but can be mitigated. Mitigation measures for all medium and high significance impacts are provided in chapter 6 of this report.

CHAPTER SIX
IMPACT MITIGATION MEASURES

6.1 General

The main purpose of this Impact Assessment Report is to examine the environmental impacts both beneficial and adverse of a proposed development project and to ensure that these impacts are taken into account in project design. The principal and most important objective of an Environmental Impact Assessment is the development and establishment of suitable actions (mitigation measures) for the identified significant and adverse impacts of a proposed project. In presenting the mitigation measures, the primary objectives were:

- Prevention by ensuring that significant and adverse potential impacts and risks do not occur.
- Reduction by ensuring that the effects or consequences of those significant potential and associated impacts that cannot be prevented are reduced to as low as reasonably practicable (ALARP).
- Control by ensuring that residual significant impacts are reduced to ALARP.

Again, as in reduction measures for potential and associated impacts, reasonable practicability was determined with reference to best industry practice and to economic, environmental, technical, health and safety considerations.

In the course of rock quarrying, processing stage and crushing of the rocks, operation and decommissioning, some potential and associated impacts are anticipated. The nature of the identified impacts has been described in Chapter 5 in line with FMENV Guideline. The proposed mitigation measures for high and medium significance adverse impacts are presented in Table 6.1.

Thus all low impacts, which are considered to be non-adverse were dropped. (I.e. no mitigation proffered for them).

Table 6.1 Proposed Mitigation Measure for Significant Impacts

Project Phase	Project Activity	Environmental Impacts		Significance Rating before Mitigation	Mitigation Measures	Significance Rating after Mitigation
Site Preparation Site Preparation / Site clearing to remove vegetation	Transportation of equipment, materials and workers	Accident related impacts from transportation		HIGH	• AKAMKPA QUARRY LIMITED shall use scout vessels and vehicles during movement of heavy equipment to warn other road and water users and reduce accidental collision etc. • AKAMKPA QUARRY LIMITED shall ensure that all vehicles and vessels are pre-mobilised and certified fit before being allowed to transport equipment, materials and personnel • AKAMKPA QUARRY LIMITED shall ensure that all drivers and captains are certified competent before movement with vehicles/vessels are allowed • AKAMKPA QUARRY LIMITED shall ensure that an efficient journey management plan is maintained to reduce the risks of accidents • AKAMKPA QUARRY LIMITED shall make/provide temporary traffic control and diversion arrangements at strategic points in line with local traffic arrangement in the area • AKAMKPA QUARRY LIMITED shall ensure that drivers/captains adhere to speed limit alarms, which shall be equipped in all operational and support vehicles/vessels. • AKAMKPA QUARRY LIMITED shall prohibit night movement • AKAMPA QUARRY LIMITED shall check health status of personnel to be mobilised to site • AKAMKPA QUARRY LIMITED shall create awareness among her personnel on communicable diseases and STIs	LOW
	Vegetation clearing within the proposed facility area	Changes in drainage and hydrological patterns which may result in erosion and flooding in the area		MEDIUM	• AKAMKPA QUARRY LIMITED shall ensure that equipment used in excavation, compaction and consolidation of soil is confined to areas acquired for the proposed rock quarrying and processing project. These areas shall be restored after decommissioning • AKAMKPA QUARRY LIMITED shall provide adequate drainage system to avoid flooding of the area and subsequent erosion • AKAMKPA QUARRY LIMITED shall put in place facilities to reduce impact of breakwater • AKAMKPA QUARRY LIMITED shall ensure that areas stripped in error are immediately restore to ensure return of soil biota	LOW

	• Strip ping of topsoil and compaction of same with earth moving equipment within the proposed project location •	Negative effects on air quality due to emission of atmospheric pollutants (CO_X, NO_X, etc.) from earth moving equipment and localized increase in background noise level	,	MEDIUM	• AKAMKPA QUARRY LIMITED shall ensure materials and foreign bodies do not find their way into the aquatic system • AKAMKPA QUARRY LIMITED shall ensure vehicles/vessels and utilities mobilised for the project adhere to strict environmental guidelines • AKAMKPA QUARRY LIMITED shall ensure that vehicles/vessels carrying materials and equipment are fit and suitable for the environment • AKAMKPA QUARRY LIMITED shall ensure draft of vessel is not more than the depth of the area to avoid disturbance of ecosystem as well as grounding • AKAMKPA QUARRY LIMITED shall as much as possible switch off all engines when operations are on break	LOW

Figure 6.2

Project Phase	Project Activity/ Environmental Aspect	Potential and Associated impact		Significance Ranking before Mitigation	Mitigation Measures	Ranking after Mitigation
Site Acquisition	Land take	Restriction of access to the proposed facility area (4670.18m^2) for as long as the facility exist		Medium	Akamkpa Quarry Limited shall ensure that: ♦ all issues pertaining to land take are adequately discussed with the landlords; and ♦ adequate compensation is paid for the acquired land ♦ Akamkpa Quarry Limited shall identify the traditional ruling structure of the community, the CDC, youth organization and actual landlords of the area. These shall be adequately consulted at each stage of the proposed project	Low
		Improvement of the economic status of landlords and traditional rulers through payment of adequate compensation		Beneficial		
		Security problems due to community interference and conflicts		High		

	Site Survey Land take	Injury to personnel (surveyors) due to exposure to wild bushes and animals		Medium	Akamkpa Quarry Limited shall ensure that: ♦ surveyors use appropriate PPEs (steel toe safety boots, hard hats, hand gloves and safety goggles) before venturing into the bush for survey; ♦ locals who are knowledgeable of the area are hired to accompany surveyors	Low
• Mobilisation / Demobilisation (Movement of vehicles and personnel**)**	Transportation of equipment / materials / personnel to worksite from Port Harcourt town	Injury / death / assets damage due to road traffic accidents and incidents e.g., collision		HIGH	♦ AKAMKPA QUARRY LIMITED shall ensure all vehicles are certified road worthy before being allowed to transport equipment, materials and personnel ♦ AKAMKPA QUARRY LIMITED shall ensure that all operational vehicles are in optimal working condition to curtail air pollution ♦ AKAMKPA QUARRY LIMITED shall ensure vehicle drivers are certified competent before movement with vehicles are allowed ♦ AKAMKPA QUARRY LIMITED shall make/provide temporary traffic control and diversion arrangements at strategic points *en route* the proposed site ♦ AKAMKPA QUARRY LIMITED shall ensure an effective journey management schedule is maintained to reduce the risk of accidents ♦ AKAMKPA QUARRY LIMITED shall ensure road load and speed limits are observed ♦ Night movements in the project area shall be avoided by AKAMKPA QUARRY LIMITED	LOW
		Noise nuisance from increased vehicular movement / use of internal combustion engines		MEDIUM	AKAMKPA QUARRY LIMITED shall ensure all vehicles are maintained at optimal conditions as stated in the equipment operating manual	LOW

Project Phase	Project Activity/ Environmental Aspect	Potential and Associated impact	Impact Characteristic	Significance Ranking before Mitigation	Mitigation Measures	Ranking after Mitigation
Rock Quarrying extraction process	Overburden removal to expose rock	Increase in the ambient noise level in the area above baseline values due to noise generated from during drilling of holes.	Adverse, direct, normal, short-term, incremental, cumulative	Low	♦ AKAMKPA QUARRY LIMITED shall ensure that equipment used in excavation, compaction and consolidation of soil is confined to areas acquired for the proposed rock quarrying and processing project. These areas shall be restored after decommissioning ♦ AKAMKPA QUARRY LIMITED shall provide adequate drainage system to avoid flooding of the area and subsequent erosion ♦ AKAMPA QUARRY LIMITED shall ensure that areas stripped in error are immediately restore to ensure return of soil biota	Low
	Rock drilling for pit development / holes with the use of air or hydraulically powered drilling machine.	Increase in the ambient noise level in the area above baseline values due to noise generated from during drilling of holes.	Adverse, direct, abnormal, long-term, irreversible, residual	High	♦ AKAMKPA QUARRY LIMITED shall ensure all vehicles are certified road worthy (including fuelling) before being allowed to transport equipment, materials and personnel ♦ AKAMKPA QUARRY LIMITED shall ensure road load and speed limits are observed ♦ AKAMKPA QUARRY LIMITED shall ensure vehicle (red caution flags) and road signs are used at strategic points	Low
	Crushing plant installation / Loading of broken or disintegrated rock fragments with excavators into dump trucks and conveyed to the crushing machines.	Injury / death / asset damage due to work place accidents/incidents during crushing	Adverse, direct, normal, short-term, cumulative, residual	Medium	♦ AKAMKPA QUARRY LIMITED shall ensure that ensure all wastes derived from crushing are containerized. ♦ AKAMKPA QUARRY LIMITED shall ensure that escalation factors such as the use of materials that constitute fire and explosion risks (e.g. cigarette lighters, smoking, cell phones, etc) within the facility area are prohibited ♦ AKAMKPA QUARRY LIMITED shall ensure that adequate firefighting equipment and personnel are available for effective emergency response ♦ AKAMKPA QUARRY LIMITED shall install appropriate warning signals at flash points and ensure that all automatic alarm systems work efficiently	LOW

Project	Project Activity/ Environmental Aspect	Potential and Associated impact	Impact Characteristics	Significance Ranking before Mitigation	Mitigation Measures	Ranking after Mitigation
Rock Processing Stage	• Dumping of the material conveyed by the dump truck to the crushing machine into the feed hopper of the primary jaw crusher.	Injury / death / assets damage due to accidents during dumping of materials from point of generation to the feed hopper	Adverse, direct, abnormal, short-term or long term, Residual	High	♦ AKAMKPA QUARRY LIMITED shall ensure effective functioning of the crushing devices work efficiently at all times. ♦ AKAMKPA QUARRY LIMITED shall also provide a workshop for maintenance and repairs of quarry machines.	LOW
		Reduction in cases of dumping of materials within and around crushing locations	Beneficial, direct, normal, long-term, cumulative	Beneficial		
		Community conflicts resulting from labour and recruitment issues, and compensation leading to security problems	Adverse, indirect, abnormal, short – or long- term	High		
	Screening of the materials leaving the cone crushing stage.	Pollution of soil and groundwater sources around the facility from improper management of wastes meant for incineration and ash residue Fire outbreak, destruction of facility, loss of life of personnel due to malfunctioning of facility or operators fault	Adverse, direct, abnormal, short – or long-term, reversible	High	♦ Akamkpa Quarry Limited shall provide proper PPEs for operation staff and ensure their usage within the premises of the rock quarry. ♦ Akamkpa Quarry Limited shall ensure regular safety meetings/talks where staff shall continuously be reminded of the need to use the PPEs. ♦ Akamkpa Quarry Limited shall issue appropriate penalty to staff defaulting on use of PPEs.	Low
		Health related hazards on operational staff due to constant inhalation of crushing materials Kidnap/forceful abduction of operation staff		High		

	Maintenance and general operations of the facility		Adverse, direct, short-or long-term, reversible		AKAMKPA QUARRY LIMITED shall: ♦ Liaise with the appropriate government organs for security during facility installation and operation construction ♦ Ensure security procedures are strictly enforced and continually improved based on updated risk information. ♦ engage youths from the community through the CDC and youth organization in surveillance ♦ maintain cordial relationship with the traditional stool and CDC of the community.	LOW

Project	**Project Activity/ Environmental Aspect**	**Potential and Associated impact**	**Impact Characteristics**	**Significance Ranking before Mitigation**	**Mitigation Measures**	**Ranking after Mitigation**
Decommissioning/ Abandonment	Decommissioning / abandonment of the incinerator and ancillary facilities	Soil and groundwater contamination from improper management and disposal of rock waste. Risk of poor management of decommissioned facilities	Within the facility	Medium	♦ AKAMKPA QUARRY LIMITED shall decommission different parts of the incinerator in line with FMEnv decommissioning procedure ♦ Parts that cannot be removed from the site shall be clearly identified and the location marked as danger zone by AKAMKPA QUARRY LIMITED to warn people ♦ AKAMKPA QUARRY LIMITED shall re-vegetate facility with indigenous species immediately if no further developments are intended	LOW

6.2. Ranking after Mitigation

It is noteworthy that all impacts associated with the proposed project were reduced to LOW after mitigation. This is based on the following:

- The parcel of land of 80 and 40 Hectares acquired by the Akamkpa Quarry Limited for the proposed Quarry I and II project respectively is within a developing area. No existence of wildlife species within the site. Thus impact on biodiversity is minimal.
- Issues associated with fire outbreak and risks associated with safety within the facility will adequately be taken care of by design and firefighting and ancillaries, which will be installed within the facility yard.
- Akamkpa Quarry Limited management shall ensure effective and continuous consultation and interaction with the landlords and entire community to ensure that community crises do not arise because of the proposed facility.
- However, Chapter 7 (Environmental Management Plan) has been provided to effectively ensure that the prescribed mitigation measures to reduce the impacts to zero in each case works out.

CHAPTER SEVEN
ENVIRONMENTAL MANAGEMENT PLAN

7.1 General

An Environmental Management Plan (EMP) is an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the design, construction, operation, decommissioning and maintenance of a project are prevented and that the positive benefits of the projects are enhanced. It also defines the legal requirements for the project and identifies the regulatory permits and licenses required for construction activities. To this end, an EMP ensures that impact mitigation and enhancement measures outlined in the EIA report form the basis for actual implementation of the proposed project.

This EMP provides the program for achieving the environmental protection/conservation objectives of the proposed rock quarrying and processing Project. The programme includes the designation of responsibility and means of achieving these objectives during the life of the proposed project.

Effective implementation of the EMP ensures increased efficiency, improved compliance assurance, and enhanced environmental security and global stabilisation. A summary of the EMP for the proposed project is presented below.

7.1.1 EMP Objectives

The objectives of this EMP for the proposed project are to:

i. Ensuring compliance with regulatory authority stipulations and guidelines.

ii. Demonstrate that a systematic procedure to ensure that all project activities are executed in compliance with applicable legislation/guidelines and relevant Akamkpa Quarry Limited policies has been established for the project.

iii. Ensure progressive reduction of the impacts of the project activities on the biophysical, health and social environment with the aim of eliminating them.

iv. Ensure that all mitigation and enhancement measures prescribed in the impact assessment document for eliminating or minimising the adverse project impacts as well as optimally enhancing the beneficial impacts are fully implemented.

v. Ensure that appropriate recovery preparedness is in place in the event that control is lost during the implementation of the proposed project.

vi. Provide part of the basis and standards needed for overall planning, monitoring, auditing and review of environmental performance throughout the project life cycle.

7.1.2 Scope of the EMP

The scope of this EMP includes health, safety, environment (HSE), and social considerations and will address the activities at the facility that can potentially have impacts on the following:

- Ambient Air Quality;
- Soil and Landuse;
- Physical Environment of The Area;
- Natural Resources (Including Groundwater) And Biological Environment;
- Socio-Economics; and
- Workplace Conditions;
- Health and Workplace Status

This EMP is a dynamic working tool and it shall take into consideration possible changes in prevailing circumstances, environmental regulations, guidelines and policies. It shall also be reviewed with changes in regulatory regime. In the event of new policies or guidelines from FMEnv, other governmental agencies or Akamkpa Quarry Limited, additions shall be made to reflect these changes. The EMP shall be updated and revised, if necessary, during the project life cycle to incorporate better environmental technologies, management systems and economic policies.

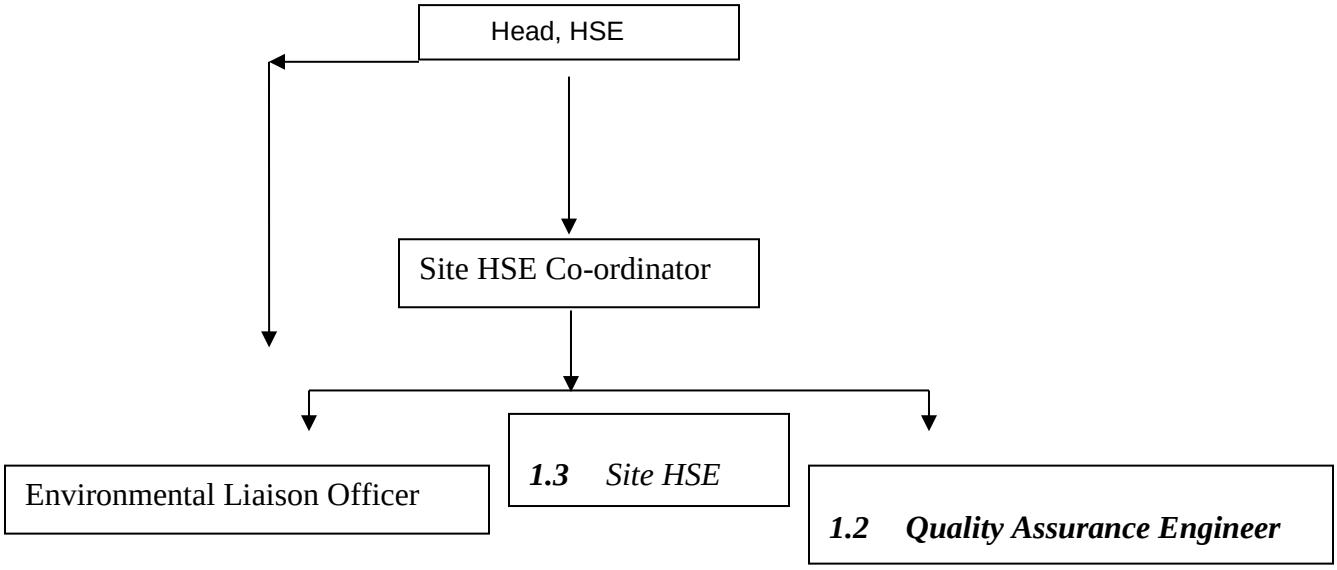
7.2 Resourcing and Responsibilities

Resourcing

Responsibilities for all environmental, health and socio-economic related matters throughout the project implementation shall be by the HSE manager. This is to ensure compliance with regulatory standards as well as Akamkpa Quarry Limited HSE policy.

In order to ensure effectiveness in the management of environmental, Health and socio-economic issues and commitments, Akamkpa Quarry Limited HSE Head shall supervise the Quality Assurance Engineer (QAE), the site project Engineer, the site HSE officers and the community relations' officer. These resource persons shall be approved by the management of Akamkpa Quarry Limited and shall be supervised by the HSE.

The organogram showing the line of authority for the implementation of the EMP guidelines is shown in Figure 7.1.



Responsibility

Figure 7.1: EMP Implementation Organogram

Akamkpa Quarry Limited shall hold the primary responsibility of ensuring that environmental and social commitments are met throughout the proposed project implementation. The company shall establish a schedule for responsibility and training on matters relating to the biophysical and socio-economic environment. Environmental and social issues shall be a line responsibility for which all levels of personnel are accountable.

Responsibility for environmental management shall lie with top management that must ensure that all environmental and social considerations are integrated into project execution. The HSE Unit shall be required to offer expert advice on protection measures and monitor performance.
Also, the relevant regulators shall be consulted at all phases of the project.

7.3 EMP Guidelines

The detailed preliminary EMP guideline covering the project activities/environmental aspects, impacts of the activities, as well as the mitigation/enhancement measures and designated responsibility for implementation are presented in Table 7.1 below.

Table 7.1 Environmental Management Plan for the Quarry Plant

Project Phase	Project Activity/ Environmental Aspect	Potential and Associated impact	Rating before Mitigation	Mitigation Measures	Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring	Action Party
Site Preparation Site Preparation / Site clearing to remove vegetation	Transportation of equipment, materials and workers	Accident related impacts from transportation	• High	• AKAMKPA QUARRY LIMITED shall use scout vessels and vehicles during movement of heavy equipment to warn other road and water users and reduce accidental collision etc. • AKAMKPA QUARRY LIMITED shall ensure that all vehicles and vessels are pre-	Low	Certificate of defensive Driving, Vehicle Monitoring analyses, Road Journey Management Records, Premob certificates, Pep Talks,	Daily, Weekly, Monthly, Quarterly	Akamkpa Quarry Limited Community Relations Officer and Head, HSE

				mobilised and certified fit before being allowed to transport equipment, materials and personnel • AKAMKPA QUARRY LIMITED shall ensure that all drivers and captains are certified competent before movement with vehicles/vessels are allowed • AKAMKPA QUARRY LIMITED shall ensure that an efficient journey management				

				plan is maintained to reduce the risks of accidents • AKAMKPA QUARRY LIMITED shall make/provide temporary traffic control and diversion arrangements at strategic points in line with local traffic arrangement in the area • AKAMKPA QUARRY LIMITED shall ensure that drivers/captains adhere to speed limit alarms, which				

				shall be equipped in all operational and support vehicles/vessels. • AKAMKPA QUARRY LIMITED shall prohibit night movement • AKAMKPA QUARRY LIMITED shall check health status of personnel to be mobilised to site ♦ AKAMKPA QUARRY LIMITED shall				

				create awareness among her personnel on communicable diseases and STIs				
	Vegetation clearing within the proposed facility area	Changes in drainage and hydrological patterns which may result in erosion and flooding in the area	• Medium	• AKAMKPA QUARRY LIMITED shall ensure that equipment used in excavation, compaction and consolidation of soil is confined to areas acquired for the proposed rock quarrying and processing	Low			Akamkpa Quarry Limited Community Relations Officer and Head, HSE

				project. These areas shall be restored after decommissioning • AKAMKPA QUARRY LIMITED shall provide adequate drainage system to avoid flooding of the area and subsequent erosion • AKAMKPA QUARRY LIMITED shall put in place facilities to reduce				

				impact of breakwater ♦ AKAMKPA QUARRY LIMITED shall ensure that areas stripped in error are immediately restore to ensure return of soil biota				
	• ***Stripping of topsoil and compaction of same with earth moving equipment within the proposed project location***	Negative effects on air quality due to emission of atmospheric pollutants (CO_X, NO_X, etc.) from earth moving equipment and localized increase in background noise level	• Medium	• AKAMKPA QUARRY LIMITED shall ensure materials and foreign bodies do not find their way into the aquatic system • AKAMKPA QUARRY LIMITED shall ensure vehicles/vessels and utilities	Low			Akamkpa Quarry Limited Community Relations Officer and Head, HSE

				mobilised for the project adhere to strict environmental guidelines • AKAMKPA QUARRY LIMITED shall ensure that vehicles/vessels carrying materials and equipment are fit and suitable for the environment • AKAMKPA QUARRY LIMITED shall ensure draft of vessel is not more than the depth of the area to avoid disturbance of ecosystem as				

				well as grounding AKAMKPA QUARRY LIMITED shall as much as possible switch off all engines when operations are on break				

Project Phase	Project Activity/ Environmental Aspect	Potential and Associated Impact	Ranking before Mitigation	Mitigation Measures	Ranking after Mitigation	Parameters for Monitoring	Frequency of Monitoring	Action Party
Site Acquisition	Land take	Restriction of access to the proposed facility area (60 hectares[6]) for as long as the facility exist	Medium	Akamkpa Quarry Limited shall ensure that: ♦ all issues pertaining to land take are adequately discussed with the landlords; and ♦ adequate compensation is paid for the acquired land Akamkpa Quarry Limited shall identify the traditional ruling structure of the community, the CDC, youth organization and actual landlords	Low	Site Inspection Records	Monthly, Quarterly	Akamkpa Quarry Limited Community Relations Officer and Head, HSE
		Improvement of the economic status of landlords and traditional rulers through payment of adequate compensation	Beneficial			Community Engagement Reports, Records of Stakeholder consultation Record of local contractor Employment Records	Monthly, Quarterly	

		Security problems due to community interference and conflicts		of the area. These shall be adequately consulted at each stage of the proposed project		Security Plan, Security Management Procedure, Record of security situation updates	Daily, Weekly, Monthly, Quarterly	
	Site Survey Land take	Injury to personnel (surveyors) due to exposure to wild bushes and animals	High	Akamkpa Quarry Limited shall ensure that: ♦ surveyors use appropriate PPEs (steel toe safety boots, hard hats, hand gloves and safety goggles) before venturing into the bush for survey; • locals who are	Low	Issuance records for PPE List of trained first aiders. First aiders schedule Record of First Aid box inventory HSE inspection reports.	Daily, Weekly, Monthly. Quarterly	Akamkpa Quarry Limited Community Relations Officer and Head, HSE

				knowledgeable of the area are hired to accompany surveyors				

Project Phase	Project Activity/ Environmental Aspect	Potential and Associated impact	Ranking before Mitigation	Mitigation Measures	Ranking after Mitigation	Parameters for Monitoring	Frequency of Monitoring	Action Party
• Mobilisation / Demobilisation (Movement of vehicles and personnel)	Transportation of equipment / materials / personnel to worksite from Port Harcourt town	Injury / death / assets damage due to road traffic accidents and incidents e.g., collision	High	Akamkpa Quarry Limited shall ensure that: ♦ all issues pertaining to land take are adequately discussed with the landlords; and ♦ adequate compensation is paid for the acquired land Akamkpa Quarry Limited shall identify the traditional ruling structure of the community, the	Low	Road Journey management records Premob certificates Pep-talk records Certificate of defensive driving Vehicle Monitoring Analysis	Daily, Weekly, Monthly. Quarterly	Akamkpa Quarry Limited Head, HSE and Site HSE Coordinator

				CDC, youth organization and actual landlords of the area. These shall be adequately consulted at each stage of the proposed project				
		Noise nuisance from increased vehicular movement / use of internal combustion engines	Medium	Akamkpa Quarry Limited shall ensure that: ♦ surveyors use appropriate PPEs (steel toe safety boots, hard hats, hand gloves and safety goggles) before venturing into the bush for survey;	Low	Premob Cerificates Equipment Maintenance Records Environmental Compliance Monitoring Reports	Daily, weekly, Monthly, Quarterly	Akamkpa Quarry Limited Head, HSE and Site HSE Coordinator

				• locals who are knowledgeable of the area are hired to accompany surveyors				

Project Phase	Project Activity/ Environmental Aspect	Potential and Associated impact	Ranking before Mitigation	Mitigation Measures	Ranking after Mitigation	Parameters for Monitoring	Frequency of Monitoring	Action Party
	Overburden removal to expose rock	Increase in the ambient noise level in the area above baseline values due to noise	♦ Medium	♦ AKAMKPA QUARRY LIMITED shall ensure that equipment	Low	• Premob Certificates • Equipment Maintenance Records	Daily, weekly, Monthly, Quarterly	Akamkpa Quarry Limited Head, HSE and Site

Rock Quarrying extraction process		generated from during drilling of holes.		used in excavation, compaction and consolidation of soil is confined to areas acquired for the proposed rock quarrying and processing project. These areas shall be restored after decommissioning ♦ AKAMKPA QUARRY LIMITED shall provide adequate drainage system to avoid flooding of the area and		• Environmental Compliance Monitoring Reports		HSE Coordinator

				subsequent erosion AKAMKPA QUARRY LIMITED shall ensure that areas stripped in error are immediately restore to ensure return of soil biota				
	Rock drilling for pit development / holes with the use of air or hydraulically powered drilling machine.	Increase in the ambient noise level in the area above baseline values due to noise generated from during drilling of holes. Injury / death / asset damage due	♦ Medium	♦ AKAMKPA QUARRY LIMITED shall ensure all vehicles are certified road worthy (including fuelling) before being	Low	Records of audiometric examination for noise exposed workers. Premob Certificates for equipment, vehicles Equipment Maintenance Records	Daily, weekly, Monthly, Quarterly	Akamkpa Quarry Limited Head, HSE and Site HSE Coordinator

		to work place accidents/incidents during crushing		allowed to transport equipment, materials and personnel ♦ AKAMKPA QUARRY LIMITED shall ensure road load and speed limits are observed AKAMKPA QUARRY LIMITED shall ensure vehicle (red caution flags) and road signs are used at strategic points		Environmental Compliance Monitoring Reports		

				♦ AKAMKPA QUARRY LIMITED shall ensure that ensure all wastes derived from crushing are containerized. ♦ AKAMKPA QUARRY LIMITED shall ensure that escalation factors such as the use of materials that constitute fire and explosion risks (e.g. cigarette lighters, smoking, cell				

				phones, etc) within the facility area are prohibited ♦ AKAMKPA QUARRY LIMITED shall ensure that adequate firefighting equipment and personnel are available for effective emergency response AKAMKPA QUARRY LIMITED shall install appropriate warning signals at flash				

				points and ensure that all automatic alarm systems work efficiently				
	Crushing plant installation / Loading of broken or disintegrated rock fragments with excavators into dump trucks and conveyed to the crushing machines.	Noise nuisance from increased vehicular movement / use of internal combustion engines	Medium	Akamkpa Quarry Limited shall ensure that: ♦ surveyors use appropriate PPEs (steel toe safety boots, hard hats, hand gloves and safety goggles) before venturing into	Low	Records of audiometric examination for noise exposed workers. Premob Certificates Equipment Maintenance Records Environmental Compliance Monitoring Reports	Daily, Weekly, Monthly, Quarterly	Akamkpa Quarry Limited Head, HSE and Site HSE Coordinator

				the bush for survey; • locals who are knowledge able of the area are hired to accompany surveyors				

Project Phase	Project Activity/ Environmental Aspect	Potential and Associated impact	Ranking before Mitigation	Mitigation Measures	Ranking after Mitigation	Parameters for Monitoring	Frequency for Monitoring	Action Party
Rock Processing Stage	• ***Dumping of the material conveyed by the dump truck to the crushing machine into the feed hopper of the primary jaw crusher.***	Injury / death / assets damage due to accidents during dumping of materials from point of generation to the feed hopper	♦ High	♦ AKAMKPA QUARRY LIMITED shall ensure that equipment used in excavation, compaction and consolidation of soil is confined to areas acquired for the proposed rock quarrying and processing project. These areas shall be restored after decommissioning ♦ AKAMKPA QUARRY LIMITED shall provide adequate drainage system	Low	Pep talks, Work site HSE Inspection Records, Records of Campaigns on Health, List of Retainer Clinics Emergency Response Plan HAZID Register	Daily, Weekly, Monthly, Quarterly	Akamkpa Quarry Limited Community Relations Officer and Head, HSE
		Reduction in cases of dumping of materials within and around crushing locations	♦ High		Low	House Keeping Records, Waste Consignment Notes, Work site Inspection Records	Weekly, Monthly, Quarterly	

				to avoid flooding of the area and subsequent erosion AKAMKPA QUARRY LIMITED shall ensure that areas stripped in error are immediately restore to ensure return of soil biota				
			♦	♦ AKAMKPA QUARRY LIMITED shall ensure effective consultation with stake holders,				Akamkpa Quarry Limited Head, HSE and Site HSE Coordinator
		Community conflicts resulting from labour and recruitment issues, and compensation	High		Low	Records/Reports of stakeholder Consultation Meetings Employment Records Register of Contractors		

	Screening of the materials leaving the cone crushing stage. • •	leading to security problems		♦ Adherence to Local Content Policy, ♦ AKAMKPA QUARRY LIMITED shall ensure road load and speed limits are observed AKAMKPA QUARRY LIMITED shall ensure vehicle (red caution flags) and road signs are used at strategic point ♦ AKAMKPA QUARRY LIMITED shall ensure that ensure all wastes				
		Pollution of soil and groundwater sources around the facility from improper management of wastes meant for incineration and ash residue Fire outbreak, destruction of facility, loss of life of personnel due to malfunctioning of facility or operators fault	♦ High		Low	PPE Issuance Records, Environmental Compliance Monitoring Report, Waste Consignment Notes, Effluent Monitoring Records Groundwater Monitoring Records, Equipment Premob and maintenance, Site Inspection Records		

				derived from crushing are containerized. ♦ AKAMKPA QUARRY LIMITED shall ensure that escalation factors such as the use of materials that constitute fire and explosion risks (e.g. cigarette lighters, smoking, cell phones, etc) within the facility area are prohibited ♦ AKAMKPA QUARRY LIMITED shall ensure that				

				adequate firefighting equipment and personnel are available for effective emergency response AKAMKPA QUARRY LIMITED shall install appropriate warning signals at flash points and ensure that all automatic alarm systems work efficiently				
	• • ***Maintenance and general***	Health related hazards on operational staff due to	♦ High	♦ Akamkpa Quarry Limited shall provide proper PPEs for	Low	• PPE issuance records. • Reports of HSE		Akamkpa Quarry Limited, HSE and

	operations of the facility	constant inhalation of crushing materials		operation staff and ensure their usage within the premises of the incinerator ♦ Akampa Quarry Limited shall ensure regular safety meetings/talks where staff shall continuously be reminded of the need to use the PPEs. ♦ Akampa Quarry Limited shall issue appropriate penalty to staff defaulting on use of PPEs.		• Environmental Compliance Monitoring Reports • Waste Consignment note		Site HSE Coordinator

		Kidnap/forceful abduction of operation staff	♦	♦ Akamkpa Quarry Limited shall provide proper PPEs for operation staff and ensure their usage within the premises of the incinerator ♦ Akamkpa Quarry Limited shall ensure regular safety meetings/talks where staff shall continuously be reminded of the need to use the PPEs. ♦ Akampa Quarry Limited shall issue appropriate penalty to staff				Akamkpa Quarry Limited Community Relations Officer, Head, HSE and Site HSE coordinator

				defaulting on use of PPEs.				

Project Phase	Project Activity/ Environmental Aspect	Potential and Associated impact	Ranking before Mitigation	Mitigation Measures	Ranking after Mitigation	Parameter for Monitoring	Parameter for Monitoring	Action Party
Decommissioning/ Abandonment	• ***Decommissioning/ abandonment of the incinerator and ancillary facilities*** •	Soil and groundwater contamination from improper management and disposal of rock waste.	Medium	♦ AKAMKPA QUARRY LIMITED shall decommission different parts of the incinerator in line with FMEnv decommissioning procedure ♦ Parts that cannot be removed from the site shall be clearly identified	Low	Equipment Premob and maintenance records, PPE issuance records. Reports of HSE monitoring Environmental Compliance Monitoring Reports Waste Consignment note	Monthly Quarterly	Akamkpa Quarry Limited Head, HSE and Site HSE Coordinator

				and the location marked as danger zone by AKAMKPA QUARRY LIMITED to warn people AKAMKPA QUARRY LIMITED shall re-vegetate facility with indigenous species immediately if no further developments are intended				

		Risk of poor management of decommissioned facilities	Medium	Akamkpa Quarry Limited shall ensure that: ♦ surveyors use appropriate PPEs (steel toe safety boots, hard hats, hand gloves and safety goggles) before venturing into the bush for survey; locals who are knowledgeable of the area are hired to accompany surveyors	Low	Equipment Premob and maintenance records PPE issuance records. Reports of HSE monitoring Environmental Compliance Monitoring Reports	Monthly, Quarterly	

7.5 Environmental Monitoring Programme

The Akamkpa Quarry Limited shall strictly operate a monitoring programme that would lead to sustainable project - environment relationship. The monitoring programme shall commence from the site preparation through rock quarrying, crushing/installations stages all the way to operations and Decommissioning/ Abandonment stage to keep track of the entire project activities and performance. The monitoring programme is to provide information on the impacts compared with prediction. By so doing, provide advanced warning of any adverse changes in both the biophysical and socio-economic environment.

Specifically, the objectives of the monitoring programme shall be to:

- Determine the effectiveness of the mitigation and enhancement measures for adverse and beneficial impacts, respectively.
- Provide a basis for recommending additional mitigation/enhancement measures.
- Ensure that the established transparent procedures for carrying out the proposed project are sustained.
- Determine whether any detected changes in the environment are caused by the project or by other natural factors.
- Monitor alterations in the existing biophysical characteristics of the environment.
- Monitor and control emissions and discharges and ensure compliance with local, national and international standards.
- Ensure sustenance of accountability and a sense of local ownership through the project lifecycle
- Provide early warning on any potentially serious problems.
- Measure long-term impacts.

The Akamkpa Quarry Limited shall comply with the FMEnv regulatory controls as well as monitor specific environmental parameters during the proposed project activities. It shall be the responsibility of the HSE department to ensure that the monitoring programme is fully implemented. Periodic reviews shall also be carried out to check the effectiveness or otherwise of the monitoring programme with a view to redefining frequency, responsibilities etc., as may be necessary. The monitoring programme designed for the proposed project is shown in Table 7.2.

Table 7.2: Environmental Monitoring Programme

Components	Impact Indicator	Location / Method of Monitoring	Duration	Responsibility
Biodiversity (Vegetation and wildlife)	Abundance and diversity of native plant and animal species, presence of exotic plant species, Type, density.	Within the facility	Yearly	Regulators/ HSE Department
Socio-economic and Health	Settlements and housing types, population and population distribution, income levels, social infrastructures/ Health records from previous studies and current studies	Community settlements around the site	Yearly	
Aquatic Life	• *Fisheries* ♦ Diversity and abundance • *Phyto/zooplankton and Benthos* ♦ Diversity and abundance	At Source discharge point, 1km upstream and 1km downstream and around the facility	Yearly	Regulators/ HSE Department
Air Quality and Noise Level	♦ CO, SO_2, NO_2, VOC, CO_2, Wind direction, Wind speed, Temperature, Relative humidity, SPM ♦ Noise Level dB (A)	Within the facility and the circumference outside the facility along the predominant wind direction	Daily, Monthly, Quarterly, Yearly	Regulators/ HSE Department
Soil Quality	pH, Temperature, EC, DO, COD, Hardness, Alkalinity, Chloride, Nutrient characteristics, Metals, Oil and	Scattered around the facility area and immediately after the perimeter fence	Monthly, Quarterly, Yearly	Regulators/ HSE Department

	Grease, TPH, Microbial characteristics etc.			
Surface Water Quality	pH, Cond., TDS, BOD, COD, Turbidity, Oil and Grease, Colour, Temperature, DO, Salinity, TSS,TPH, TOG, Metals, THB,THF,HUB,HUF	At Source discharge point, 1km upstream and 1km downstream and around the facility	Monthly, Quarterly, Yearly	Regulators/ HSE Department
Sediment Characteristics	pH, Temperature, EC, DO, COD, Hardness, Alkalinity, Chloride, Nutrient characteristics, Metals, Oil and Grease, TPH, Microbial characteristics etc.	At Source discharge point, 1km upstream and 1km downstream and around the facility	Monthly, Quarterly, Yearly	Regulators/ HSE Department
Ground water	pH, Cond., TDS, BOD, COD, Turbidity, Oil and Grease, Colour, Temperature, DO, Salinity, TSS,TPH, TOG, Metals, THB,THF,HUB,HUF	At Source discharge point, 1km upstream and 1km downstream and around the facility	Monthly, Quarterly, Yearly	Regulators/ HSE Department

7.6 Guideline for Consultation

Akamkpa Quarry Limited recognises the importance of consultations in all phases and activities of the proposed project. This is because appropriate and adequate consultations will ensure smooth project implementation and guarantee economic and commercial sustainability of future development in the area.

Consultations, which began during the baseline data gathering in the project area would continue throughout the project life cycle via a proactive and structured approach namely, interviews, administration of questionnaires, courtesy calls, and meetings with landlords.

The objectives of consultations are to:

- Ensure that all stakeholders are given early and adequate information on the activities

involved in the proposed project;

- Provide a framework for improving the understanding of the potential impacts of the proposed project on the socio-economics and biophysical environment;
- Include stakeholders' views and concerns as part of the EIA execution especially as it concerns the potential impacts;
- Identify contentious issues in the proposed project execution;
- Establish transparent procedures for carrying out the proposed project; and

The following consultation techniques shall be applied by Akamkpa Quarry Limited:

- Holding informal field visits with the immediate residents and other stakeholders to discuss the effectiveness of the project and its impact on the lives of the people as well as other concerns of the project etc.
- The consultation programme that will be adopted by Akamkpa Quarry Limited for the proposed project is presented in Table 7.3.

Table 7.3: Consultation Programme

Body	Consultation Goal	Duration
Stakeholder community/landlords	♦ Identify concerns / opinions ♦ Identify areas of conflict ♦ Formation of appropriate mitigation / enhancement measures	Throughout the project lifecycle

7.7 Guideline for Waste Management

These guidelines apply to projects that generate, store or handle any quantity of waste. A waste is any solid, liquid, or contained gaseous material that is being discarded by disposal, recycling, burning or incineration. The manner in which wastes are handled, stored and disposed is dictated by the nature of the waste, this waste management guideline takes into consideration the nature of all wastes that shall be generated during the proposed project. The standard for the guideline includes the regulations of the Federal Ministry of Environment (FMEnv) and other national and international environmental agencies and these standards are binding on all staff and contractors involved in the proposed project with respect to the:

- Emission or release of pollutant, exhaust and/or fugitive gases;
- Discharge or spill of effluent into surface water or land;
- Discharge of solid wastes (including domestic waste) into surface water or land

- Generation of noise and vibration.

7.7.1 Waste Handling Guidelines

Waste disposal/handling can be sometimes complicated and expensive and regulations designed to ensure proper disposal of waste have dramatically increased. For proper handling and disposal, wastes shall be well defined at a source and the definition transmitted along with the waste to the final disposal points. Akamkpa Quarry Limited 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 categorisation;
- Waste segregation information; and
- Recommended management practices.

7.7.2 Waste Minimisation Guidelines

Waste minimisation implies reduction to the minimum extent possible, the volume or toxicity of waste materials. It involves a set of processes and practices intended to reduce the amount of waste produced. By reducing or eliminating the generation of harmful and persistent waste, waste minimization supports efforts to promote a more suitable society. The four principles of waste minimisation process; recycle, reduce; reuse and recovery 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. In addition, all oil, hydraulic fluids, oily sump water, etc. shall be recycled or treated before disposal at any government approved site in Cross River State.

7.7.3 Waste Segregation Guidelines

This is a process in which waste is separated into different elements (dry or wet) which could occur manually or automatically in materials recovering facilities or mechanical biological treatments systems. For effective implementation of appropriate waste disposal methods, it is important that wastes be segregated, preferably at source into clearly designated bins at strategic locations. Particular attention shall be given to work areas where a variety of wastes are generated such as scrap metals, pigging waste, cans, drums etc.

7.7.4 Waste Disposal Guidelines

All debris, spoil materials, rubbish and other waste shall be clearly disposed at government approved dump sites. Instructions on material safety handling sheet shall be strictly adhered to and shall form the basis for the disposal of wastes related to such products. Wastes on transit shall be accompanied and tracked by consignment notes. The waste consignment notes shall contain the following information as a minimum:

- Date of dispatch;
- Description of waste;
- Waste quantity/container type;
- Designated disposal site and method;
- Consignee /driver name and means of transportation; and
- Confirmation of actual disposal (time and date).

7.7.5 Operational Wastes and Disposal Methods

Solid wastes

Provision shall be made for the proper storage, evacuation or treatment and subsequent disposal of all solid wastes generated. No dumping of wastes in the water system shall be permitted. All operational solid wastes shall be segregated prior to disposal in government approved dump sites.

Liquid Wastes

These will include chemical and hydrocarbon spills. All contingency plans for pollution control shall be maintained and where discharges are unavoidable, they shall be closely monitored and minimised. The HSE Manager via the Site Environmental and HSE officers are responsible for management of all wastes from cradle to grave.

Operational Wastes

The operational wastes that are anticipated to be generated during the project lifecycle shall be liquid waste and effluent. Akamkpa Quarry Limited shall ensure that wastes generated from the operations shall be managed in line with the FMEnv guidelines (Table 7.3).

Table 7.3: Waste Management Guideline for Rock Quarrying and Processing Project

Type of Waste	Sources	Treatment &Control
Marble Waste ($CaCO_3$)	Derived from extraction, sawing and polishing in a marble processing plant. In the manufacturing process of the marble slab which is about 2cm thick, the waste produced in each slab is 1cm.	During the cutting process, 33% of waste can be produced ad this waste can be used for making other important materials like bricks, block etc. Using of marble waste in concrete can save the stone industry disposal costs and produces a greener concrete for construction. The use of a diamond wire machine in the quarry process can reduce the waste produced by 7%.
Chromites ($FeCr_2O_4$) mining waste	Originates from the processes of excavation, dressing and further physical and chemical processing of wide range of metalliferous and non-metalliferous minerals by open cast and deep cast method.	Reducing the Cr (VI) to Cr (III) is the first step to reduce the toxicity of the wastes. More often, stabilization/solidification processes are employed in dealing with Cr-containing wastes or contaminated soils, which aim to immobilize Cr components in a stable matrix through chemical treatment (such as cementation reactions) or/and thermal treatment (such as calcinations). Secondary recycling of Cr resources from industrial wastes is increasingly favored for its economic value.

		Products such as cement, glass, abrasives, tiles, bricks, and pigments can be obtained and those finalized materials can be applied to the building industry.

7.8 Noise Minimisation Guidelines

Noise and vibration generated by facilities and equipment shall meet the ergonomic requirements of the Akamkpa Quarry Limited 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 Akamkpa Quarry Limited 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 (e.g. welding and generator areas) shall be required to use earmuffs at all times. Permanent warning signs shall be posted at the boundaries of these restricted areas. The HSE Manager through the Site Environmental and HSE Officers at work sites shall ensure the full implementation of this plan.

7.9 Transport Operations

All vehicles/vessels to be used for transportation of equipment, materials and personnel as well as the actual site preparation and construction stages of the proposed project shall be pre-mobilised by the Akamkpa Quarry Limited Logistic Officer. The pre-mobilisation shall be conducted to confirm the ferry worthiness of each vehicle/vessel, its fitness for purpose and the competency level of the driver/captain for the job.

Each trip/journey to be undertaken during the proposed project shall be managed in such a manner that it will not result to harm to life or property. A journey management plan specific to each trip shall be produced and submitted to the HSE Manager or site HSE Co-ordinator / Officer for approval. The details of the journey management plan shall include proposed mobilisation date, mode of transport, route(s), type of cargo as well as the details of the job hazard analysis (JHA) conducted for the trip. The HSE Manager or site HSE Officer may only approve the trip if he can confirm that all necessary precautions have been taken to forestall transport accidents/incidents.

7.10 Prevention of Workplace Accidents/Incidents

Prevention of workplace accidents and incidents during the proposed project shall be achieved using the JHA tool and written work procedure. Consequently, the engineering team must conduct JHA for

all operations and develop written and explicit work instructions for such operations. The work instructions shall integrate the recommendations of the JHA. It is only upon submission of the written work instructions and the supporting JHA or risk assessment document that the HSE Manager or site HSE Co-ordinator / Officer may consider the project activity for approval. Project activities may only be approved if the HSE Manager or site HSE Co-ordinator / Officer is objectively convinced that the work instructions are practical, safe and in accordance with regulatory requirements.

7.11 Plan for Training and Awareness

In order to assure HSE competence and awareness the project team headed by HSE and Construction Managers shall ensure that the company employees and other parties that will be involved in the project have the appropriate training and competence for various aspects of the project including HSE critical activities e.g. welding offshore, loading and offloading, etc. The competency requirements for contractor staff shall be stipulated in the contract document. The project team shall be subjected to periodic competence gap analysis from which training needs can be derived for the current job. The programme shall be reviewed on an on-going basis as the project progresses by the HSE and Project Managers (based on reports from site EHS officer) and shall among others include the following aspects:

- HSE induction course;
- Emergency response drill including;
- First aid.

7.12 Communication Plan

An effective two-way communication of HSE issues shall be maintained by the Akamkpa Quarry Limited and its contractors at all phases of the project. This will include awareness programme to motivate staff and contractors. The site HSE Co-ordinator / Officer shall make available to the entire project team necessary HSE information and experiences to facilitate improvement in HSE performances.

HSE personnel at all levels shall be made aware of the importance of compliance with the HSE policy and objectives, and their individual roles and responsibilities in achieving it. They shall be made aware of the risks and hazards of their work activities and the preventive and mitigation measures and the emergency response procedures that have been established. They shall also be made aware of the potential consequence(s) of departure from agreed operating procedures.

A duty officer's programme shall be established to manage and maintain effective communication. Contractors shall set up appropriate lines of communication to handle HSE issues e.g. direct access to the nearest clinic, direct access to emergency services, etc.

The Akamkpa Quarry Limited management already has an established HSE performance scheme to promote staff HSE performance improvements e.g. personal recognition, suggestion schemes, HSE performance bonus schemes for specific performance or at the end of a recognisable milestone or small give away for recognisable performance. These shall apply during the proposed project.

7.13 Emergency Response / Contingency Plan

Compliance to regulatory standards, codes and specifications as well as HSE guidelines shall form the basis for the execution of the proposed project. However, emergency situations could still occur as a result of equipment failure, negligence and/or sabotage. Consequently, a contingency plan, which is an organised and predetermined course of action to be pursued in the event of accidental occurrence, shall be developed by the Akamkpa Quarry Limited as a backup to other containment systems to be put in place to handle such occurrences. At a minimum, the contingency plan (with responsible parties for actions to be taken) which shall apply to both Akampa Quarry Limited and contractors addresses the following:

- Fires and explosions;
- Serious injury or illness;
- Hydrocarbon or chemical spills;
- Road accidents
- Boat mishaps; and
- Security issues.

7.14 Environmental Audit and Review

In order to assure that environmental and social commitments and management procedures are being adhered to as well as ensure that the project phases and activities are performed in accordance to laid down procedures/standards and that appropriate controls are in place, audit and reviews shall be carried out at predetermined milestones as management checkpoints throughout the project lifespan.

Akamkpa Quarry Limited shall constitute a team led by the HSE Manager or his designate to embark on periodic audit of the proposed project activities as they progress in order to:

- Identify prevalent environmental issues;
- Evaluate periodic management practices and monitor standards;
- Compare environmental status with established baseline condition and national / international regulatory standards and requirements; and
- Recommend areas of improvement in the EMP.

In implementing the audit programme, activities or structures in the project area perceived as having high environmental risks shall be thoroughly investigated and recommendations made for the improvement of the management system of the operation, where it is found wanting.

Recommendations from audits shall be used to carry out review and hence make improvements in the management system of the operation, where shortcomings are found.

7.15 Decommissioning Plan

The design of the proposed project shall take due recognition of the need to decommission installed structures at the end of their useful life. Thus, at the expiration of the life span of the project, the Akamkpa Quarry Limited shall issue an abandonment plan for review and approval by the FMENV.

However, all installations shall be uprooted and removed. All the abandoned location on land shall be re-vegetated with indigenous plant species sourced from the same or similar locality or from forest reserve zones within the region.

CHAPTER EIGHT

CONCLUSION

The EIA of the proposed Akamkpa Quarry in Obung Cross River State, has been carried out by Akamkpa Quarry Limited in order to identify and predict the likelihood of impact of this project on the recipient environment (ecological and socio-economic). Hence, the status and sensitivities of the various ecological and socio-economic components of the project environment have been carefully established and assessed through literature research, field sampling and measurements within the proposed project axis, using a multi-disciplinary team of experts.

The study revealed that the air quality indices were within regulatory limits. The noise levels were below the tolerable limit or noise (90dBA). The pH of the surface water and soil was acidic though the surface water was more acidic. The surface water showed characteristics of a freshwater habitat. The TPH of the soil, surface water and sediment was high. The heterotrophic microbial count of the surface water and sediment was normal. The Total Heterotrophic bacterial count represented the most predominant microbial group in soil, surface water and sediment. The groundwater did not meet regulatory requirements for domestic water acceptability. The biodiversity (microflora, macroflora microfauna and macrofauna life) was high. The vegetation was generally luxuriant and showed no sign of major pathological disorders. Wildlife species identified in the include taxa are amphibians, reptiles, birds, and mammals. The adherence to the EMP will ensure a reduced negative impact of the Quarry activities in this area.

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APPENDICES

Appendix 1

DETAILED APPROVED TOR

AKAMKPA QUARRY LIMITED

TERMS OF REFERENCE

AND

SCOPE OF WORK

For the

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDIES FOR THE PROPOSED AKAMKPA QUARRY LIMITED PROJECT

IN

Obung Community, Akamkpa L.G.A
Cross River, Nigeria.

SUBMITTED TO

The Federal Ministry Of Environment, Abuja

January, 2020

Contents

1.0 INTRODUCTION

The earth is made up of rocks and sand, stone,granite and such products are derived by breaking these hard rocks into smaller pieces. Naturally, this is a process that should take hundreds of years but who is willing to wait a hundred years just to get a handful of rocks?

Hence, the need to come up with a method to speed up the process so that granites, gravel, sand and other related products are available within minutes. Think of the number of roads and building projects carried out in Nigeria yearly and may begin to have an idea of how lucrative quarry business can be in Nigeria.

Akamkpa Quarry Limited (AQL) as a responsible cooperated partner to the Federal Republic of Nigeria, wishes to contribute its quota to the achievement of these laudable goals by particitpating in the production of granites, gravel, sand and other related products. AQL has acquired two locations for the proposed quarry operation and production. The Two (2) locations aquired are abandoned quarry plant sites which were formerly operated by **CHINA CIVIL ENGINEERING CONSTRUCTION COMPANY (CCECC) and IMPRESITE BAKALORI.** The proposed quarry plant sites are 2km apart.

This document presents the Terms of Reference (TOR) for the Environmental and Social Impact Assessment (ESIA) studies for the quarry plants by Akamkpa Quarry Limited (AQL).

Environmental Impact Assessment (EIA) is the study that documents environmental baseline characteristics, evaluates project description, identifies interfaces and predicts potential impacts of the project activities on the environment. The study produces an environmental management plan (EMP) which is aimed at project improvement and environmental compliance monitoring during project execution.

This EIA study is intended for compliance with FME guidelines. The draft report will be presented to FME for review before the final report is completed as required by statutes.

1.1 The Proponent

Akamkpa Quarry Limited (AQL) hereby described as the Proponent. The proponent has the intention to prepare an ESIA and seeks the approval of the EIA Terms of reference (TOR) from the Federal Ministry of Environmnet (FMEnv) hereby referred to as the Regulator.

The objective of the operator is to become one of the leading Quarry company in Nigeria within a very short time through effective management of manpower, technology and Resources while contributing to the economic and technological development of Nigeria by becoming a major producer of materials such as granite, gravel, sand and other related products for construction.The mission is to engage in these activities profitably and responsibly for the benefit of all stakeholders within the best class Health, Safety and Environmental Practices in the industry.

AQL has applied for approval for the generation and evacuation of the granite produced from the relevant agencies and wishes to carry out an Environmental and Social Impact Assessement for the proposed site as required by Federal law.

1.2 Location

The proposed project sites are in Obung Community, Akamkpa Local Government Area, Cross River State.

Figure 1: Map of Nigeria showing Cross River state

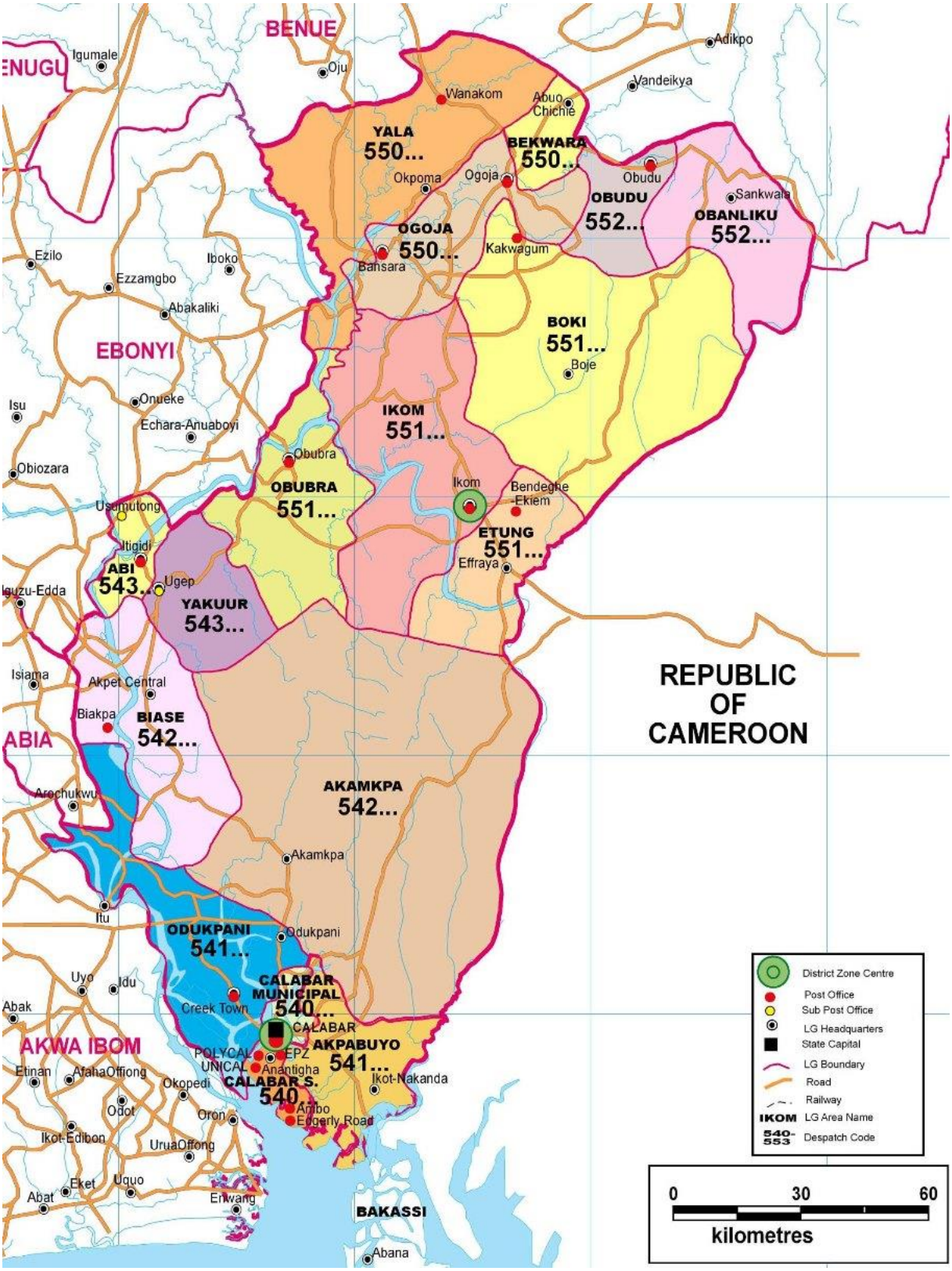

Figure 2: Map of Cross River state showing Akamkpa LGA

2.0 EIA OBJECTIVES

The objectives of this EIA study are:

- To provide information on the current condition of the environment within which the Quarry industry is to be located.
- To determine the impacts of the project on the environment including impact on socio-economic and socio-cultural activities of the community.
- To determine the probable impacts of the auxiliary facilities on the environment
- To examine and assess the potential impacts on the natural, social and health environments.
- To provide recommendations for the mitigation of identified adverse impacts.
- To develop a management plan for the implementation of the mitigation measures.

2.1 Overview and concept selection

In conceptualizing the facilities development of the quarry, AQL took cognizance of the following key issues:

Acquisition of a suitable location (available) for citing the facility. Utmost criteria include that proposed site is rich in mineral materials with good connectivity and close to existing infrastructure.

The facility infrastructures are of optimum sizing, engineered to the specific application of the Quarry project and profiles, proven standard equipment, cost effective and simple to operate.
Suitable land has been identified for the process facilities in Obung community, Akamkpa L.G.A.

2.2 Scope of Work

In line with Government's guideline and requirements on the establishment of projects of this nature, Akamkpa Quarry Limited requires the services of a renowned Environmental Management Company that will carry out **DETAILED ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDIES FOR THE PROPOSED AKAMKPA QUARRY AND THE FACILITATION OF APPROVALS WITH THE FEDERAL MINISTRY OF ENVIRONMENT (FMENV)**.
As a precedent, both the world environmental practice and latest regulatory provisions on the protection of the environment are required to be the basis in the production of documents that will be guiding in the activities of production, processing and transporting of the mineral materials. Engineering codes and specifications are vital wherever applicable for references.
The work shall include data acquisition within the geographical coordinates of the both sites

Table 1: Coordinates for Site Location of the Quarry plant 1

Latitude	Longitude
05°20’30"N	08°24’00"E
05°20’30"N	08°24’30"E
05°21’00"N	08°24’00"E.
05°21’00"N	08°24’30"E

Table 2: Cordinates for Site Location of the Quarry plant 2

Latitude	Longitude
05°20’45"N	08°24’45"E
05°21’15"N	08°24’45"E
05°20’45"N	08°25’30"E.
05°21’15"N	08°25’30"E

Figure 3: Pictorial overview of the two site locations on google map

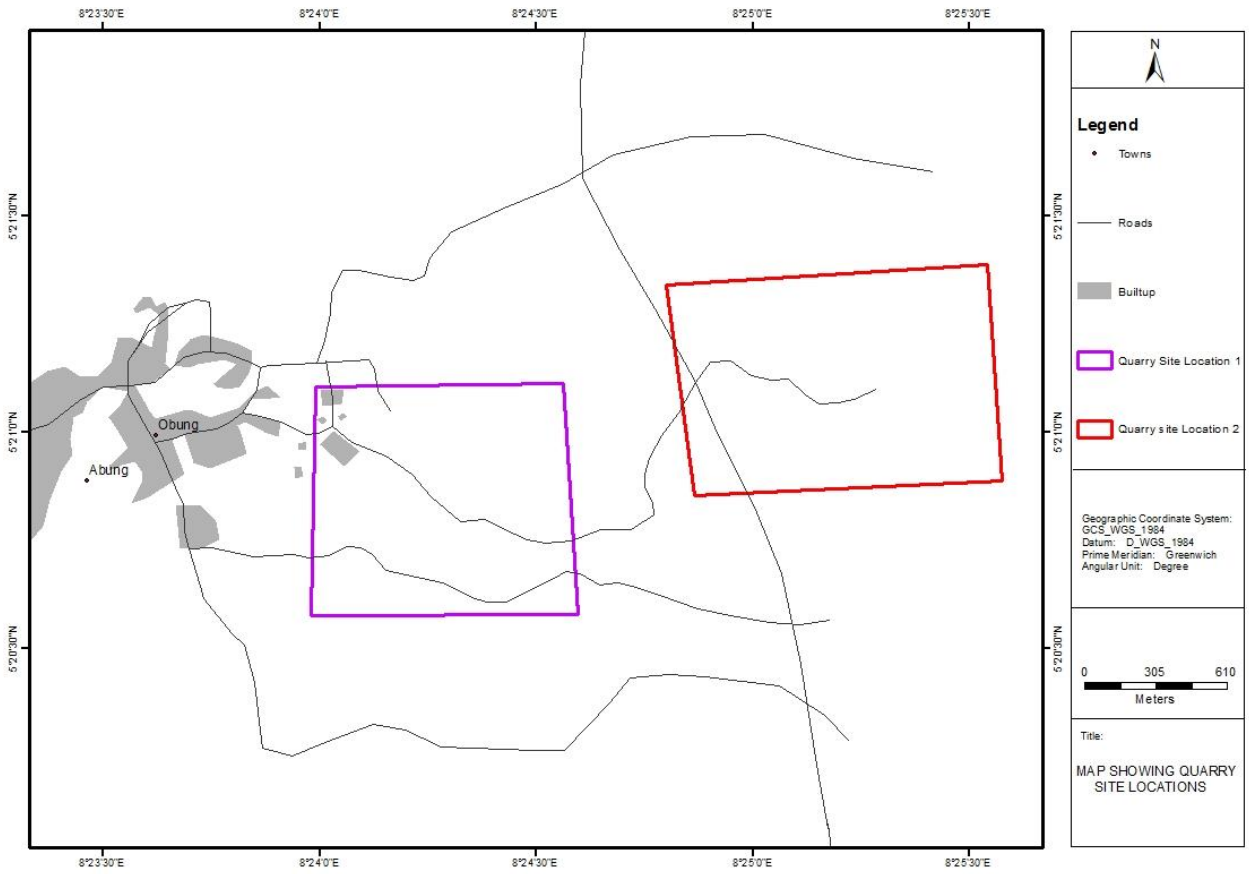

Figure 4: Project Map, showing the overall perimeter of the project areas

2.3 Area of the project sites

Quarry 1- 80 Hectares
Quarry 2- 40 Hectares

2.4 Present Status

Preliminary survey works and site visits have been carried out. Land acquisition has been completed. Presently, no quarry operation has commenced on the sites. There is the need to carry out a robust EIA to identify, assess, control, and mitigate all potential environmental & socio-economic impact the proposed project would have on the environment.

2.5 Project Description

The Quarry project is located within the Obung Community in Akamkpa Local Government Area, Cross River State.

At the quarry, there will be extraction of mineral materials and these will be done by drilling and blasting of the body of rocks into smaller units of specific sizes. These units are then loaded /conveyed to another location for crushing. This activity will be followed by transportation of the crushed materials to our local customers as required.

2.6 Staff Management Plan: Figure 3, describes the staff strength and working condition of each staff for the Akamkpa Quarry Limited

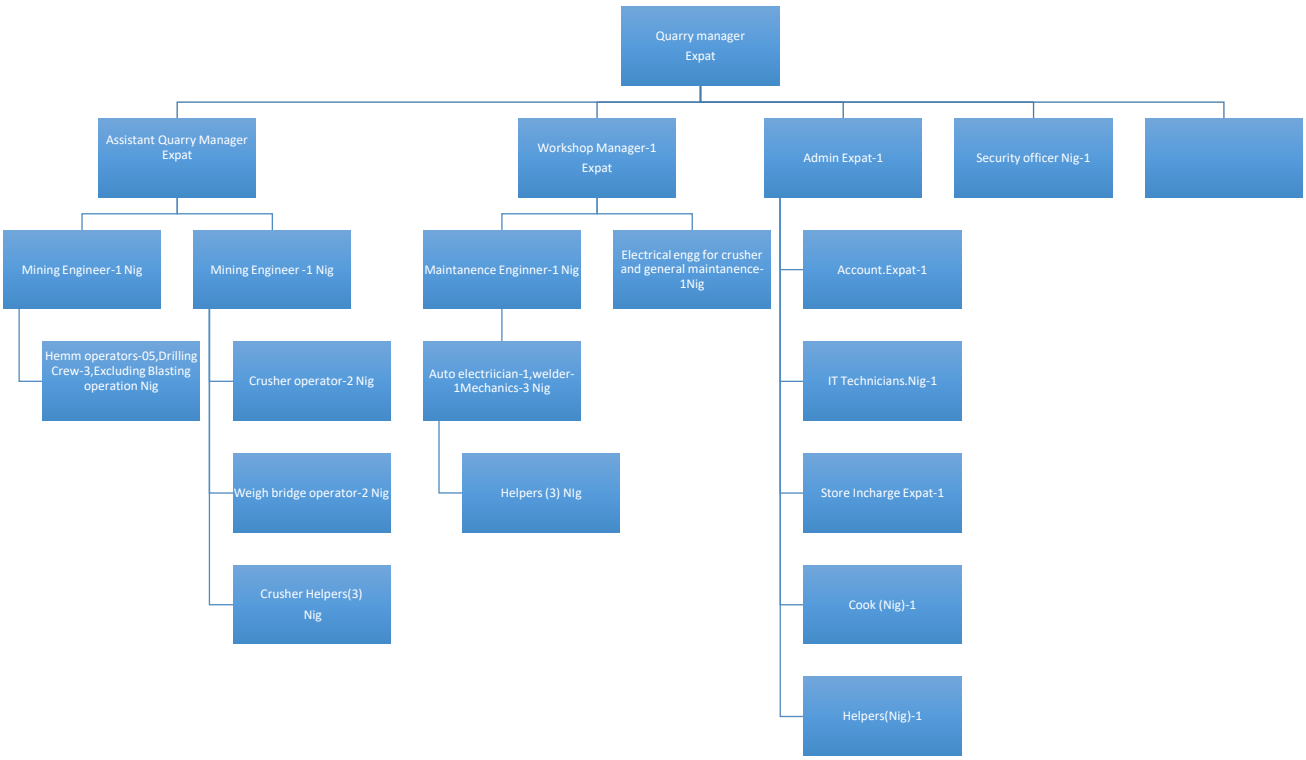

Figure 5: Organizational Chart

2.7 Equipment Considerations

Facility will take cognizance of essential equipment required to ensure safe, efficient processing and transportation of mineral materials to end-users, factory. Essential equipment's are listed;

- Drill machine
- Excavator
- Wheel loader
- Dozer and
- Dump Truck

The proposed Project includes all tasks necessary to construct, install and commission/start-up of the Quarry.

2.8 Type of Blasting

Controlled blasting (using Slurry, ANFO and Nonelectric detonators for less vibration)

3.0 LITERATURE REVIEW

The literature review will focus on the following:

- Relevant Federal and State regulations
- Site layout diagrams and location of the various facilities
- Climatic conditions including rainfall pattern

- Site Geology and water biochemistry
- Previous environmental studies carried out in the area

3.1 Hazards and effects identification process:

Risks and effects from the identified hazards will be evaluated against standardized screening criteria taking into account probabilities of occurrence and severity of consequence for people, assets, the environment and reputation. An HSE Risk Matrix will be used in conjunction with the judgment of experienced personnel to identify those areas of risk that need to be managed.

The essential steps that will be taken in the risk/hazard management are as follows:

- Identify hazards and effects
- Establish screening criteria
- Evaluate hazards and effects
- Document significant hazards and effects and apply legal or other standards
- Set detailed objectives and performance criteria
- Identify and evaluate risk reduction measures
- Implement selected risk reduction measures

3.1.1 Detailed Summary of Ecological features of the projects Environment Community / Families

Akamkpa Local Government Area covers Ten communities which includes the following: New Netim, Nsan, Ekong, Ikot Omin, Oban, Iko, Obung, Ojuk South, Ojuk North, Ikpi. The major community where the site will be located is Obung community in Akamkpa Local Government Area of Cross River State.

Climate: Typically, this zone is inundated with heavy rainfall, high temperature, high humidity and mild wind. The zone is dominated by two major air masses:the warm, dry and dusty west African trade wind from the Sahara to the South, otherwise called the harmattan winds in the dry season months from November to March each year and the hot and humid tropical maritime air from the Atlantic Ocean, otherwise called the South - Westerly Monsoon winds, which are prevalent in the wet season from April to October.
Generally, rain falls all the year round but over 80% of the rain occurs in the months of May to September. The rainfall of this zone is estimated to be between 1300mm to 3000mm annually and occur largely in September. Temperature ranges from low (15^{o}C) to high (30^{o}C) all year round.
The minimum and maximum relative humidity in the area for the rainy season is about 79.1% and 87.3% respectively. The wind speed varies between 2.0 and 4.5 knots around this location most periods of the year with an average speed of 2.7 knots.

Vegetation: The vegetation is characterized by typical rain forest vegetation mangrove swamps, to derived savannah, and montane parkland with a galloping terrain and patches of farm lands which could be seasonally flooded. The most common vegetative species found in this area include; *Anthocleista vogelii (cabbage tree), Anthostema aubryanum (*Niddle grass*), Pennisetum purpureum (*Elephant grass*) Panicum* spp (Greatheart), *Calamus decratus (*Rottan palm*), Commelina benghalensis (*Wondering jew*), Chromolaena odorata (*Siam weed,)
Cash crop vegetation include*; Elaeis guineensis (*Oil palm*), Aframomum sp.* (Grain of paradise), *Cocos nucifera (*Coconut palm) and *Mangifera indica (*Mango). Others include; *Manihot esculenta* (Cassava)

Musa cultivars (Banana), *Ananas comosa* (Pineapple), *Ipomaea batatas* (Sweet potatoes) and *Zea mays* (Maize).

Soil: The soil in this zone is mainly predominantly sandy loam and sandy clay loam. The soil texture determines the porosity and therefore the infiltration capacity, aeration and fertility of the soil. The pH of soils in this zone range from 4.7 to 5.5, the organic carbon content ranged from 0.98 to 2.03% and total N ranged from 0.06 to 0.17% available P was low (6.5 to 13.(mgkg), i.e., to say the soils are relatively acidic in nature and rich in organic matter, nitrogen, phosphorus and potassium. Also soils from this region have high iron content.
The soil composition may explain why the soils in the zone drains easily on the top soil encouraging aeration and greater crop produce and yield while possibly holding up floods on heavy rains during very wet seasons. The soil fertility is depleted by unsustainable farming techniques and improper soil management.

Aquatic: The pH values of surface water vary from 6.0 to 7.5 within the year. Most biological activities of aquatic organisms are temperature dependent. High levels of solid in water increase the water density and affect osmo-regulation of freshwater organisms thereby reducing the solubility of gases such as oxygen. Nitrogenous compounds and Phosphate in surface water is of major concern as they are sources nutrient element that can cause eutrophication of the surface water body when it occurs in high concentrations especially as run-offs during periods of heavy precipitation. Nitrate and Nitrite are indicators of nitrogen loading of waters.
Sediment is a veritable medium for assessing the quality of aquatic ecosystems. The sediment of a water body can be used to determine the presence of or the contamination of the ecosystem. Sediments are known to accumulate heavy metals and hydrocarbon contaminants.

Phytoplankton are the microscopicchlorophyll-a containing plants found in aquatic ecosystems. In such ecosystems the phytoplankton and zooplanktons are the primary producers in the ecosystem their absence indicates pollution of the environment. Zooplanktons are microscopic animals found mainly in the pelagic zone of water bodies where they depend on water currents and waves for motion.

The benthic fauna are the bottom dwelling organisms. Majority of them are found living in or on the bottom sediment as **infauna**, while others live on the surface either attached to different types of substrates (sessile) or as mobile benthic inhabitants, these are known as **epifauna.** Again their absence may indicate pollution**.**

Fishing is one of the occupations of the inhabitants especially those who inhabitant the coastlines of the River Niger. Fishing activities in the area is artisanal. Fishing gears used include basket traps, gill net, cast net, fish trap, and long lines. Fish catch is a measure of the natural quality of the stream or river.

3.2 Field Data Acquisition

During the fieldwork, socio-economic and health data will be acquired using questionnaires and interviews. Data on the natural environment will be collected *in-situ* using field equipment. Also, samples will be collected at pre-determined locations and will be taken to the laboratory for analysis. **One season field samples collection is recommended** since several EIA study have been conducted around and within this environment.

The sampling protocol and plan are based on the area of the site and the ecological features as well as the presence of communities scattered within the location. Hence the air quality stations are based on the communities that have been identified within the project area.

The sampling stations and points are geo-reference as shown on the Table 3.

Table 3: Sampling Stations and Points

S/N	Environmental component	Sampling points or Stations	Description of sample point
1	Aquatic Studies (Surface Water, Sediment, Plankton, Fisheries and Microbiology)	3	At source discharge point. 1 km upstream and 1 km downstream and around the facility
2	Borehole Water	3 + 2	3 (Three) as sample stations and 2 (Two) as control
3	Vegetation		Within the facility
4	Soil	24	Scattered around the facility area and immediately after the perimeter fence
5	Ambient Air Quality	24	Within the facility and the circumference outside the facility along the predominant wind direction
6	Socio-economic and Health		Community settlements around the Site.

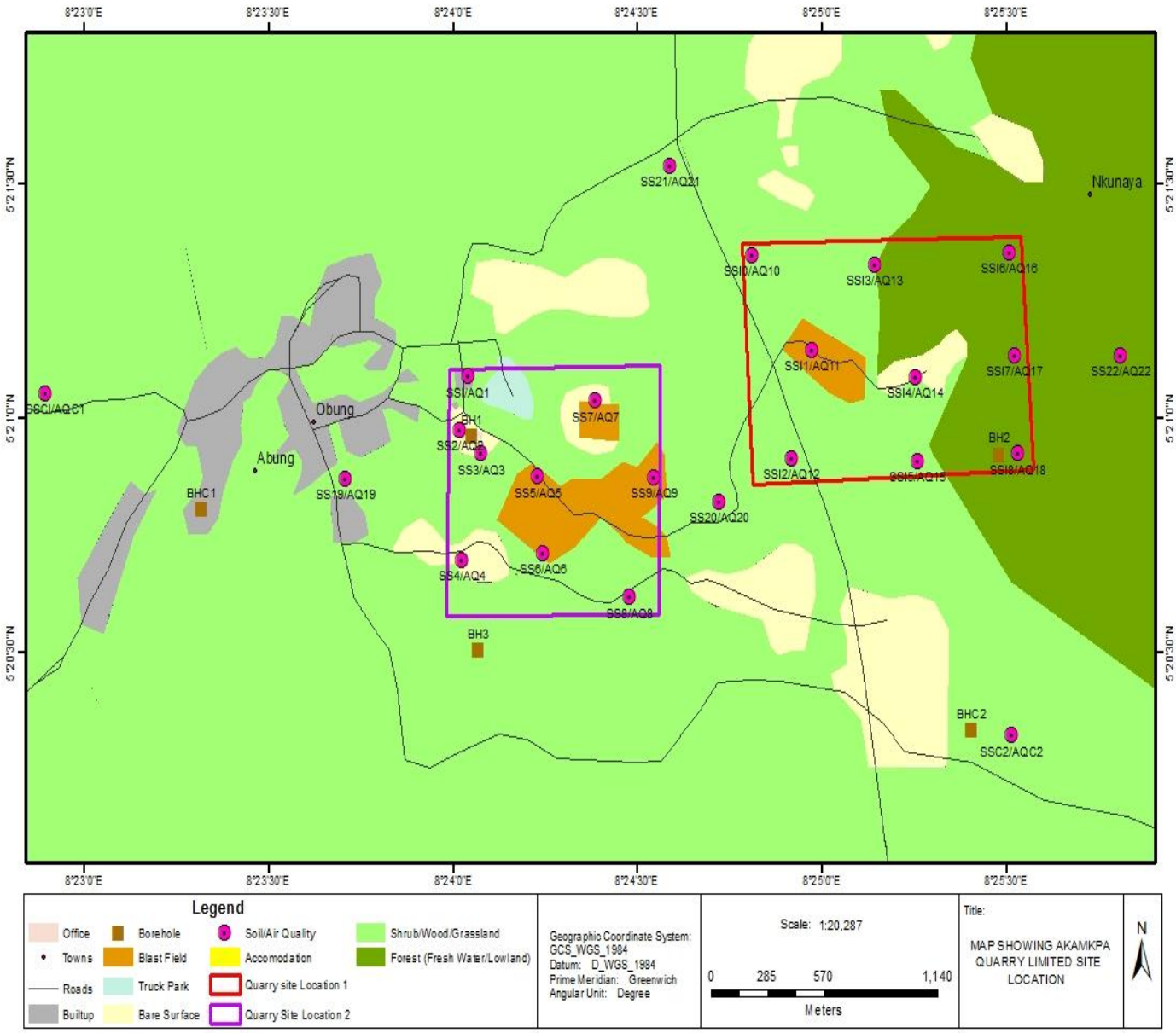

Fig 6: Map showing sampling rationale for Akamkpa Quarry Limited's EIA

Table 3a: SAMPLING COORDINATES FOR AKAMKPA QUARRY SITE

SOIL/AIR QUALITY

SAMPLING STATION	EASTING	NORTHING	X(m)	Y(m)
SS1/AQ1	8°24'2.12"E	5°20'59.76"N	433587.97	591378.00
SS2/AQ2	8°24'0.76"E	5°20'52.86"N	433545.91	591166.16
SS3/AQ3	8°24'4.20"E	5°20'49.84"N	433651.70	591073.32
SS4/AQ4	8°24'1.12"E	5°20'36.26"N	433556.49	590656.41
SS5/AQ5	8°24'13.83"E	5°20'43.91"N	433947.91	590890.94
SS6/AQ6	8°24'14.28"E	5°20'37.11"N	433961.56	590682.12
SS7/AQ7	8°24'22.65"E	5°20'55.93"N	434219.73	591259.77
SS8/AQ8	8°24'28.39"E	5°20'31.41"N	434395.66	590506.67
SS9/AQ9	8°24'28.87"E	5°20'45.62"N	434410.86	590943.00
SS10/AQ10	8°24'46.31"E	5°21'12.73"N	434948.42	591774.95
SS11/AQ11	8°24'52.90"E	5°21'0.08"N	435150.87	591386.32
SS12/AQ12	8°24'48.51"E	5°20'47.62"N	435015.39	591003.84
SS13/AQ13	8°25'8.29"E	5°21'12.69"N	435624.90	591773.08
SS14/AQ14	8°25'10.31"E	5°20'57.35"N	435686.63	591301.98
SS15/AQ15	8°25'10.67"E	5°20'45.78"N	435697.37	590946.69
SS16/AQ16	8°25'27.82"E	5°21'12.37"N	436225.97	591762.69
SS17/AQ17	8°25'28.42"E	5°20'59.37"N	436244.07	591363.48
SS18/AQ18	8°25'28.66"E	5°20'46.89"N	436251.09	590980.25
SS19/AQ19	8°23'44.56"E	5°20'46.75"N	433047.00	590979.00
SS20/AQ20	8°24'38.20"E	5°20'42.57"N	434698.00	590849.00
SS21/AQ21	8°24'27.79"E	5°21'27.27"N	434379.00	592222.00
SS22/AQ22	8°25'45.32"E	5°20'57.22"N	436764.00	591297.00
SSC1/AQC1	8°23'13.69"E	5°20'38.68"N	431286.00	591385.00
SSC2/AQC2	8°25'28.54"E	5°20'2.41"N	436620.00	588677.00

BORE HOLE

SAMPLING STATION	EASTING	NORTHING	X(m)	Y(m)
BH1	8°24'2.67"E	5°20'53.06"N	433604.70	591172.24
BH2	8°25'24.68"E	5°20'46.86"N	436128.60	590979.44
BH3	8°24'6.64"E	5°20'25.22"N	433726.06	590317.24
BHC1	8°23'21.63"E	5°20'45.36"N	432114.00	590571.00
BHC2	8°25'26.37"E	5°20'5.82"N	436495.00	588796.00

Sampling Justification:

The sampling points were taken within the Project facility and the immediate environmental layout. Twenty four (24) sampling points were highlighted and these are scattered in such a way to cover the whole

project area and its immediate environment. Out of the twenty four sampling points, eighteen (18) sampling points were projected within the Quarry point perimeter area, three (3) sampling points were projected within stakeholder community while considering the air pollution effect of prevailing winds. Two control samples are equally taken 5 km from the field area.
This is to compare result with the baseline from the previous EIA on the project site. This in essence will provide an evalution of the effect of the project work on the environment.

3.3 Sampling protocol and distribution

3.3.1 In-situ

Measurements will be carried out for some parameters for surface water and ambient air. Also, socio-economic and health data will be collected during fieldwork.
Details of the parameters to be determined in situ are given in Table 4.

Table 4: List of parameters for In-situ analysis determined during field work

S/N	Environmental Component	Parameters
1	Surface Water	Colour, Temperature, pH, DO, Salinity.
2	Vegetation	Type, density and species diversity.
3	Socio-economics	Settlements and housing types, population and population distribution, income levels, social infrastructures.
4	Ambient Air	VOC, SOx, NOx, CO, COx, Wind direction, Wind speed, Temperature, Relative Humidity, Noise, Suspended Particulate Matter
5	Health	Health records from previous studies and current.

3.3.2 Laboratory Analysis

All the samples collected during the fieldwork will be analyzed where necessary for the different parameters as listed in Table 5 below:

Table 5: List of parameters for Laboratory analysis

No	Environmental Component	Parameters
1	Surface Water	**General:** Temperature, pH, TSS, TDS. **Metals:**,Magnesium, Calcium**,** Zinc, Iron, Copper, **Organics:** Total Petroleum Hydrocarbons (TPH) Oil and Grease. **Microorganisms**: Hydrocarbon Utilizing Bacteria, Hydrocarbon Utilizing Fungi, Total Heterotrophic Bacteria, Total Fungi Count
2	Soil	**General:** Temperature, pH, Conductivity, DO, COD, Hardness, Alkalinity, Chloride, Nutrient Characteristic (NPK) **Metals:** Magnesium, Calcium**,** Cadmium, Zinc, Iron, Copper, Chromium, Nickel, Lead, Vanadium, Arsenic, Barium, Cobalt and Mercury. **Organics:** Total Petroleum Hydrocarbons (TPH), Oil and Grease. **Microorganisms**: Total Bacterial Count, Hydrocarbon Degrading Bacteria,Hydrocarbon Utilizing Fungi, Total Fungi Count
3	Sediment	**Physiochemical**: pH, Na, Ca, K, Mg, PO_4, SO_4, $N0_4$.

		Metals: Manganese, Calcium**,** Cadmium, Zinc, Iron, Copper, Chromium, Nickel, Lead, Vanadium, Arsenic, Barium, Cobalt and Mercury. **Organics:** Total Petroleum Hydrocarbons (TPH), Oil and Grease. **Microorganisms**: Total Bacterial Count, Hydrocarbon Degrading Bacteria, Hydrocarbon Utilizing Fungi, Total Fungi Count **Macro fauna (benthos)**
4	Plankton / Fish & Fisheries	Phytoplankton and Zooplankton : Fishing and fisheries

3.4 Quality Assurance and Quality Control

Quality Assurance and Quality Control (QA/QC) shall be an integral part of the entire process of field data gathering, sample collection and transfer laboratory analysis and reporting exercise.

3.4.1 Field Procedures

All field procedures shall be in accordance with general QA/QC requirements.

- Contamination of samples will be avoided by using clean sampling containers
- Separate samples shall be collected for parameters requiring different treatment or preservation before analysis
- Composite sampling technique will be adopted for surface water and soil.
- Control samples will be collected at appropriate points remote from impacted sites
- Samples shall be adequately preserved using standard custody transfer procedures

3.4.2 Field Research

Field research shall be used to complement and verify information gathered from desktop studies. The fieldwork shall be to determine the specific ecological baseline and socio-economic conditions of the project environment. Specifically, the survey shall cover the following environmental components:

- The physical environment – surface water and sediment characteristics, air quality and potential natural hazards;
- The biological environment - surface water and sediment 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.

3.4.3 Potential and Associated Impact Assessment

The identification and evaluation of the associated and potential impacts of the proposed project shall be based on standards and /or recommended environmental assessment tools such as the ISO 14001 approach and the Hazard and Effect Management Process (HEMP). The Risk Assessment Matrix (RAM) shall be used in determining the risks posed by the identified potential and associated impacts in order to proffer

appropriate mitigation measures. In predicting impacts, the experimental/practical 'worst case scenario' approach shall be used to determine the importance of affected environmental components. The impact evaluation results shall form the basis for developing the SEMP for the proposed project.

3.4.4 Laboratory Procedures

- Analysis will be carried out in a FMENV accredited laboratory
- Analysis shall be carried out within the holding time of respective parameters
- Only functional and calibrated equipment shall be employed
- Only experienced staff shall be involved in the analytical work

3.4.5 Reporting Exercise

The data obtained from the study shall be analyzed using appropriate statistical tools and principles to bring out salient point and trends on the facility and establish relationships between past studies.

3.5. Evaluation of Potential Impacts

Impacts on soil, vegetation, surface water, socio-economic and health of the communities will be quantified and evaluated using standard laboratory analytical methods to assess the magnitude of the impact to the environment. Interpretation of these data will be done by benchmarking with the available baseline data from field work results and data from other studies carried out in the field as well as with National/International standards/limits.

3.6 Regulatory Requirements

The main Nigeria regulatory provisions related to the EIA process include, but are not limited to, the following:

3.6.1 Environmental Impact Assessment (EIA) Act

The Environmental Impact Assessment (EIA) Act No. 86, 1992 stipulates that the public or private sector of the economy shall not embark on or undertake or authorize projects or activities without prior consideration of the environmental effects at early stages.
Where the extent, nature or location of a proposed project or activity is such that it is likely to significantly affect the environment, its EIA shall be undertaken in accordance with the provisions of the Act. Generally, the EIA shall be conducted in line with the following guidelines:

- Environmental Impact Assessment Procedural Guidelines, FMEH&UD, 1995

3.7 Environmental Management Plan

The management plan shall provide detailed environmental, social and health impacts to be mitigated to ensure that the recommended remedial measures are effectively implemented.

4.0 Report Writing

All findings relating to this EIA study will be documented in a report and reviewed by FMENV before the final report production for FMENV. The EIA report will have the following;

- Title page
- Table of contents
- List of Tables
- List of Figures
- List of Maps
- List of Plates
- List of acronyms and abbreviations
- List of Preparers
- Acknowledgement
- Executive Summary

Chapter One – Introduction; - Background information, Administrative and Legal framework, Terms of reference, Declaration

Chapter Two – Project Justification: Objectives, Aims, Benefits and Sustainability.

Chapter Three – Project Description – Proposed Quarry activities

Chapter Four – Description of Project Environment- Ecological characteristics of the project Environment Baseline data acquisition (vegetation, soil, topography, surface water, ground water, sediments etc)

Chapter Five -Study approach and methodology, literature review - Field data acquisition methodology (sampling, *in-situ* measurement and QA/QC), geographical location, climatic conditions, air quality, aquatic studies, vegetation characteristics, and soil studies. Socio-economic and health studies. Laboratory analysis methodology and Laboratory QA/QC.

Chapter Six –Associated and Potential Impacts – Results and discussion from the fieldwork and laboratory analysis, comparison of present data with previous data. – Result of impact evaluation and discussion of impacts.

Chapter Seven - Recommendation of Remedial Measures: - Description of remedial measures, Evaluation of remedial measures and Identification of residual impacts.

Chapter Eight - Environmental Management Plan, - Description of potential impacts matched with mitigation (intervention and adaptive) measures and time frame (short, medium and long) for implementation.

Chapter Nine - Conclusions and Recommendations

Bibliography/references

Appendices

5.0 WORK SCHEDULE

The Draft Report will summarize all the sampling results and conclusions throughout the Environmental Impact Assessment (EIA) exercise.

The draft report shall be reviewed by the proponent and comments sent back to contractor within 15 days. The draft reports shall be submitted electronically and in hard copy to FMENV for approval. Contractor shall submit the Final Report within 15 days of receiving comments from the regulator and company. The final reports shall be submitted electronically and in hard copy to FMEnv for approval.

Party is requested to quote the minimum shortest possible time required to submit the draft report after the issue of the contract.

The final consultancy service will terminate at the production of approval from the regulators. (FMEnv).

Appendix 2

SAMPLING CO-ORDINATES

Appendix 2: Akamkpa Quarry EIA Sampling Co-ordinates

SAMPLING STATION	ENVIRONMENTAL COMPONENT	UTM ZONE 32N		WGS 1984	
		X(m)	Y(m)	LONGITUDE	LATITUDE
SS1/AQ1	Soil/Air Quality	433588	591378	8° 24' 2.121" E	5° 20' 59.760" N
SS2/AQ2	Soil/Air Quality	433546	591166	8° 24' 0.763" E	5° 20' 52.855" N
SS3/AQ3	Soil/Air Quality	433652	591073	8° 24' 4.210" E	5° 20' 49.830" N
SS4/AQ4	Soil/Air Quality	433556	590656	8° 24' 1.104" E	5° 20' 36.247" N
SS5/AQ5	Soil/Air Quality	433948	590891	8° 24' 13.833" E	5° 20' 43.912" N
SS6/AQ6	Soil/Air Quality	433962	590682	8° 24' 14.294" E	5° 20' 37.106" N
SS7/AQ7	Soil/Air Quality	434220	591260	8° 24' 22.659" E	5° 20' 55.937" N
SS8/AQ8	Soil/Air Quality	434396	590507	8° 24' 28.401" E	5° 20' 31.421" N
SS9/AQ9	Soil/Air Quality	434411	590943	8° 24' 28.875" E	5° 20' 45.620" N
SS10/AQ10	Soil/Air Quality	434948	591775	8° 24' 46.296" E	5° 21' 12.731" N
SS11/AQ11	Soil/Air Quality	435151	591386	8° 24' 52.904" E	5° 21' 0.070" N
SS12/AQ12	Soil/Air Quality	435015	591004	8° 24' 48.497" E	5° 20' 47.625" N
SS13/AQ13	Soil/Air Quality	435625	591773	8° 25' 8.293" E	5° 21' 12.687" N
SS14/AQ14	Soil/Air Quality	435687	591302	8° 25' 10.322" E	5° 20' 57.351" N
SS15/AQ15	Soil/Air Quality	433697	590947	8° 24' 5.676" E	5° 20' 45.728" N
SS16/AQ16	Soil/Air Quality	436226	591763	8° 25' 27.821" E	5° 21' 12.380" N
SS17/AQ17	Soil/Air Quality	436244	591363	8° 25' 28.418" E	5° 20' 59.354" N
SS18/AQ18	Soil/Air Quality	436251	590980	8° 25' 28.657" E	5° 20' 46.882" N
SS19/AQ19	Soil/Air Quality	433047	590979	8° 23' 44.556" E	5° 20' 46.749" N
SS20/AQ20	Soil/Air Quality	434698	590849	8° 24' 38.202" E	5° 20' 42.568" N
SS21/AQ21	Soil/Air Quality	434379	592222	8° 24' 27.795" E	5° 21' 27.271" N
SS22/AQ22	Soil/Air Quality	436764	591297	8° 25' 45.315" E	5° 20' 57.221" N
SSC1/AQC1	Soil/Air Quality	431286	591385	8° 22' 47.326" E	5° 20' 59.914" N
SSC2/AQC2	Soil/Air Quality	436620	588677	8° 25' 40.716" E	5° 19' 31.894" N
BH1	Groundwater	433605	591172	8° 24' 2.680" E	5° 20' 53.052" N
BH2	Groundwater	436129	590979	8° 25' 24.693" E	5° 20' 46.846" N
BH3	Groundwater	433726	590317	8° 24' 6.638" E	5° 20' 25.212" N
BHC1	Groundwater	432114	590571	8° 23' 14.255" E	5° 20' 33.432" N
BHC2	Groundwater	436495	588796	8° 25' 36.651" E	5° 19' 35.765" N
SW1	Surface Water	434312	590838	8° 24' 25.667" E	5° 20' 42.200" N
SW2	Surface Water	434144	590746	8° 24' 20.211" E	5° 20' 39.202" N
SW3	Surface Water	433994	590603	8° 24' 15.344" E	5° 20' 34.542" N

Appendix 3

HEALTH AND SOCIAL ECONOMIC ASSESSMENT QUESTIONAIRE

Appendix 3: Socio-Economic and Health Assessment Questionnaire for the Environmental Impact Assessment (Eia) Study of Akamkpa Quarry Limited in Akamkpa – Cross River State

This questionnaire is intended to gather socio-economic and health status information on the community of the project location. The outcome of the study will be used to predict the appropriate impacts and effective mitigation measure(s) for any potential negative impacts that may be associated with the project.

Date of Interview: …….
Name of Settlement/Community: …….
L.G.A……
State: ……

DEMOGRAPHICS
1. Sex: …… **a**) Male b) Female
2. Age: ……a) < 20 years B) 21- 30 C) 31- 40 D) 41- 50 E) 51& above
3. Marital status: a) single b) Married c) Widowed d) Divorced
4. Education……a) Primary b) Secondary c) Vocational d) Tertiary e) No formal education
5. Religion……a) Christian b) Muslim c) Traditional d) Others (specify)
6. What is the major tribe of your community? ……
7. What is the size of your household? ……
8. Respondent's Employment Status
a) Student b) Unemployed c) Employed d) Others (please specify)

9. What do you do in this area? ……..
a) Live here b) Work here c) Live & Work here d) Visiting e)Others(specify) ……

10. **If resident, how long have you lived/worked here?**
a) < 1 years b) 1 – 2 years c) 3 – 5 years d) 6 – 10 years e) 11 – 20 years f) 21 – 30 years g) > 30 years

ACTIVITIES AND INCOME
11. What is your primary occupation?
a) Student b) Agriculture c) Artisan d) Trading e) Civil Servant f) Mining g) Housewife/ Unemployed h)Self-employed/Business sourcing i) Others (please specify) ……

Average Income Distribution.

Monthly income in naira (₦)	Percentage (%)
1,000 - 20,000	
21,000 - 40,000	
41,000 - 60,000	
61,000 - 80,000	

81,000 - 100,000	
Above 100,000	

STANDARD OF LIVING

12. What type of housing do you live in? (tick as appropriate)

S/N	12.1) Construction material - Walls	12.2) Construction Material - Roofing	12.3) Construction Material - Floor	12.4) Toilet facility	12.5) Tenure of Housing
a)	Mud	Corrugated sheets	Earthen	Pit latrine	Owner occupier
b)	Plastered mud	Asbestos	Cement	Water borne system	Rent/Lease
c)	Cement blocks	Tile	Tile	Bush use (Short-put) or None	Non-rent payment occupier
d)	Wood	Thatch	Terrazzo	-	-
e)	Others (specify)	Others (specify)	Others (specify)	Others (specify)	Others (specify)

13. What type of lighting does your household use? (circle all that apply)
a) PHEDC and Torch & batteries b) PHEDC and Kerosene lamp c) PHEDC d) PHEDC and Generator e) Others (specify) ……..
14. What type of cooking fuel does your household use? (circle all that apply)
a) Charcoal/firewood and kerosene b) Kerosene Stove c) LPG Stove d) Electricity – Generator e) Others (specify) ……..
15. Do you get water from any of the following? (tick all that apply)
a) Wellb) Borehole (Personal) c) Public water supply d) Stream/River e) Water vendor f) Tanked Water g) Rain Harvesting h) Others (specify)
16. What is your source of drinking water?
a) Well b) Borehole (Personal) c) Public water supply d) Stream/River e)Water vendor) Tanked Water g) Rain Harvesting h) Others (specify)
17. How do you regularly dispose of your domestic waste? (Circle all that apply)
a) Throwing in the drains/gutters b) Private Cart Pushers (Kole-Kole) c) Burning outside/backyard d) Burying e) Others (specify)

18. In your opinion, how has your standard of living changed over the previous three years?
a) Same b) Better c) Worsened
19. Why (Ask for explanation and write summary below)
……
……
……
HEALTH ASSESSMENT AND HEALTH RISK PERCEPTION
20. How would you describe your overall state of health?
a) Excellent b) Good c) Poor

21. Where do you often get treatment when you are sick?
a) Self Medication/Stay at home to rest b) Buy drugs from medicine hawker c) Go to the chemist for treatment d) Attend Government Clinic/Public Hospital e) Attend Private Clinic/hospital f) Attend Trado-medical/herbal/Natural medicine home

22. If you do attend Clinic/hospital, when last did you visit one last?
a) Last 6 months b) Last 1 year c) Last 5 years d) More than 5 years e) Never visited one

23. Please tick any of the complaints you have had in the last 6months.

S/N	Ailment/Disease	Occurrence (tick as appropriate)
1.	Headache	
2.	Fever	
3.	Skin Irritation/Rashes	
4.	Watery Stool/Diarrhoea	
5.	Vomiting	
6.	Cough	
7.	Sleep disorder/Insomnia	
8.	Asthma/Nasal Issues	
9.	Hypertension	
10	Chest pains/Pneumonia	
11	Burns	
12	Eye Conditions	
13	Impaired Hearing/ partial Deafness	

24. Are you aware of any health risks associated with living or working near a stone quarry site?
a) Yes b) No

25. If Yes, what health risks are associated with stone quarry site(s)?

……..

……..

……..

OPINIONS

26. Do you have any objection to the proposed project?
a) Yes b) No c) Indifferent
27. How do you think the proposed project can contribute to the development of this area?
a) Improved Security b) Employment generation c) Infrastructural development d) Others……
28. Do you think the services the company is going to provide will benefit the community?
29. Do you have any concerns about company operations or activities?
a) Yes b) No
30. If yes, what concerns?
……..
……..
……..
Thank you.
NB: PHEDC – Port Harcourt Energy Distribution Company