DRAFT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT FOR THE PROPOSED PROJECT: STEEL-MANUFACTURING PLANT/ CONSTRUCTION OF 1.3KM 132KV TRANSMISSION LINE- BY INNER GALAXY STEEL COMPANY LTD., UKWA-WEST L.G.A., ABIA STATE.

DRAFT REPORT, MARCH, 2016.
by: Richflood International Limited.

EXECUTIVE SUMMARY

General Background

Metallurgical Processes of the Iron and Steel-Manufacturing industry has made the industry remain as one of the important *basic* industry, driving Infrastructural Development in Nigeria; this is because of the high demand of steel-utilization in manufacturing industries for various industrial and construction uses attributable to quest for economic and urban development.

Most of the iron and steel production in Nigeria use steel scraps and iron ore as the major raw materials. The recycling of steel scraps reduces the usage of imported pig iron produced from natural iron ore. However, the demand of iron and steel in the manufacturing industries have increased and far exceeded the production capacity of the intermediate iron and steel production, which led to the increasing volume of imported intermediate products.

In order to bridge the gap between the required production-capacity of industries and the availability of needed Steel-resources (as raw material), Inner Galaxy Steel Company Ltd, (a *privately owned* steel-manufacturing company) have decided to acquire a 85 hectare of land for the setting up of a Manufacturing-Plant, to Produce Steel-Bars, and increase supply of needed steel-material; required for increased industrial-development and various construction uses of manufacturing industries.

Essentially, the company (project-proponent) in order to accelerate the availability of Steels, proposes to use the source of billet, as major raw material to be processed by the steel-manufacturing Plant.

However, the Plant in producing Steel-Products will require *heavy*-Power-Source. This will necessitate the immediate Construction of a 132KV Transmission Line, extending power (electric supply) from *an already situated* Power Plant to provide needed power-source (electric energy) for the steel-Plant operations.

Therefore, the nature of the project is in response to the need to contribute to infrastructural development by the provision of industrial steel-products, thus, the project proponent proposes to basically set-up a manufacturing plant which produces steel from billet, and to consequently construct a 132KV transmission line for powering (extending electric supply from *Alaoji* Power Plant) to the steel-manufacturing plant.

The central objective of the project is to set up a Steel Manufacturing Plant / Construction of 132KV Transmission Line which will enable the company to produce Steel Bars from **billets**.

With steel-products produced, the economic gains and income of the project locations is set to increase, due to industrial development, provision of social amenities and job opportunities in the area.

Other benefits of the project will be to alleviate poverty through employment creation to the local people and the improvement in the standard of living of the host communities in general through infrastructure development such as grading of local road networks near the site.

This will not only have positive economic multiplier effect but will also reduce importation of pig iron and/or the intermediate steel products; as the project-proponent (commercial company) has its primary business-interest in the manufacture and sale of steel-product from the processed billet.

In compliance with regulatory bodies, like the Federal Ministry of Environment (FMEnv) statutory provisions and in accordance to the Environmental Impact Assessment (EIA) Act 86 of 1992, Inner Galaxy Steel Company Limited (the project-proponent) has commissioned Richflood International Limited, *being a reputable environmental consultant*, to conduct an Environmental Impact Assessment (EIA) of the proposed Steel-Manufacturing Plant-operations/Construction of a 132KV Transmission Line in Ukwa-West Local Government Area of Abia State.

However the benefit and needs of the project may be, it is definitely not without some environmental concerns, thus the EIA Report seeks to identify and assess the potential impacts of the proposed project operations on the environment and the socio-economic well-being of the Host Communities (Ahala Ukwu Village, Umuahala Community, Obuzor Ukwu Autonomous, and Umuacheke, Umuigwe/Umuogogo Community, Isimiri Umuorie Autonomous).

To this regard, relevant regulatory & legislative guidelines and national & international environmental standards are been employed as the yardstick for assessments, thus, setting the boundaries of infringement of operations on human health and safety and on the environment; as captured in this report. The company, in compliance with environmental regulations in the country, carrying out this EIA Study of the proposed project, has hence produced this document, the EIA Report, to concur with set guidelines that encourage environmental sustainability and engender industrial best practices.

About the Project Proponent

Inner Galaxy Steel Company Limited is a privately owned company registered in Nigeria under the Corporate Affairs Commission with RC No. 1065816, on the 18th of September, 2012; whose commercial interest is in the sale of **Steel**-Bars product; thus the setting up of a Steel-Manufacturing Plant which will be powered (electric supply) by the Construction of a 132KV Transmission Line, extending power-source from a Power Plant located in the area.

Hence, the Company is set towards contributing to the nation's industrialization and urban/infrastructural development, by the provision of needed Steel-materials and indeed increase the economic gains and social amenities of the project area/location. This is not without the provision/expansion of electric-power-supply.

Project Location/Landmass

The project-site, location of the proposed installation of steel-manufacturing plant, which is an acquired 85 Hectares piece of Land, cut across two (2) autonomous communities located at AhalaUkwu Village, Umuahala Community, ObuzorUkwu Autonomous, and Umuacheke Village, Umuigwe/Umuogogo Community, IsimiriUmuorie Autonomous in Ukwa West Local Government Area of Abia State; South-East, Nigeria.

The proposed construction of 132KV Transmission Line is located close to the above stated project-site (factory area), with a distance of 1.3Km.

The Transmission Line will originate from the already existing Afam-Alaoji Power Plant, within the area, Ukwa-West, transversing a distance of 1300m (without presence of community, nor water body), to the 85 hectares of land mapped out for installation of the proposed steel-manufacturing plant.

The proposed transmission line and associated activities of steel-plant operations has been planned to eliminate adverse impacts on the environment. Impacts that could not be eliminated have been reduced to as minimal as possible. Detailed evaluation and discussion of the impacts and mitigation of the proposed transmission line on the environment are presented in chapters five and six of this report.

The installation of the steel-manufacturing plant and construction of 1.3km 132KV Transmission line is a major development project that could have negative impacts on the biophysical and social environments. However, if duly mitigated and planned the project will enhance the economic potential of the country, while impacting minimally on the affected environment. All the significant impacts identified have been thoroughly investigated during the impact assessment phase. None of these impacts are impossible to mitigate and manage with a detailed EMP in place.

Apart from meeting the need of Steel supply to manufacturing industries, Project implementation is also encouraged by the location-advantage of the project-site; as the site is located close to an already situated *Alaoji* Power Plant, to provide needed power-supply for the operations of the manufacturing plant; by extending a 132KV Transmission Line at the 22nd tower of the situated Transmission Station, which is close the proposed factory with a distance of 1300 meters.

Project Initiation

- The proposed project-site of Inner Galaxy Steel Company Limited, occupies a landmass of 85 Hectares for the Setting up of a Steel-Manufacturing Plant.
- The vast land of the factory/project-site cuts across two (2) Autonomous Communities, as hosts, Located at Ahala-Ukwu Village, Umuahala Community, ObuzorUkwu Autonomous, and Umuacheke, Umuigwe/Umuogogo Community, IsimiriUmuorie Autonomous, in Ukwa-West Local Government Area of Abia State, South-East, Nigeria.
- The Site is near the Aba-PortHarcourt Express Road, with a distance of about 7km.
- The proposed plant-installation for steel-manufacturing will require the Construction of a 1.3km 132kV Transmission Line (4 double-circuit Tower), to Power Inner Galaxy Steel Company Ltd's operations
- Located along this road, is the Afam-Alaoji 132KV Transmission Station Lines; thus the Proponent proposes by legal requirements to Construct a Transmission Line to Connect to the Alaoji Power Plant by extending the 132KV power supply at the 22nd tower of the Transmission Station, which is close the proposed factory with a distance of 1300 meters.
- The average power-consumption of the proposed project *(Steel-Manufacturing)*, as required for the factory operations of the Steel-Plant is 80MW, at full production-capacity.
- The production-capacity of the proposed project is benchmarked at 10,000 tons of Steel-Bar per month.

Project Scope of Work: Sequence of Activities

The scope of work of the proposed project would involve the following listed principal activities; which does not however show the interdependencies of the project activities.

- Survey of the proposed project site
- Determine technically feasible alternative transmission line routes or corridors (*based on environmental preferences*).
- Negotiation of final route corridor within corridor with landowners/host communities.
- Clearing of the proposed project factory-site (85 hectares)
- Clearing of vegetation from essential parts of the 1.3km Right of Way (ROW) for the 132kV Transmission Line construction
- Development of access road to the project site
- Establishment of construction camps
- Mobilisation
- Transmission line detail design
- Final design of line and placement of towers (Selection of best-suited structures and foundations).
- Material production (conductor, insulator, line hardware)
- Material testing and shipment
- Tower production
- Tower testing and shipment
- Clear and grub site along transmission line corridor (wayleave)
- Construction of Foundations for tower installation
- Tower assembly and erection
- Conductor stringing
- Provision of associated digital communication facilities at the substations to facilitate supervision and maintenance of the transmission line operations
- Commissioning and testing of Transmission Line
- Procurement and supply of all operational materials and machineries
- Installation of the Steel-Manufacturing Plant
- Construction of buildings/production facilities
- Project Waste management/structures
- Provision of needed Safety/security measures
- Commissioning of the steel-manufacturing facility
- Demobilization/de-commisioning
- Rehabilitation of all working areas

Transmission Line Project Activities – Environmental Indicators *Interaction Matrix*

Project Activities	**Pre-Construction**			**Construction & Installation**									**Operation/Maintenance**									**Decommissioning**		
				Planned Activities						**Unplanned**			**Planned Activities**			**Unplanned**								
Environmental Indicators ↓	Mobilization of construction	Recruitment/community	Site preparation	Onsite fabrication	Tower foundation	Tower erection/stringing	Waste management	Fuel / hazardous materials	Painting and coating	Logistics	Fires / explosions	Incidents / Accidents	Commissioning / Testing	Power Transmission	ROW maintenance	Line element replacement	Waste management	Logistics	Tower falling incidents	Fires	Incidents and Accidents	Geo-hazards	Transmission Line	Abandonment / Restoration
Air Quality																								
Particulates	x		x	x	x					X	X				x			x		x		x	x	x
NOx, SOx, COx, etc.	x		x	x	x					X								x				x	x	x
Gaseous Hydrocarbons										X								x				x		
Water Quality																								
Turbidity			x		x										x		x						x	x
Water Physio-chemistry	x		x		x	x	x								x		x						x	
River-bed Physio-chemistry			x		x	x											x						x	
Aquatic Ecology																								
Plankton					x		x	x									x						x	
Fishes							x	x									x					x		
Macro-benthos					x		x	x									x					x		
Terrestrial Ecology																								
Fresh Water Swamps			x		x		x	x							x		x						x	
Mangrove Swamps			x		x		x	x							x		x					x		
Rainforests			x		x		x	x			x				x		x			x		x	x	
Avifauna	x		x		x	x				X	x			x	x			x					x	x
Rodents and Mammals	x		x		x	x	x	x		x	x			x	x		x	x				x	x	x

Project Activities	Pre-Construction			Construction & Installation									Operation/maintenance									Decommissioning		
				Planned Activities						Unplanned			Planned Activities			Unplanned								
Environmental Indicators ↓	Mobilization of construction	Recruitment/community	Site preparation	Onsite fabrication	Tower foundation	Tower erection/stringing	Waste management	Fuel / hazardous materials	Painting and coating	Logistics	Fires / explosions	Incidents / Accidents	Commissioning / Testing	Power Transmission	ROW maintenance	Line element replacement	Waste management	Logistics	Tower falling incidents	Fires	Incidents and Accidents	Geo-hazards	Transmission Line	Abandonment / Restoration
Soil Quality																								
Physic-chemistry			x		x	x	x	x	x							x	x						x	
Topography / Natural Drainage	x		x		x	x				x					x			x				x	x	x
Sensory Perceptions																								
Noise Disturbance	x		x	x	x	x				x	x			x	x			x					x	
Visual Intrusions			x		x	x							x						x				x	x
Socio-Economics / Human Health																								
Existing / Planned infrastructures	x		x		x	x	x			x	x	x		x	x		x	x	x	x			x	
Employment Opportunities		x	x	x	x	x	x		x	x					x		x	x					x	x
Worker Safety / Occupational Health	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Public Health			x				x							x	x		x		x			x		
Land-use			x		x			x			x		x										x	
Fishing			x				x	x																
Traffic on local roads	x		x		x	x				x								x					x	
Macro & Micro Economics	x	x	x	x	X	x	x						x	x	x	x		x					x	x

Environmental Impact Indicators

The environmental impact indicators are easily observable parameters that will indicate change/deviation, which can be used to monitor the various environmental components, as presented in below.

Environmental Components and Potential Impact Indicators

S/N	ENVIRONMENTAL COMPONENTS	IMPACT INDICATORS
1	Air Quality	SPM, CO_2, NOx, SOx, CO, VOC, CH_4, NH_3, etc
2	Soil/Agriculture	Soil type and structure, physico-chemical and microbiological characteristics, etc
3	Surface Water Quality	Physico-chemical and microbiological parameters such as; dissolved and suspended solids, turbidity, toxicity, etc
4	Ground water quality	Physico-chemical and microbiological parameters such as; dissolved and suspended solids, turbidity, toxicity, etc
5	Socio-economics/Health	Needs and concern of host communities, perception on the proposed project/ Health risks, Waste streams, handling, treatment and disposal, etc.

Summary of Identified Impacts associated with the Transmission Line Construction Project's activities

Environmental and Social Components	**Associated and Potential Impacts' Description**
Physical Environment	
Geology	The geology in the line route and subsequent different soil formation shall require use of different construction methods for foundations. Blasting and drilling may cause rock movement and breakages thereby, disturbing the general geology in localized areas and spots. However, such disturbance shall be confined to the construction period only. In the hilly parts of the project area, the rocks are held in place by lose soils. Clearing vegetation along the wayleave may induce mudslides and rock falls.
Topography	The study area is generally undulating with few hills in places making it conducive to work through. However, the region experiences high rainfall hence any disturbance to the natural cover could lead to accelerated water induced soil erosion. This, however, is not confined to hilly areas, but throughout the route as the route falls within the high rainfall zone of the country.
Soils	The soils in the study area have serious rooting limitation due to subsoil acidity hence prone to water induced erosion. Construction of the line might open up areas that could be exposed to soil erosion. The variability in soil texture in the study area entails that certain sections of the route could be exposed without any serious threat to water induced erosion. For instance, clayey top soils are highly prone to water induced erosion once exposed. Vegetation removal exposes soil to weather conditions.
Hydrology	The drainage density comprising perennial and ephemeral streams in the area makes the whole route prone to water induced erosion. Opening up of the area could also lead to the disturbance in the natural flow regimes of

	the streams especially when establishing appropriate crossing points. Increase in turbidity due to expose of soil surface run-offs carry sediment drainage pattern due to changes in topography and improper re-instatement. Inflow of run-offs may cause change in water quality.
Wetlands	The movement of surface water in wetlands contributes to the character of the existing ecosystem. Cut and fill activities may inhibit, enhance, or redirect the flow of water and, in so doing, change the nature of both the established water regime and the biological community of a site. Engineering structures in wetlands can often affect both the timing and duration of water regime fluctuations. When the changes are pronounced, they may have significant effects (e.g., alteration of vegetation assemblages) on the wetlands involved. A shift in wetland habitat composition (such as distribution and abundance of wetland habitat types within the wetland) is a community level effect that may result from altered water levels and may occur to a lesser extent from changes in periodicity or sedimentation. Wetland habitat composition is a major determinant of wildlife found in the area, especially wetland mammals. Any changes in composition of wetland can result in wildlife disturbance.
Air Quality	The construction of the 132kVline shall have little impact on air quality since such pollution shall be confined to the construction period and during maintenance. The construction activities that may cause air pollution during construction are equipment operation and movement, clearing and grubbing and excavation activities. Release of gaseous emissions and particulate may also cause an effect on the quality of air. Emission of exhaust gases from fuel consumption engines can alter the local ambient air quality; with increase in dust during the dry season.
Noise	Noise shall be created during construction especially since heavy-duty equipment shall be used in excavating, stringing and tower erection. Noise pollution shall, however, be limited to the construction and routing maintenance period. However, during operations transmission conductors will produce noise under certain conditions because of

	corona discharge. Corona discharge is the ionisation of the air next to the conductor by the electric field which is related to the voltage on the conductors. The loudness of the noise depends on conductor conditions, voltage level, and weather conditions, making a hissing, popping or cracking sound.
Biological Environment	
Fauna: Mammals, Reptiles, Birds, Fish	The wayleave for the proposed transmission line could open or truncate some migratory routes for wild animals. However, open areas under the wayleave could provide new browsing grounds for various animals/wildlife. The presence of the construction workers in the project area may induce poaching. Leftover Aluminum conductors from construction works may give rise to snare wire that poachers eventually use to trap animals in the area. Tower foundation works could disturb habitats for smaller mammals such as rodents and cane rats, especially in the grassy areas. Most of reptiles are water, ground and tree dwellers and therefore the unmanaged removal of vegetation, especially the under-storey layer would impact adversely on the reptiles' habitat and lives. Feeding of browsers may also be affected negatively resulting into migration of reptiles that may not adapt to the new environment. This may eventually lead to either evolution due to change in environment or extinctions from failure of adaptation. The impact may finally result in reduction of biodiversity. Adverse impacts may arise, from erected transmission lines, through accidental ramming of large birds into the power lines during their normal or regional and seasonal migratory flights. All vegetation layers, emergent, canopy and under-storey, allows for birds' habitat and nesting and therefore, the removal of vegetation may impact negatively on these activities. Erection of towers close to rivers and streams banks and on areas such as dambos may impact negatively of water flow regimes and water recharge patterns. This in turn impacts on the fish habitat and eventually disturbs their productivity and their biodiversity. The excavation of soils, resulting from tower erection, may cause soil

	erosion that will result into siltation and sedimentation, impacting on water quality. This may adversely affect the fish and other forms of aquatic life in the river resulting in biodiversity loss. Most water polluting agents, such as; oil, silt, vegetative material and other debris, impact negatively on the Dissolved Oxygen content in water bodies. This results in fish kills through asphyxiation.
Flora	The proposed transmission line stretches approximately 1.3km. The wayleave clearance will result in loss of vegetation. Removal of riverine vegetation as a result of tower construction may result in erosion and loss of natural river flow regimes. In general vegetation removal shall result in reduction of biodiversity as valuable trees such as those of medicinal importance, wild fruits, and endangered species may be adversely impacted upon. Fauna providing habitat for most birds, snakes and other predators may also be affected, as vegetation of the understorey is reduced. Disturbance to flora will lead to reduction in biodiversity.
Social Economic Impacts	
Population	During construction, there will be an influx of people from outside the project in search of jobs. The Contractor is also expected to come with a team of skilled personnel for various specialized tasks during the entire construction phase.
Settlement Patterns and Traditional Authority	There will be no significant impact on settlement patterns in the project areas as few houses in the villages will be demolished because most of the houses will be avoided. During construction, the contractor will build temporal camps in different places along the proposed route for the power line. They will not alter the settlement patterns in the areas because the camps will be demolished upon completion of the construction activities.
Social and Cultural Set-up	Experience derived from past projects, shows that most of the construction workers leave their spouses in their respective places of residence as it is assumed to be burdensome. Arising from this, some workers develop the

	tendency of getting women from the areas where they have camped. This could create conflict between the villagers and the construction workers which could even culminate into social strife leading to delays in work schedules. The influx of people into the project area may breed social problems such as theft, prostitution and drug abuse. Some of the people coming into these areas could be people with questionable characters and may bring their bad habits into the area.
Local Economy	Besides infrastructural development (by the availability of electricity supply, for steel-bar manufacturing), employment opportunities shall be availed to the locals during construction. This shall lead to an improvement in the income levels and, in turn, in the standard of living with people being able to buy foodstuffs, groceries, clothes and other essential commodities resulting in a multiplier effect. Some of the income will be used for paying school fees, medical expenses and other domestic needs. Materials such as sand and crushed stones may be bought within the Districts, benefiting the local economy. Other materials like cement, timber, poles and conductors may also be bought within the Districts and other parts of the Country, benefiting the national economy. Electricity provides an important source of energy that can boost the development of any area. It is expected that the availability of firm and reliable power supply will lead to the development of the Districts and the nation as a whole.
Land Tenure/Land Use	The existing land tenure will not be disturbed. Chiefs, local authorities, the state and farmers will maintain their land ownership during both during the construction and operation phases of the project. Utilization of the land under the power line and within the wayleave will be restricted. Building of houses, planting of fruit and other trees and similar activities under the power line will not be allowed. However, growing of low crops such as groundnuts, beans, sweet potatoes and maize maybe permitted, but no ploughing is allowed at the foot of the tower to avoid destabilizing the foundations.

Agriculture	There shall be significant impacts on agriculture, both positive and negative. Since crops grown in the wayleave are restricted, crop diversity is negatively affected. On the other hand, provision of firm and reliable supply of power shall for the use of mechanized electrical agricultural equipment, such as center pivots. The line may also traverse a few existing agricultural fields with a possibility of crops being damaged, especially during the construction period. The wayleave cleared of vegetation will provide good grazing grounds for cattle, sheep, goats and other livestock. During construction, the workforce will provide a ready market for various agricultural produce and will boost farmers' incomes.
Employment	There shall be temporary employment opportunities to the local communities during the period of construction, especially for works such as; bush clearing and excavation of foundations for the towers. When recruiting workers, the Contractor shall ensure that the local people are given priority. Some construction materials, such as crushed stones and sand will be obtained within the area and this will indirectly contribute to employment creation for those engaged in crushing stones and mining of sand.
Education	No significant pressure is anticipated on the existing education facilities in the project area. However, reliable and firm power supply will improve the quality of education delivery through; the use of computers, laboratory facilities, etc. Night schooling will also be encouraged, therefore increasing literacy levels. In addition, teachers will be attracted to work in an area with a ready power supply.
Health	The interaction of construction workers from outside the project areas with the local people may lead to the spread of HIV/AIDS and other communicable diseases. This interaction could also lead to spread of water borne diseases such cholera, dysentery and typhoid. The workers may also be exposed to the risk of accidents during construction phase which may lead to injuries. In view of the above, this shall exert pressure on the existing health facilities. On the other hand, provision of power will enable the use of advanced medical equipment such as X-rays, CT scans, Spectrophotometers,

	electron microscopes and refrigerated storage facilities.
Water and Sanitation	There is likely to be more pressure on the existing water and sanitation facilities resulting from an increase in the population during the construction phase. It is envisaged that appropriate and adequate sanitary facilities like pit latrines and places to bath shall be constructed for the workers. (mitigation) Domestic waste generated at the camps for workers could adversely affect the sanitation in the area. Domestic waste such as leftover foodstuffs and human waste could pollute the environment if not well managed. Provision of power will enhance the efficiency of existing of water treatment plants and promote the use of water borne toilets.
Infrastructure and Social Services	The availability of power will promote infrastructure development and provision of social services. Investment will be encouraged in activities such as; trading, telecoms, ICTs, and other social amenities. During project implementation, some feeder roads will be upgraded and bridges repaired to facilitate the movement of construction equipment and materials. The improvements in some of the roads will greatly benefit the local people and open up the area for numerous opportunities. The reinforcement of power supply enhance the production capacity of existing industries in the area and promote the development of new industrial activities.
Archaeological and Cultural Sites	The proposed power line will not affect any known archaeological or cultural site.
Safety	During construction, construction workers may be exposed to risks such as falls during tower erection and stringing of the conductor, snake bites and injuries from various construction activities. There are also risks of road traffic accidents for both construction workers and other road users. However, the Contractor is to develop and implement a construction HSE management plan to manage the impact of construction disturbances on the environment.

Summary of Mitigation Measures (to reduce identified impact) of Transmission Line Project's Aspect

Project Phase	Type of Impact identified	Mitigation Measures Recommended
Operational phase	Risk of Bird-Electrocution	□ Provide artificial bird safe perches and nesting platforms placed at a safe distance from the energized parts □ Cross-arms, insulators and other parts of the power lines can be constructed so that there is no space for birds to perch where they can be proximate to energized wires. □ All terminal structures (transformers) should be constructed with sufficient insulation on jumper wires and surge arrestors □ Keeping cables far apart >60cm, will certainly minimize or eliminate this risk of electrocution along the lines. □ Where wide spacing of electric cables is not practical then insulation is recommended
Pre-construction and Construction phase	Disturbance, alteration and destruction of Natural habitats	□ Destruction of woody grassland during construction should be minimized. □ Destruction of riparian habitats and water pans during construction and operation should not be allowed □ The activities of the construction and operations staff must be restricted to the wayleave and immediate surrounds. □ Birds should not be exposed to more disturbance than is inevitably brought about by construction and operations activities. □ Care should be taken in sensitive areas such as grassland, wetland and valleys not to create more disturbance than is necessary. Access of machinery and vehicles to these areas should be carefully controlled and maintenance and construction activities must be restricted to the

		wayleave where practical Use of existing tracks and roads in the general as far as possible will help minimize construction of access roads to deliver materials. Clearance of plants (trees and shrubs especially) should be minimized unless necessary. This should be easy to observe as trees and shrubs in the area are already short below overhead cables.
Pre-construction and Construction phase	Waste-generation at construction-site	Comprehensive waste management is being developed to help in minimizing waste accumulation on site. Oil spill handling strategy especially mopping up oil immediately after spill, engine maintenance particularly oil change off site plan should help avoid pollution due to oils. Old transformers should be changed on time to minimize leakages. They should be stored in concrete floors and rooms with roofs to avoid precipitation.
Pre-construction and Construction phase	Dust/particulate matter impact	This impact is low but can be made less in magnitude and extent when dust mufflers are used and watering is done on the construction sites where dust more likely to be an issue. Construction can be timed when the ground is not too dry and dusty and bats are not desperate
Pre-construction and Construction phase	Noise from construction plant	Silencers fitted to the engines could significantly reduce impact of noise Switching off engines not in use can also reduce noise duration and intensity
Pre-construction and Construction phase	Terrestrial woody plant alteration	The impact could influence the decision to develop in the area unless it is effectively mitigated. Traditional construction of a wayleave that involves grading of the belt should be avoided.

		This causes damage to vegetation and habitats that they provide to animals. □ Avoid grading in areas with high slope angles to avoid future possible erosion □ Minimize grading of rugged areas by looking for alternative passage within the 60 m wayleave. □ Avoid cutting of short trees that heights are lower than the power line. Height difference should be maintained at least 15 m. □ When points of erecting pylons is exactly on cluster of bushes, offset backwards or forward within the proposed line to avoid destruction of the potential habitats or refugia for reptiles and small mammals
Pre-construction and Construction phase	Introduction of Alien Invasive Plant Species (AIPS)	□ Equipment to be used should be decontaminated e.g. washing equipment to remove soil potentially carrying AIPS propagates □ Avoid importing soils/gravels to use for level grounds for vehicles to pass in ROW. If brought from outside, the surface of the soil should be removed to avoid mixing of soils potentially harboring AIPS propagates with the lower soil profiles. □ Since AIPS appears later after soil disturbance, aftermath proliferation of AIPS should be controlled by reducing their population and recruitment
Pre-construction and Construction phase	Aquatic Habitat Alteration	□ There is need to ensure sedimentation is not caused in the drainage system. □ Minimization of activities that disturb soil layer near the river valley would contribute to the conservation of the system
Pre-construction and Construction	Temporary obstruction of movement of wild-	□ Speed of vehicles should be controlled at a maximum limit of 40 km/h. Once a driver notices a herd of gazelles is crossing s/he should wait until all have crossed or slow down to

phase	herbivores	avoid hitting individuals Avoid grading or clearing of vegetation where the mounds of moles and Aardvark holes occur. These are probably their hidings from predators and severe climate conditions. Construction activities should be restricted to day time from 6am to 6pm. This provides time for foraging for nocturnal animals. This group is normally sensitive to presence of human activities and flood lights at night. During dry season the upland is dry of grasses but the lowland still has grass, herbs and shrub reserves. Most of herbivores migrate to this area thus construction activities during dry season can affect utilization of this area. Construction should therefore be scheduled after the onset of rainfall. Generally, vegetation in the area responds quickly to rainfall hence herbivores will disperse to avoid any adverse impacts. Impact on the species will be localized. Disturbance of their habitats would affect negatively the hidings of geckos and lizards in the rock outcrop area. Implementation of operation times, speed limit and driver’s keenness can potentially reduce this impact.
Operations phase	Exposure of wild herbivore to electric and magnetic fields	Excessive clearing of vegetation should be avoided to prevent incidences of wild herbivores congregating along the wayleave. In case there will be possible electric inductions on wire fences, rubber breaks should be introduced on wires to avoid possible conduction of electric domains.
Operational phase	Exposure to Electromagnetic Field	No permanent structures will be allowed within the 1.3km wayleave; this will be enforced by Inner Galaxy

	(EMF)	Residents should limit their exposure by staying away from the wayleave Inner Galaxy Steel Co. Ltd. should have periodic engagement sessions with the local community on the hazards associated with the 132kV transmission line Also consider providing surveillance mechanism of the transmission line corridor

ENVIRONMENTAL MANAGEMENT PLAN SCHEDULE/PROGRAMME FOR PROJECT'S ASPECT

ENVIRONMNETAL MANAGEMENT PLAN	OBJECTIVE	TARGET	ACTION	MONITORING AND REPORTING	Responsibility
AIR QUALITY MANAGEMENT PLAN	To minimise the release of emissions (combustion products and particulate/dust) to air during all construction phases of the project	Limit emissions of pollutant gases like NOx, SOx, CO, in addition to dust, smoke, and fumes, within acceptable standards through all construction phases of the project work activities	•Maintenance programme shall be developed and implemented for all associated power generators and heavy duty equipment • Controlling fuel consumption for all equipment and vehicles through prudent work execution and effective journey management • Implement basic environmental awareness management program • Limit use of diesel powered generators to minimum required to sustain uninterrupted operation. • Vehicle speeds in construction area and unpaved local roads shall be limited to a maximum of 30km/h. • Where practicable, vehicles and machinery that are used intermittently should not be left idling for long periods of time. • Re-vegetate disturbed areas as soon as possible. • Wet areas that have the potential of raising significant dusts during work activities • No open burning of waste to be undertaken.	Visual inspection shall be undertaken by the HSE focal person/Contractors to check for evidence of excessive dust generation. If necessary, dust monitoring shall be undertaken in areas likely to generate dust that would affect nearby residents and workplaces to determine whether controls are being applied effectively. Maintenance schedule and records shall be kept. Maintain a log book for site fuel consumption and estimate emission from consumption. All issues shall be documented, acted on and reported in accordance with site procedures.	Site Environmental Officer

			• During construction, particulate matter (dust-generation) will be controlled by the use of water sprays and dust suppressants, as required.		
NOISE AND VIBRATION MANAGEMENT PLAN	To minimise the generation of noise emissions during all the construction phases of activities and to mitigate any potential noise impacts	Construction activities undertaken to comply with FMENV recommended ambient noise level guidelines	Contractors during the construction phase shall implement the following strategies: • Notify residents in affected areas of the project prior to commencement of construction. The notification would include the type of works to be undertaken, the duration of the proposed works, and a contact for any questions or concerns that may arise in the course of the work • Ensure that all equipment have effective noise control measures. Effective noise controls include: o Monthly inspection and maintenance of all vehicle and construction equipment and generators used in operation. o Use of sound suppressive device such as mufflers and silencers where possible. o Where practicable, vehicles and machinery that are used intermittently should not be left idling for long periods of time. • Noisy activities during construction/decommissioning shall be conducted during the day. • Best available work practices shall be engaged on-site to minimise occupational noise levels. • Haul routes for construction traffic entering and leaving the site shall be selected in a way that	Monitor high noise areas for proper use of PPE equipment in accordance with WHO / FMENV guidelines and standards. Schedule maintenance shall be undertaken for construction equipment and power generators to ensure an optimal working condition. All complaints shall be documented, acted on and reported in accordance with site procedures.	Site Safety, Health and Environmental Officers

			ensures noise levels at noise sensitive receptors are kept at a minimum. • Use of personal protective equipment(PPE) e.g. ear plugs for personnel working in areas where noise is a concern i.e. above 90dB(A) • Define high noise level working areas by engineering analysis of equipment for which hearing protection is required and provide appropriate warning signs		
WATER QUALITY MANAGEMENT PLAN	Avoid the contamination of surface water during construction.	Surface water is not contaminated during construction activities	• Implement controls such as berming, use of secondary containment and trays to ensure all transfer of fuels and chemicals are properly managed to prevent spillage outside of bunded areas. • Provide bunded storage areas for fuels and hazardous substances with spill clean-up kits in accordance with FMENV requirements/standard. • The project shall ensure that measures are adopted to avoid incursion into areas adjacent to the work site or any secondary effects from pollution, sedimentation, or accidental spills. • Suitable site drainage system to be constructed in lay-down areas and marshalling yards	Inspections of construction areas and assessment of the condition and operability of site drains shall be conducted. Weekly inspection of all fuels and chemicals storage areas to ensure adequate containment and handling. All complaints shall be documented, acted on and reported in accordance with site procedures. • Incidents of water contamination or spills • Results of inspections • Results of any corrective actions	Site Health and Environmental Officers

SOIL-Contamination MANAGEMENT PLAN	Prevent soil contamination	No incidents of soil contamination by hazardous substances (diesel, petrol, hydraulic oil, lubricants and paints)	• Avoid the risk of soil contamination from all construction activities. Measures to be adopted shall include: • Construct spill containment facilities (containment walls). • Train operators on safe handling of chemicals and enforce the implementation of safe work practices/procedures. • Develop and implement site specific emergency and spills response plan • Provide emergency and spills response equipment and training of personnel on effective and timely use • Use drip pans during fuel transfer operations • Identified contaminated area shall be promptly cleaned up, reported and monitored in accordance with regulatory and project approved Requirements	• Weekly inspection of all fuels and chemicals storage areas. • Maintain records of inspections. • During construction, records of any contamination incidents shall be reported according to approved procedures	Site Environmental Officers
FLORA MANAGEMENT PLAN	To minimise disturbance and loss of local flora population.	No disturbance of flora outside of designated construction areas.	Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora management. This plan shall indicate lists of animals and plant species of concern, development and implementation of a training program that would	Periodic inspection of the site area. (6 monthly to a year depending on the phase of project to check for disturbances to floristic composition) Any incidents of invasive species shall be reported in accordance	Site Environmental Officers

			include photos and other information to identify the various species, procedures for responding if one of the species is found (such as contacts, stopping work until relocation or protection is effected, reporting the incident in routine progress reports, etc.), where appropriate to ensure the designation of certain areas as sanctuaries for species that may be displaced by the project and requirement for a survey by qualified biologist(s) ahead of ROW clearing, as well as strict prohibition for the workforce on killing or capturing any of the species. • Limit construction of lay-down areas, marshalling yards, access road, ROW clearing etc. to maximum foot print required for safe operation. • Areas of terrestrial habitat that were temporarily disturbed during construction (lay-down areas, marshalling yards, etc) will be reclaimed (e.g. topsoil replacement, backfilling trenches, etc). • The project specific emergency and spill response plan will cover hazardous materials management plan such as fuels, oil, and other potentially hazardous materials on the site. • A project specific waste management plan shall address adequate management of potential wastes to be generated by the project	with site reporting procedures along the ROW.	

FAUNA MANAGEMENT PLAN	To minimise temporary disturbance of terrestrial fauna during transmission line construction and operations	Minimise impact on the local fauna	• Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate fauna management. This plan shall indicate lists of animals and plant species of concern, development and implementation of a training program that would include photos and other information to identify the various species, procedures for responding if one of the species is found (such as contacts, stopping work until relocation or protection is effected, reporting the incident in routine progress reports, etc.), where appropriate to ensure the designation of certain areas as sanctuaries for species that may be displaced by the project and requirement for a survey by qualified biologist(s) ahead of ROW clearing, as well as strict prohibition for the workforce on killing or capturing any of the species. • Work activities to be limited within minimum area required for operations to minimize disturbance to wildlife habitats • Workforce shall be educated on biodiversity and good conservation practices. • Construction workers shall be prevented from transporting or keeping pets in the construction camp. • Species identified to be unable to move from the project site shall be safely relocated prior to	Monitoring for evidence of habitat disturbance or invasive species shall be Undertaken Incidents of non-approved disturbance of fauna shall be reported and addressed to prevent repetition. • Vulnerable species in line with Nigerian conservation ranking (Act 11, 1985) sighted shall be reported. Report should include the date and location (latitude/longitude) of the animal	Site Environmental Officers

			commencement of work in the area		
AESTHETICS MANAGEMENT PLAN	Minimise the visual impact of the transmission line corridor on surrounding areas.	Minimize visual impacts as practical	• Landscaping where necessary on the acquired ROW • Identify and incorporate plant species with the potential to effective screening. • Utilise indigenous species, preferably those that are endemic to the area • Good housekeeping practices shall be maintained accordingly to reduce poor aesthetic conditions around construction sites.	Inspection of the health and vigour of the landscaping/ planting areas. Any improvement or deterioration shall be reported in accordance with site reporting procedures	Site Environmental Officers
SOCIAL-CULTURAL MANAGEMENT PLAN	To ensure that there are no adverse effects on the region's cultural values. • Minimise social and/or community impacts associated with all work activities. • Maximise opportunities for local engagement and businesses opportunities during the various project phases especially during the construction period.	• Cultural values understood and protected by Inner Galaxy Steel Company Limited • Receive and respond to complains about social or community management issues	• Develop and implement community relations and engagement plan • Develop a RAP in line with OP 4.12 for The World Bank's approval. • Ensure ROW acquisition strategies in line with the approved RAP prior to commencement of work. • No unauthorised disturbance of cultural activities by the transmission line works • Plan activities in recognition of indigenous cultural activities. • Continue to consult with the indigenous communities. • Accommodation shall be provided for some construction workers (not from surrounding communities) to minimise pressure on existing	Review feedback from the traditional rulers and the community groups and related Government/non-Governmental Organisations. Monitoring shall be by stakeholder feedback and by review of complaints. All complaints received shall be reported to the project manager. Monthly reports shall be prepared on social and cultural management issues and any corrective actions undertaken	Community Relations Officer

			infrastructure • Basic health and medical services (first level assist, first aid) shall be available to reduce the demand on existing health facilities. • Specify and implement the behaviour standards expected from all construction workers. This shall be formalised in a code of conduct that shall be agreed to and signed by every employee and sub contractor. • Complaints about unacceptable behaviour from construction workers shall be investigated and, appropriate action taken. • Use a wide range of communication tools to ensure that community is kept informed of project progresses. • Offer opportunities for the involvement of local businesses and for the employment of local residents		
SECURITY, HEALTH, and SAFETY MANAGEMENT PLAN	To ensure that the project does not adversely affect the security, health, safety of the employees, contractors or the general public as well as the environment.	Zero reportable injuries, spills, and work-related illnesses	• The EPC contractor shall be required to prepare a project specific Security, Health, Safety, and environmental Management Plan in accordance with the requirements of Inner Galaxy Steel Company Limited management system. • Site specific Environmental Management Plan to be prepared by the EPC contractors will be developed prior to construction activities, after specific areas have been determined for project activities to ensure appropriate environmental	The security, safety, health, and environmental performance shall be monitored in accordance with the project and corporate procedures and reported to the project management team. Monthly/Quarterly audits shall be executed	Inner Galaxy Steel Company Limited CR&E unit, Project SHSE Manager, and Project Manager

			management strategies. • All workers on the project shall go through a compulsory orientation programme before they start work. • Environmental, Health, Safety, and Security plans, programs, and regulations governing the project would be implemented and complied with. • Every worker would be made to sign a personal commitment to individual and corporate safety while at work. • Health, Security, Safety, and environmental awareness programs e.g. AIDS, and malaria awareness) shall be organized for personnel. Public health risks present significant issues for Inner Galaxy Steel Company Limited operations. Inner Galaxy Steel Company Limited management as well as employees and contractors will be committed to working actively together to mitigate the impact of infectious diseases such as HIV/AIDS and of malaria. In addition, EPC contractor will be required to prepare and submit the project security plan to Inner Galaxy Steel Company Limited for review and approval before mobilisation to site. The project team will also organise a security workshop to identify, evaluate and recommend contingency plans for all security risks.	Monthly reports shall be prepared on health, security, environment and safety performance along incidents and corrective actions undertaken	

Monitoring (Schedule) Plan for the Proposed Projects

S/N	Environmental Component	Impact/Aspect	Indicator Parameter	Monitoring method and Location	Timeline/ Frequency	Responsibility
1	Air quality	Air pollution	Gaseous emissions (SO_2, CO_2, NO_2, etc.), SPM	Use of Air-sampling instrument/ Point measurements at the plant area, mine pit, weighing bridge, office etc.	Biannually	Project Manager, HSE Officer/Site Coordinator; Consultant
2	Noise level and Vibration	high level of noise and earth-vibration effects	noise decibels and crack on walls of closest villagers	Use of Noise-monitoring meter at Mine pit and plant area. Nearby structures to be inspected for effects of vibration	Monthly	Project Manager, HSE Officer/Site Coordinator, CLO; Consultant
3	Vegetation Status (Biodiversity) and Wildlife Status	Loss of flora and fauna	Presence or extinct of rare or native vegetation and wildlife	Vegetation (sample) collection by use of 10m by 10m quadrants around the entire project area; and Wildlife Sampling through interview of reputed hunters, and walk through the area to ascertain the presence of animals by sighting and correlation of cries and footprints	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator, CLO; (Community Liaison Officer); Consultant
4	Surface (and ground) water quality	Water pollution	Temp., pH, Turbidity, Nutrients (sulphate, nitrate, etc.), Heavy metals (Fe, Cu, Pb, etc.)	Sample collection (and analysis) from water sources (of closest surface water-body or borehole)	Quarterly	Project Manager, HSE Officer/Site Coordinator; Consultant
5	Soil (and sediment) quality	Soil contamination	Heavy metals in soil, crop productivity	Soil-sample collection/analysis (esp. around fuel storage areas)	3-Yearly Audit	Project Manager, HSE Coordinator, Consultant

6	Socio-cultural	Social-life Impact	Cultural conflicts, norms, social vices, project-perception of community leaders, hospitality of indigenes	Continuous effort of Consultations (at all levels); assessment of land compensation-homage; review of implementation of Community Dev. Agreement in the host community	Monthly	Project Manager, HSE Officer/Site Coordinator, CLO: (Community Liaison Officer)
7	Community health	Health Impact	Common/prevalent diseases in the host communities	Use of questionnaires within the host communities as well as collection of health statistics from clinic and hospitals within the area	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator, CLO; Consultant
8	Demographic pattern	Economic Impact	Accommodation; markets; social infrastructure; industrialization;	Use of questionnaires within the host communities, as well as data-gathering from interviews, observations and consultation	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator, CLO; Consultant
9	Occupational health	Hazard-exposure to workforce	Frequent illness of workforce, workplace accident, medical fitness	Observation, interviews, and the use of Job-Hazard-Analysis report	Every 6 months	Project Manager, HSE Officer/Site Coordinator
10	Environmental nuisance	Aesthetic/Visual impact	Dust-raise, waste littering, effluent discharge, degradation of land formation	Observations and findings during site audit of project operations	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator; Consultant
11	Hydro-biological components (plankton, fisheries, benthos	Marine life impact	Abnormalities of indicators of Water Parameters	Sample collection of closest water source and analysis	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator; Consultant

Waste Stream Management Guideline for Proposed Steel-Manufacturing/Transmission-Line Construction Project

WASTE /EMISSION	CATEGORY	HAZARD	ORIGIN	DISPOSAL OPTION(S)
Empty drums & aerosol cans (plastic & steel)	Potentially Hazardous (noncombustible)	Dependent of original contents of drum	Packaging of lubricating oil, fuel and corrosion chemicals	• Residue from drums shall be purged and cleaned before reuse (subject to quality assurance). • Return empty gas cylinders to supplier(s) for refilling. • Return drums, barrels, and used containers to vendor or crush at site for recycling
Oil & fuel filter cartridges, waste water filters	Hazardous (combustible)	Potential water and sediment contamination from hydrocarbons	Internal combustion engines, equipment maintenance and repairs	• Collect in properly labelled metal or plastic drums placed at designated strategic locations. • Store in sealed, properly labelled metal or plastic drums placed in a closed container located within the designated hazardous waste storage area for evacuation to incineration sites.
Oily rags & sorbents; used protective clothing (hand gloves, coveralls, shoes, rainwear, etc	Hazardous (combustible)	Potential water & sediment contamination from hydrocarbons	Maintenance & spill clean-up operations, regular work wear	• Where possible, oily rags and protective clothing shall be washed and reused at site. Otherwise, these wastes shall be drained of excess hydrocarbon, packaged separately and contained safely for incineration in approved facilities.
Scrap metal chippings, scrap cables	Non-hazardous (combustible)	Safety risks	Scrapped equipment / engine parts / miscellaneous refuse metal	• Recycled or re-used. • Non reusable materials shall be stored in the designated containers for evacuation and disposal at recycling facilities.
Medical waste (soiled dressings, empty drug containers, used needles & syringes, expired drugs, blood & blood	Hazardous (combustible)	Potential health risk	Inner Galaxy Steel Company Limited clinics / health centers, site first-aid	• All medical waste shall be packaged separately and safely contained in designated containers for incineration at approved facilities. • Empty drug carton/bottles may be re-used at the clinics subject to quality assurance.

products, cultures and stocks)			treatment	• Used syringes/needles, containers for storing blood & its products, and culture/ stocks media shall be autoclaved (sterilised) shall be safely contained in designated containers for incineration at approved facilities • Expired tables/capsules may be cruHSEd/dissolved using hot water before flushing down the drain with expired syrups
Sanitary wastewater	Hazardous (non combustible)	Potential to contaminate water column & sediment	Black waters (urinals, toilet) & gray waters (sinks, showers)	• At camps, treated in sewage treatment plant to regulatory limits with certified equipment before discharge if feasible. Otherwise shall be collected and taken offsite to approved sewage treatment facilities and treated to meet regulatory requirements before discharge offsite.
Diesel fuel spill/leaks	Hazardous (combustible)	Potential to contamination of soil, water bodies & sediment	Fuel storage/transfer lines, leaking pipes, equipments, etc.	• Store in sealed drums for recycling
Contaminated soil affected by spills/leak	Hazardous (combustible)	Potential to to contaminate groundwater	Top soil removed from spill/leak site	• safely contained in sealed designated containers for evacuation to incineration facilities
Domestic waste (empty food containers, food waste, used cooking oils, office wastes, construction)	Non-hazardous (combustible, biodegradable)	Attracts rodent	Accommodation, office, canteen, worksite	• Manually sort plastics and metals for recycling. • Appropriate segregate and contain for evacuation to approved incineration facilities

Batteries: (lead-acid, nickel- cadmium)	Toxic and corrosive	Corrosive adverse environmental, health & safety effects. Lead or heavy metals may cause contamination to surface water/sediment	Warning equipment, portable & emergency electrical tools & electronics, construction & transmission facilities	• Lead-acid and Ni-Cd batteries shall be safely kept at designated storage locations for evacuation to facilities where they will be recycled, incinerated and safely disposed.
Spent lubricants	Hazardous (combustible)	Potential for water, soil, and sediment contamination by hydrocarbons	Engine and rotating equipment, lubricating system, etc	• Collect in properly labelled metal or plastic drums placed at designated strategic locations and sealed to prevent spill during evacuation. To be recycled or incinerated in approved facilities.
Wood scraps, pallets and packaging materials	Hazardous (combustible)	Attracts rodents	Wooden crates, paper cartons/sacks, plastic wrappings, Styrofoam, etc	• Wood pallets/paper cartons shall be returned to the supplier and non reusable one safely contained and evacuated to approved facilities for incineration
Paint & paint-related materials	Hazardous (combustible)	Potential to contaminate soil	Paint cans, spent thinner, epoxides, latex, etc	• Safely contained in designated containers and locations prior to evacuation to approved facilities for recycling or incineration.
Refrigerants (HCFC)	Non-combustion source-emission	Stratospheric ozone depletion, formation of photochemical smog;	Refrigerants & air conditioners	• Safely contain in designated locations for return to manufacturer, or to approved reuse, and recycling facilities

CONCLUSIONS

Inner Galaxy Steel Company Ltd has carried out the Environmental Impact Assessment (EIA) of the proposed 1.3km 132kV Transmission Line, coupled with supplementary proposed establishment of Steel-manufacturing Factory project, at Ukwa-west Local Government Area of Abia State, South-East Nigeria.

This was carried in order to predict the impact of the proposed project activities on the various biophysical and socio-economic components of the project environment and host communities and also to proffer adequate mitigation and enhancement measures for adverse and beneficial impacts respectively. The overall goal of the EIA is to ensure that potential environmental and social impacts of the proposed project are identified and evaluated and adequate mitigation measures proffered for significant impacts.

Extensive literature review and field sampling and measurements/testing were used to carefully establish and assess the status and sensitivities of the various ecological and socio-economic components of the project area.

Data acquisition from terrestrial, aquatic and socio-economic environment as well as the assessment of the sensitivities of the various biophysical and socio-economic parameters involved a multi disciplinary approach. Consultations with the host communities (Ahala Ukwu Village, Umuahala Community, Obuzor Ukwu Autonomous, and Umuacheke, Umuigwe / Umuogogo Community, Isimiri Umuorie Autonomous), local government authority and officers as well as regulatory authorities are ongoing and shall continue throughout the project life cycle.

The potential and associated impacts assessment of the proposed development indicated that the project would beneficially and significantly impact on national energy and power transmission and the overall economic and social benefits accruable from power supply to the Nigerian people. It would also result in provision of direct and indirect employment opportunities as well as skill acquisition for Nigerians.

The adverse impacts of the project may result from injury due to operational accidents/incidents, health condition for onsite personnel due to exposure to communicable diseases and increased noise and emissions. Perturbation of surface water and aquatic fauna and flora resulting from disturbances to nearby aquatic ecosystems due to oil leaks, wastes and other associated sources during construction. However, majority of these adverse impacts are temporal, and mitigation measures have been recommended for both short- and long-term to reduce the adverse impacts to negligible limits.

The impacts assessment of the proposed development project shows that it will impact positively on the national economy as well as the revenue base of Inner Galaxy Steel Company Ltd and its joint venture partners, contribute to socio-economic development within the host communities and result in economic empowerment for the indigenes and residents as well as other professionals. These would be by way of increased financial benefits, skilled and semi skilled employment opportunities, award of contracts for supplies and services among others.

The adverse impact of the proposed project on water, land use, vegetation wildlife air, socio-economics and health are localized and can be controlled and ameliorated if the recommended measures are strictly followed.

Consequently, the EMP was developed to ensure effective implementation of prescribed mitigation measures and for proactive environmental management from project inception to conclusion. Implementation of these measures will ensure a successful execution of Transmission Line project in an environmentally safe and sustainable manner.

Considering the workable proffered mitigation measures for adverse impact, the benefits of the proposed project outweighs the negative impacts. In view of the foregoing, Inner Galaxy Steel Company Ltd requests that the proposed project be approved for implementation.

CHAPTER ONE
INTRODUCTION

1.1 General Background

The Metallurgy of Steel-Manufacturing has been a major contributor not only to the infrastural development, manufacturing needs and urban development of an industrialized world, but also to the economic growth and development of many developing nations. At the same time, however, there are indications that the environment and its natural resources are being threatened by the activity of this Industrial Sector, notably in developing countries, like Nigeria. The gains from the sector in the form of increased investment are being achieved at great environmental, health and social costs to the people, as challenges posed by the extractive industry bring to the forefront the need to have an efficient management in place as regards the current operations by deploying investment in new technologies in order to minimize the impacts that directly or indirectly affect the environment and human health with considerations of the cost of a polluted environment.

However, a setback to exploring the gains from the industrial (steel-manufacturing) sector is the availability of Power-supply, particularly in the area of inadequate transmitting electric power-generating capacity; thus, the need to construct more transmission lines to extend needed power supply to steel-manufacturing plants; as the productivity and processes of the manufacturing plant is dependent on the construction and operation of transmission line (source of power).

The metallurgical processes of the manufacturing industrial sector is a major aspect of our Infrastructural Development, which if well managed can contribute, significantly, to national economy growth, industrial revolution and increase in employment. However, Urbanization precepts that does not consider potential Environmental Impacts is not 'Sustainable'; hence the need to conduct an Environmental Assessment of any proposed project-development.

Environmental Impact Assessment (EIA)/Environmental Assessment is deemed to be one of the most widely used processes in the pursuit of Sustainable Development, largely, because of its legislated nature in most countries, like Nigeria.

For a sustainable development, management and protection of the environment and eco-system in line with the Environmental Impact Assessment (EIA) Act No. 86 of 1992, in-depth studies/ assessments of the baseline characteristics and proposed methods of planning, construction operation of major developmental projects shall be carried out with a view to mitigating potential negative impacts, enhance beneficial impact and developing a system of periodic monitoring of the facility.

In 1992, the Environmental Impact Assessment (EIA) Act No. 86 was enacted to give legal muscle for the enforcement of the various policy provisions on the need for studies in the environment impacts of both public and private sector projects as such projects are being planned. Today, the Federal Ministry of Environment have been legally empowered to administer the EIA Act No. 86 of 1992. The Act, being the main law which regulates the implementation of EIA processes in Nigeria, deals with the consideration of environmental impact, in respect to any proposed public and private projects.

Thus, EIA is the process of identifying, predicting, evaluating and mitigating the bio physical, social and other relevant effects of developmental proposals prior to major decisions being taken and commitments made.

UNEP (2002) defines Environmental Impact Assessment (EIA) as a tool used to identify the environmental, social and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision- makers.

Environmental Impact Assessment (EIA) is also defined as a tool used to identify the environmental, social and economic impacts of a project prior to decision- making.

It is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.

The concept is also seen as the assessment or evaluation of the potential impacts made on the environment (land, water and air) by different magnitude of development projects.

In furtherance of the 1992 United Nations Conference on Environment and Development (UNCED) AGENDA 21 which stipulates environmentally sustainable industrial development activities, it is important that industrial activities be conducted in a way that the socio-cultural and environmental impacts on the environment are minimized considerably. Long-term sustainable activities need to ensure environmental performance by addressing: Potential environmental impacts at an early stage through Environmental Impact Assessment (EIA); and Control of environmental hazards in on-going projects through pollution control.

In compliance with regulatory bodies, like the Federal Ministry of Environment (FMEnv) statutory provisions and in accordance to the Environmental Impact Assessment (EIA) Act 86 of 1992, well as good industry practice of National and International Regulations, Inner Galaxy Steel Company Limited (the project-proponent) has commissioned Richflood International Limited, *being a reputable environmental consultant*, to conduct an Environmental Impact Assessment (EIA) of the proposed Steel-Manufacturing Plant-operations/Construction of a 132kV Transmission Line in Ukwa-West Local Government Area of Abia State.

To this regard, relevant regulatory & legislative guidelines and national & international environmental standards are been employed as the yardstick for assessments, thus, setting the boundaries of infringement of operations on human health and safety and on the environment; as captured in this report. The company, in compliance with environmental regulations relevant to the project, carrying out this EIA Study of the proposed project, has hence produced this document, the EIA Report, to concur with set guidelines that encourage environmental sustainability and engender industrial best practices.

1.2 About the Project Proponent

Inner Galaxy Steel Company Limited is a privately owned company registered in Nigeria under the Corporate Affairs Commission with RC No. 1065816, on the 18th of September, 2012; whose commercial interest is in the manufacture and sale of **Steel**-Bars product; thus the setting up of a Steel-Manufacturing Plant which will be powered (electric supply) by the Construction of a 1.3km 132kV Transmission Line, extending power-source from a Power Plant located in the area.

Hence, the Company is set towards contributing to the nation's industrialization and urban/infrastructural development, by the provision of industrial-needed Steel-materials and indeed increase the economic gains and social amenities of the project area/location. This is not without the provision/expansion of electric-power-supply.

1.3 Project Location/Landmass

The project-site, location of the proposed installation of steel-manufacturing plant, which is an acquired 85 Hectares piece of Land, cut across two (2) autonomous communities, is located at AhalaUkwu Village, Umuahala Community, ObuzorUkwu Autonomous, and Umuacheke Village, Umuigwe/Umuogogo Community, IsimiriUmuorie Autonomous, within Ukwa West Local Government Area of Abia State; South-East, Nigeria.

The proposed construction of 132kV Transmission Line is located to the above stated project-site (factory area), with a distance of 1.3Km.

The Transmission Line will originate from the already existing ‘Afam-Alaoji Power Plant’, within the area, Ukwa-West, transversing a distance of 1300m *(without presence of community, nor water body along the ROW)*, to the 85 hectares of land mapped out for installation of the proposed steel-manufacturing plant.

The proposed transmission line and associated activities of steel-plant operations has been planned to eliminate adverse impacts on the environment. Impacts that could not be eliminated have been reduced to as minimal as possible. Detailed evaluation and discussion of the impacts and mitigation of the proposed transmission line on the environment are presented in chapters five and six of this report.

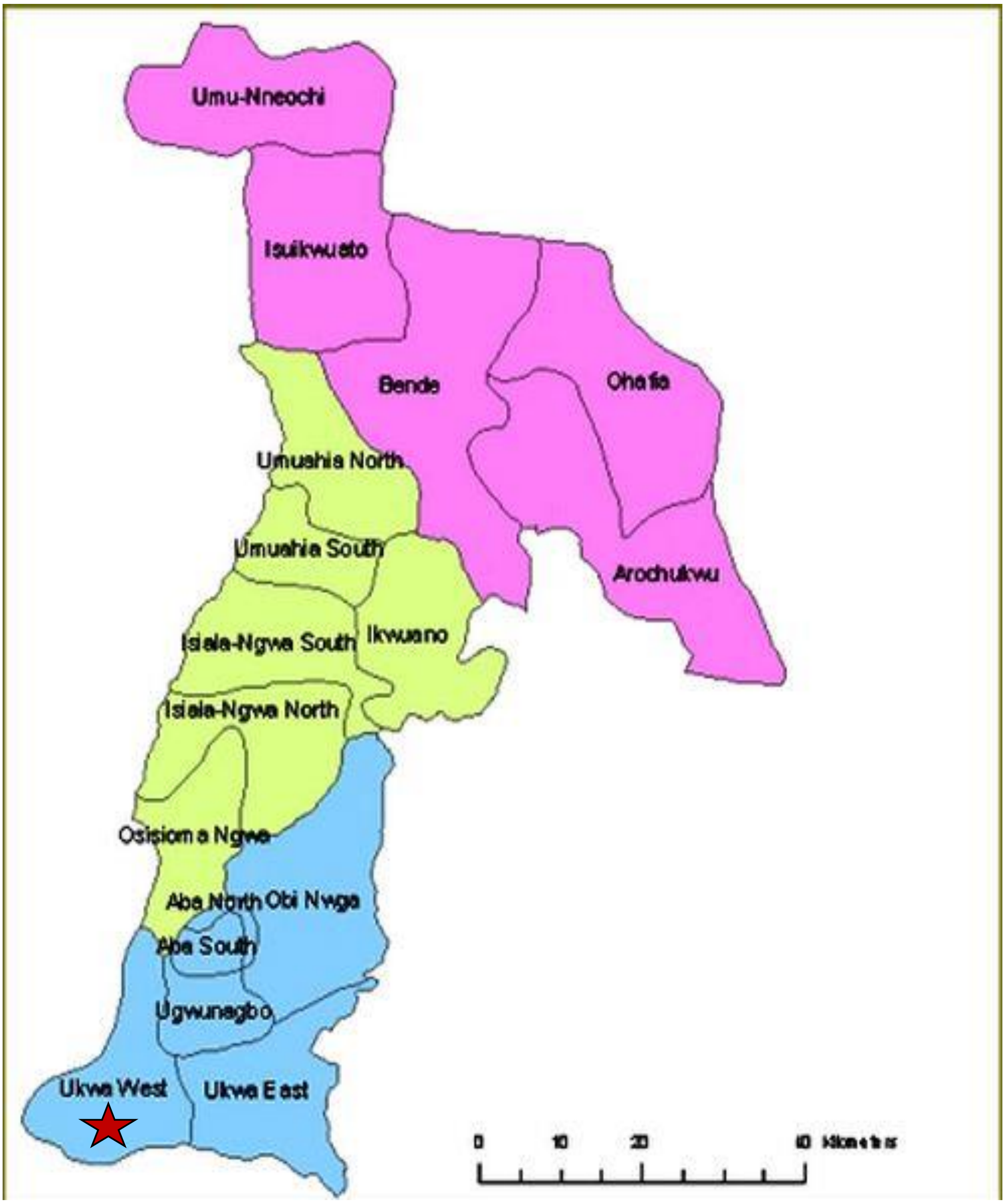


Figure 1.1 Map of Abia State showing Project-Location, Ukwa-West Local Government Area

Figure 1.2 Maps (*both*) of Nigeria showing Project-Location, Abia State

1.4 Objectives/Overview of the Project

Metallurgical Processes of the Iron and Steel-Manufacturing industry has made the industry remain as one of the important *basic* industry, driving Infrastructural Development in Nigeria; this is because of the high demand of steel-utilization in manufacturing industries for various industrial and construction uses attributable to quest for economic and urban development.

Most of the iron and steel production in Nigeria use steel scraps and iron ore as the major raw materials. The recycling of steel scraps reduces the usage of imported pig iron produced from natural iron ore. However, the demand of iron and steel in the manufacturing industries have increased and far exceeded the production capacity of the intermediate iron and steel production, which led to the increasing volume of imported intermediate products.

In order to bridge the gap between the required production-capacity of industries and the availability of needed Steel-resources (as raw material), Inner Galaxy Steel Company Ltd, (a *privately owned* steel-manufacturing company) have decided to acquire a 85 hectare of land for the setting up of a Manufacturing-Plant, to Produce Steel-Bars, and increase supply of needed steel-material; required for increased industrial-development and various construction uses of manufacturing industries.

Essentially, the company (project-proponent) inorder to accelerate the availability of Steels, proposes to use the source of **billet**, as major raw material to be processed by the steel-manufacturing Plant.

However, the Plant in producing Steel-Products will require *heavy*-Power-Source. This will necessitate the immediate Construction of a 132kV Transmission Line, extending power (electric supply) from *an already situated* Afam-Alaoji Power Plant in the area, with distance of 1.3km to provide needed electric energy (power-source) for the steel-Plant operations.

Therefore, the nature of the project is in response to the need to contribute to infrastural development by the provision of industrial steel-products, thus, the project proponent proposes to basically set-up a manufacturing plant which produces steel from billet, and to consequently construct a 132kV transmission line for powering (extending-*1.3km* electric supply from *Alaoji* Power Plant) to the steel-manufacturing plant/factory site.

The central objective of the project is to set up a Steel Manufacturing Plant / Construction of 132kV Transmission Line which will enable the company to produce Steel Bars from **billets**.

With steel-products produced, the economic gains and income of the project locations is set to increase, resulting from industrial development, provision of social amenities and job opportunities in the area.
Other benefits of the project will be to alleviate poverty through employment creation to the local people and the improvement in the standard of living of the host communities in general through infrastructure development such as grading of local road networks near the site.

This will not only have positive economic multiplier effect but will also reduce importation of pig iron and/or the intermediate steel products; as the project-proponent (commercial company) has its primary business-interest in the manufacture and sale of steel-product from the processed billet.

However the benefit and needs of the project may be, it is definitely not without some environmental concerns, thus the EIA Report seeks to identify and assess the potential impacts of the proposed project operations on the environment and the socio-economic well-being of the Host Communities (Ahala Ukwu Village, Umuahala Community, Obuzor Ukwu Autonomous, and Umuacheke, Umuigwe/Umuogogo Community, Isimiri Umuorie Autonomous).

1.5 Objectives of the EIA

The objectives of the EIA for the project-site are to:

- Provide information and evidence required for developing an Environmental Impact Statement for the project-site;
- Establish baseline information for the project-site.
- Identify associated/potential impacts of the project in the area;
- Recommend preventive, mitigative and control measures for the identified potential/associated adverse impacts of the project; and
- Develop a cost effective Environmental Management Plan (EMP) for the lifetime of the project.

The EIA Report seeks to identify the potential negative impacts (like degradation of land, biodiversity-threat, water contamination, air pollution, excessive noise, etc.) of the project's operations on the environment and on the socio-economic well-being of the communities close to the project-site; in accordance to the legal frameworks and regulations of the Federation (FMEnv Decree No. 86 on EIA, the World bank OP/BP 4.01 Environmental Assessment Policies, etc.); addressing the environmental and social issues that might arise due to the proposed project as well as presenting possible mitigation/enhancement measures for the identified negative/positive impacts.

Hence, the EIA Report is a document-presentation of the process by which the environmental consequences of Inner Galaxy Steel Company Ltd. proposed project (Setting up of a Steel-Manufacturing Plant/Construction of a 132kV Transmission Line) activities/programme are evaluated, potential environmental-impacts identified/analysed, and mitigation measures stipulated, within the context of an Environmental Management Plan.

The main aim of the EIA Report is to ensure environmental sustainability of the project (in reference to observed environmental baseline of project's area), through the compulsory compliance with the EIA Act, as stipulated/required in the EIA studies (Terms of Reference) of all sampling/laboratory analyses of specified environmental components or parameters.

1.6 The Report Structure

The EIA is structured into eight (8) chapters, as follows:

- Chapter one presents the introduction, study objectives, EIA Terms of Reference (TOR), scope of work and methodology. It also provides information on the legal and administrative framework for the EIA in Nigeria as applicable to the proposed project.
- Chapter two examines the justification for the project and its alternatives.
- Chapter three describes the technical details of the project. This includes the project processes. It further highlights the waste management programme for the proposed operation, plant abandonment/ decommissioning and the project schedule.
- Chapter four describes the methods adopted in environmental data acquisition, description of the physical, chemical, biological as well as socio-economic aspect of the proposed project site.
- Chapter five highlights the impact assessment approach and presents the potential and associated impacts of proposed development.
- Chapter six presents the mitigation measures to be applied and highlights the beneficial impacts of the proposed activities.
- Chapter seven provides the Environmental Management plan (EMP) that shall be adopted throughout the project lifecycle. This includes environmental monitoring programme.
- Chapter eight outlines the conclusion (from key findings) of the project-study; highlighting the key remediations/recommendations.

The list of the references and appendices are included thereafter.

1.7 Terms of Reference of the Project

In summary, the major issues covered include but not limited to the following:

(A) Establishing the baseline for the existing ecological and socio-economic conditions of the project area.

The baseline environmental data for the project area covered the following

- Air Quality
  - Ambient air quality and pollution trends

(ii) Soil and Land Use

- Soil erosion and channel erosion sites
- Land surface alternations-microtopographic changes affecting water flow
- Auger and profile samples to be taken to determine morphological, physical and chemical properties.
- Geomorphic features.

- Waste Management.
  - Obtain all relevant physical and mechanical information and data on sewage treatment plants if any.
  - Determine the nature and style of sewage disposal in the project area.
  - Ascertain the quality level of influents and the conditions of discharge outflow.

(B) Identify, evaluate and predict the project's impact on the environment.

(C) Develop control strategies with a view to mitigate and ameliorate significant impacts of the project. This include:

- Identification of measures to reduce harmful effects.
- Monitoring measures or steps to avoid the occurrence of such effects if preventable, etc.

(D) Recommend measure to increase the beneficial use of the project.

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

(F) Recommend an Environmental Management Plan (EMP): The EMP contains the following:

- The environmental objectives and commitments.
- The means by which these will be achieved.

- The responsibilities/accountabilities.
- The corrective actions which will be employed should the need arise.
- Review schedules and criteria.

The scope of the EIA is intended to cover all the activities that constitute the project.

Table 1.1 below shows the detailed requirement for the **Terms of Reference (ToR)** for the preparation of the Environmental Impact Assessment (EIA) report of Inner Galaxy Steel Company Ltd. (project-site) located at Ukwa-West Local Government Area of Abia State.

Table 1.1: Environmental Parameters for the EIA Studies and Sample analysis of the Proposed Steel Manufacturing Plant/Construction of 132kV Transmission Line

S/N	ENVIRONMENTAL PARAMETERS	PARAMETER	NUMBER OF SAMPLES/ DISTRIBUTION	PARAMETERS TO BE MONITORED
1.	Climate/ Meteorology	Microclimate/ Regional Climatic features	In-situ measurement, secondary data	Temperature, Rainfall, Relative humidity, wind direction and speed, visibility, cloud cover and their local effects.
2.	Surface water	Physico-chemical & microbial	2 numbers plus control samples	Colour, pH, turbidity, salinity, hardness, heavy metals – Cu, Pb, Fe, BOD, COD, THC, Electrical conductivity, Phosphate, SO_4, NO_3, TSS. Microbiology- (faecal coliform, total coliform, total plate), water body depth and width, flow direction and flow rate, fisheries and fish spawning areas, plantons, benthos, aquatic macrophyte and hydrodynamics.
3.	Ground Water	Physico-chemical & microbial	2 numbers plus control samples	Colour, pH, turbidity, salinity, hardness, heavy metals – Cu, Pb, Fe, BOD, COD, THC, Electrical conductivity, Phosphate, SO_4, NO_3, TSS.

				Microbiology- (faecal coliform, total coliform, total plate), water body depth and width, flow direction and flow rate, fisheries and fish spawning areas, plantons, benthos, aquatic macrophyte and hydrodynamics.
4.	Soil	Physical	15 numbers plus control samples	Profile (depth, type) colour, permeability, porosity, bulk density, texture (grain size).
		Chemical	15 numbers plus control samples	Heavy metals (V, Ni, Fe, Pb, Cu, Zn), pH, Moisture content, sulphate, nitrate
		Soil Microbiology	15 numbers plus control samples	Total heterogenic bacteria (total hydrocarbon, Fungi, total hydrocarbon bacteria (THB), faecal coliform.
5.	Land use	Land cover	-	Land use types: Recreational, agricultural, forestry, industrial, residential, institutional, commercial, trends, etc.
6.	Ambient Air Quality		10 numbers plus control samples	Suspended particulate matter, NO_x, SO_x, CO_2, CO, VOCs, H_2S.
7.	Noise	Noise Level	10 numbers plus control samples	dB
8.	Ecology	Vegetation/ wildlife		Flora and Fauna Habitat status, floral composition, density and distribution, vegetation suction, plant pathology
9.	Geology/Hydro-geology	Local and Regional		Stratigraphy, structure, fractures patterns, flow direction, aquifer level/lithological regional geology, stratigraphic properties etc.
10.	Socio-economic			Education, Culture, distribution of livelihood, land use, etc. with structured questionnaire administration.
11.	Health Impact Assessment			Health status and prevalent diseases within and around the project area and the host community

Source: Federal Ministry of Environment (FMEnv)/Environmental Assessment Dept., Nov., 2015

The ToR was such that adequately captured all the required answers and proffered solutions to those questions that could not be immediately answered by this study. Apart from the two seasons field works, an elaborate but workable Environmental Management System (EMS) was developed to include Monitoring Plan (MP).

The overall terms of reference was explicitly distributed and grouped in such a way as to facilitate and ensure efficiency and comprehensiveness in the scope of work. In order to execute the project as best as possible, we performed all work necessary including but not limited to these given below:-

- Obtained from relevant government and local authorities, information on new industrial and residential development, and assessed their likely impact on the Project.
- Established what laws and regulations exist relevant to the environment in the site and summarized their main provisions since they applied to the retail project. Seasonal variations were determined as appropriate.
- Local rivers, estuaries and water courses on the site were surveyed to establish flow rates and movement with seasonal or tidal variations. Water samples (as applicable) were also taken and analyzed for pollutants including but not limited to;
  - Biochemical Oxygen Demand (BOD)
  - Chemical Oxygen Demand (COD)
  - Dissolved Oxygen (DO)
  - Faecal Coliforms
  - Hydrocarbons
  - Inorganic carbon
  - Inorganic Nitrogen
  - Inorganic Phosphate
  - pH
  - Temperature
  - Suspended Solids
  - Toxic Substances
  - Turbidity
  - Heavy Metals

Consequently, we were able to establish, by analysis of data available from existing sources the specific pollution problems of the area. Similarly, we also established:

- The determination of suitable waste management methods.
- Measurements of existing noise levels under representative conditions at communities within 2km of the site boundary for baseline data purposes.
- Acquisition of available climatic data to analyze the prevailing meteorological condition of the project area.
- Obtained from government and local authorities and otherwise information on the availability of required manpower within the state capital and project area (say between 5-10km radius), and of transport.
- Studied the magnitude of existing abstractions of surface water which may be polluted by particulate matter from the Project.
- Find out the location, approximate magnitude and quality of discharges to existing water bodies.
- Established by observation, trapping, reference to specialist institutions and experts, and otherwise, the abundance and distribution of vegetation and wildlife and habitat.
- Recommended a continuing program of air, water and noise monitoring during construction and after commissioning of the Project, including method of measurement, location and frequency.
- Under the supervision of Richflood International Ltd, will conduct a Public Forum in accordance with the FMEnv regulatory guideline if so directed.
- Be present at any public hearing on the EIA and respond to any issues raised by the regulatory agencies and stakeholders during the panel review.
- Capture and incorporate all the comments generated through the EIA report review into the Final Environmental Impact Assessment (EIA) report.

1.8 EIA-Study Guide/Methodology

The Scope of the EIA study is to:

- review national and international regulations guiding the activities to be carried out;
- carry out a comprehensive literature review to adequately describe the background condition of the environment of the study area;
- collate field data collected and analysed for effective characterisation of the area;
- identify, predict and evaluate potential impact;
- develop effective mitigation/ameliorative measures and monitoring programmes; and
- prepare updated EIA reports following current regulatory guidelines and procedures.

This EIA is guided by the following**:**

- EIA report writing format issued by the Federal Ministry of Environment.
- The National policy on environment launched in 1989 by the Federal Government of Nigeria to achieve a sustainable development in Nigeria.
- A Technical Main Points in the Assessment of Environmental Impact Procedure issued by the Federal Ministry of Environment. The contents of which are related with outlines of associated environmental impact, assessment and analysis of environmental components etc.
- The Project description as provided by the Inner Galaxy Steel Company Ltd.

Generaly, the approach adopted in conducting the study/report is in compliance to the EIA process as resonance with the FMENV guidelines and standards.

Thus, the EIA Methodology include the following sequence:

- ✓ Development & Submission of Project Proposal & EIA ToR
- ✓ Literature Review/Gap Analysis
- ✓ Development of Field Work Plan
- ✓ Field Sampling/Measurements
- ✓ Observation/Documentation
- ✓ Laboratory Analysis of Samples

- ✓ Interpretation of Data
- ✓ Existing Environmental Description
- ✓ Impact Identification & Evaluation
- ✓ Development of Mitigation Measures
- ✓ Development of Environmental Plan
- ✓ Preliminary, Draft & Final Report Development
- ✓ Client/Regulators/Study Team/Stakeholders Review
- ✓ Implementation of Mitigation Measures
- ✓ Auditing & Monitoring

Consultation with Stakeholders and Experts

Bodies that were consulted at various stages of the project are as follows:

- ✓ Management and employees of Inner Galaxy Steel Company Ltd.
- ✓ The Federal Ministry of Environment, EIA and Pollution Control (PC) departments.
- ✓ Abia State Ministry of Environment.
- ✓ Ministry of Mines and Steel Development.
- ✓ Non Governmental Organizations (NGOs) in Abia State.
- ✓ Host communities, Umuahala, in Ukwa-West Local Government Area

Precisely, among other tasks required for the efficient and proper documentation of the Environmental Impact Assessment as regard to any proposed project includes:

- Description of proposed project (location)
- Description of the environment (physical, biological, and cultural)
- Legislative and Regulatory Framework (ensuring Environmental quality)
- Determination of Potential impact of the projects
- Analysis of Alternatives of the proposed project
- Development of Checklists and Guidelines (for mitigation & assessment)
- Development of a Management Plan to mitigate negative impacts
- Development of Monitoring Plan
- Environmental and Social Impact Assessment requirements

The EIA Study-scope and methodology sequence is as illustrated in a flow chart below:

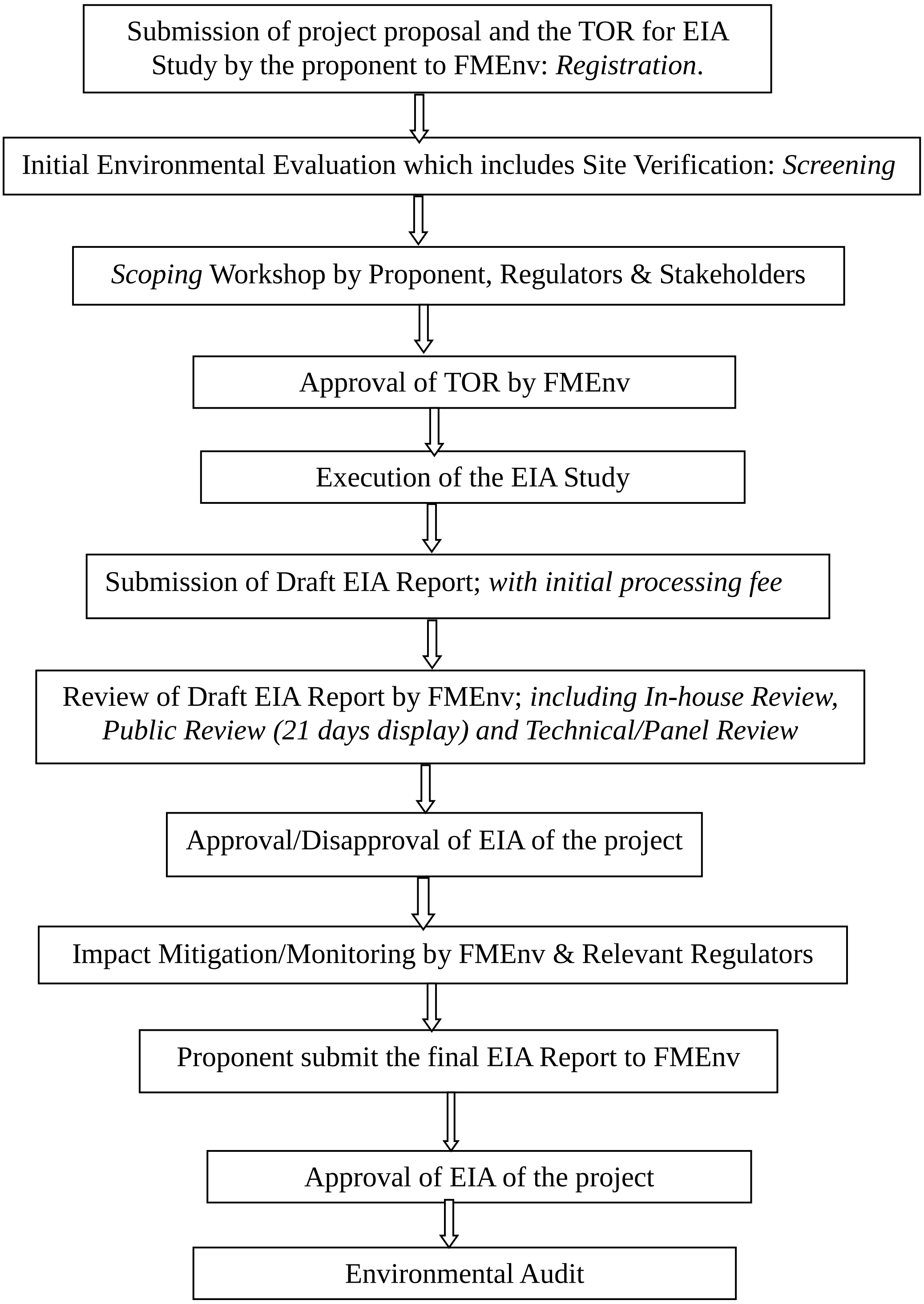


Figure 1.3: EIA Study Approach

1.9 The Environmental Policy of Inner Galaxy Steel Company Ltd.

The company's role is to provide a reliable supply of steel materials for industrial development, road/building construction and for other manufacturing uses on which industrial development depends.

It is the policy of Inner Galaxy Steel Company Ltd. to conduct its businesses in a manner that shall minimize impact on the public, employees, customers and overall environment. The objectives of the policy are:

- Promotion of interest in HSE issues through adequate training that underscores each individual’s responsibility for sound company’s environmental management.
- Ensuring that HSE matters are in line with management responsibility and shall be given equal importance as other business objectives. Every employee must plan and perform his/her duties in accordance with the policy.
- Implementation of a sound Health, Safety and Environment (HSE) programme.
- Integration of HSE aspects into company’s management system.
- Prevention of all avoidable negative impacts on all employees and on the environment through its proactive Environmental Management System.
- Maintaining environmental auditing programme to monitor compliance with company policy and government laws and regulations.
- Collaborating with government agencies and industry groups in developing practical, economically feasible and scientifically based environmental laws and regulations and industry standards.

1.10 Legal Regulatory Framework for Environmental Protection

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

Inner Galaxy Steel Company Ltd is committed to conducting its operations in compliance with applicable national and international legislations and with the companys policies. Existing statutes on environmental protection in Nigeria contain specific provisions designed to prohibit or control environmental pollution / degradation and also prescribe sanctions or fines to be enforced against persons or corporate entities who contravene the provisions. The legal and regulatory framework for carrying out EIA of the proposed project are contained in relevant national statutes and international environmental conventions to which Nigeria is signatory; consequently, the following sections present the applicable and relevant: National legislations, International Agreements, Inner Galaxy Steel Company Ltd’s Safety, Health and Environment (SHE) policies, which shall ensure the protection of human health, equipment safety and the environment.

The relevant policies, regulations, laws and guidelines that guides the project’s operations are highlighted below:

1.10.1 Federal Ministry of Environment (FMEnv) Regulations

Act 58 of 30 December 1988 established the Federal Environmental protection agency now Federal Ministry of Environment (FMEnv), as the chief regulatory body for environmental protection in Nigeria. The Act was amended as Act No 86 of 1992. FMEnv is vested with the responsibility of ensuring that all industrial activities, operations and emissions are within the limits prescribed in the National Guidelines and Standards. The Federal Government of Nigeria established the Federal Ministry of Environmental from the defunct FEPA with an overall mandate to protect, restore and preserve all ecosystem of the Nigerian environment. Twenty-one guidelines for pollution abatement in all categories of industries were laid. Part of the guidelines is a mandatory requirement for environmental auditing of all existing industries and Environmental Impact Assessment (EIA) of new industries and major development projects. Today, The Federal Ministry of Environment is in the forefront of implementing the Nigerian policy on the environment coupled with some assistance from environmental friendly organizations and non-governmental organizations, especially in creating the awareness for environmental consciousness.

The Federal Ministry of Environment, since inception has been empowered with the overall responsibility of environmental matters in Nigeria. It has developed instruments of intervention to halt environment degradation in form of policies, standards, guidelines and regulations. 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. These policies/regulations are as follows;

1.10.1.1 National Policy on Environment

The National Policy on environment, 1989, describes guidelines and strategies for achieving the policy goal of sustainable development by;

- Securing for all Nigerians a quality of environment adequate for their health and well-being;
- Restoring, maintaining and enhancing the ecosystem and ecological processes essential for the preservation of biological diversity.

1.10.1.2 National Guidelines and Standards for Environmental Pollution Control in Nigeria

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

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

1.10.1.3 National Effluent Limitation Regulation

The national effluent limitation regulation, S.I.8 of 1991 (No. 42, Vol. 78, August, 1991) makes it mandatory for industries as waste generating facilities (including research institutes, clinics, hotels etc.) to install anti-pollution and pollution abatement equipment on site. The regulation is specific for each category of waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem. Appropriate penalties for contravention are specified also in the regulation.

1.10.1.4 Pollution Abatement in Industries Generating Wastes Regulation

Where and when applicable, 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.

1.10.1.5 Management of Hazardous and Solid Wastes Regulation

The management of hazardous and solid waste regulation, S.I.15 of 1991 (No. 102, Vol. 7, August, 1991) defines the requirements for groundwater protection, surface impoundment, land treatment, water piles, landfills, incinerators etc. it also describes the hazardous substances tracking programmed 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.

1.10.1.6 National Environmental Protection on Management Procedure for (EIA) Regulations as stated in Act. No. 80 of 10 December, 1992.

This makes EIA mandatory for any major development project and prescribes procedures for conducting and reporting EIA studies.

1.10.1.7 EIA Sectoral Guidelines of 1995 on procedural guidelines for oil and gas industry projects, detailing the EIA process including a categorization of environmental projects into Categories I, II and III.

1.10.1.8 The Environmental Impact Assessment Act

The Act No. 86 of 1992 makes EIA mandatory for all new major public and private projects in Nigeria. It provides guidelines for activities for which an EIA is compulsory and prescribes the procedure for conducting and reporting EIAs. Some of these activities include road development, metallurgical activities, major building projects, coastal reclamation, etc. the required process involves the preparation of the mandatory EIA report and an assessment by a review panel.

The schematic presentation of the EIA procedure in Nigeria is presented below (fig. 1.4).

The Act sets out to:

i. Consider the likely impacts and the extent of these impacts on the environment before embarking on any project or activity;

ii. Promote the implementation of appropriate policy in all federal laws consistent with all laws and decision making processes through which goal of this Act may be realized;

iii. 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 boundaries or inter-state or on the environment of bordering towns and villages.

An Environmental Impact Assessment (EIA) is an assessment of the potential impacts whether positive or negative, of a proposed project on the natural environment; dealing with the considerations of environmental impact in respect of public and private projects.

This regulatory framework for EIA Implementation in Nigeria confers the mandate on the FMEnv to ensure proponents of all new major developments activities carry out EIA on their proposed projects. There is also a provision for penalties in case of violation and non-compliance, as stipulated by NESREA.

Sections relevant to environmental emergency prevention under the EIA include:-

- **Section 2 (1)** requires an assessment of public or private projects likely to have a significant (negative) impact on the environment.
- **Section 2 (4)** requires an application in writing to the Agency before embarking on projects for their environmental impact assessment to determine approval.
- **Section 13** establishes cases where an EIA is required and
- **Section 60** creates a legal liability for contravention of any provision

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

FMEnv developed a National EIA procedure in response to the promulgation of the EIA Act No. 86 of 1992. The Procedure (as seen in the Fig.1.4 below) indicates the steps to be followed from project conception to commissioning in order to ensure that the project is implemented with maximum consideration for the environment.

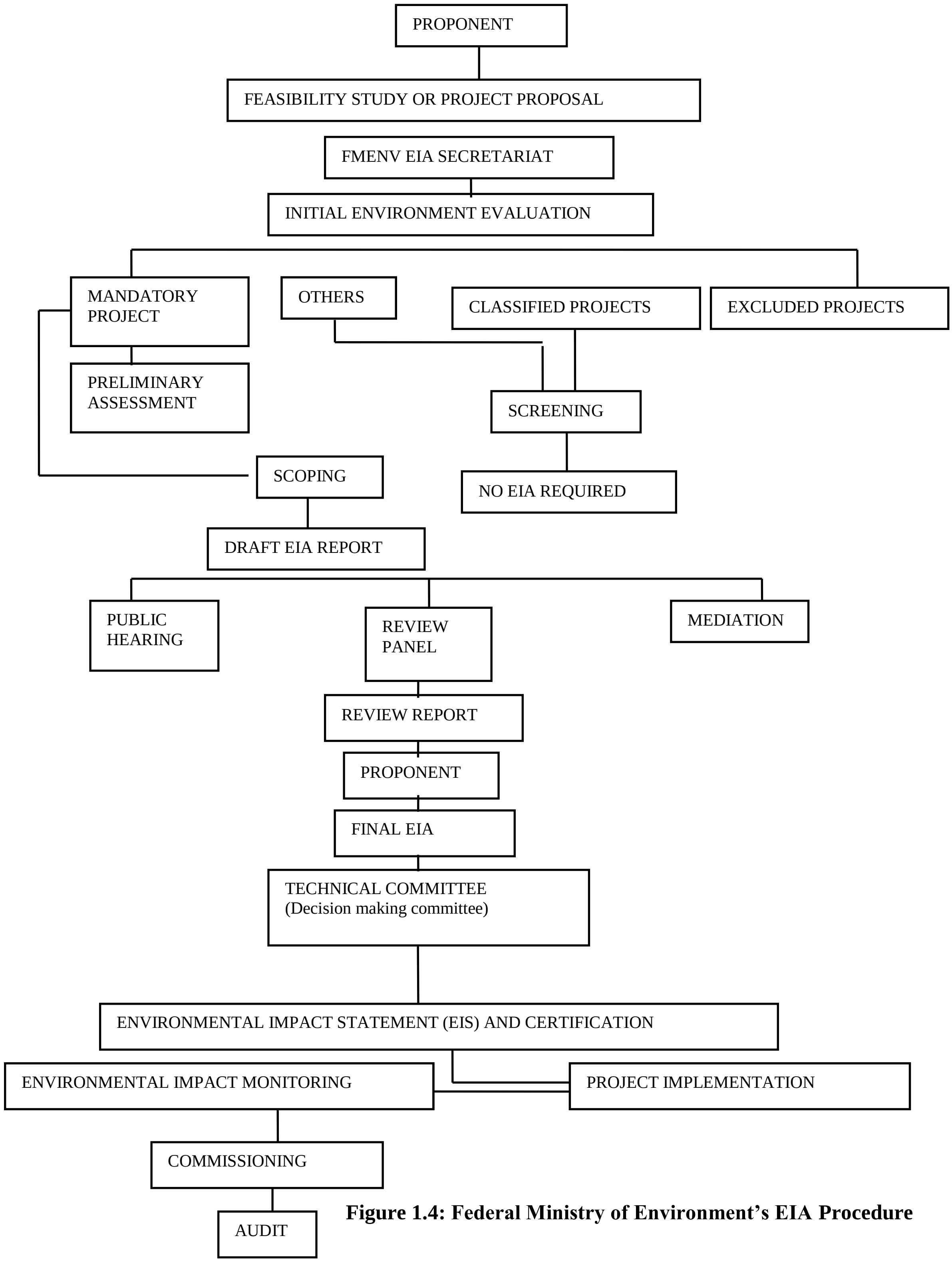


Figure 1.4: Federal Ministry of Environment's EIA Procedure

The EIA Process

Environmental Impact Assessment (EIA) may be defined as the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effect of development proposal prior to their extraction.

The procedure that has been laid down by FMEnv for undertaking an EIA to satisfy the requirements of Act No. 86 0f 1992 is presented in the figures 1.4 above. The process involves the submission of a project proposal by the proponent to the FMEnv. An initial evaluation of the proposal is done by the Ministry to categorize the project. The proposal is then screened and scoped and the EIA draft report is prepared by the proponent through literature reviews and field data gathering exercises. The report is then passed through a public hearing or review/meditation panel. A review report is then sent to the proponent for allowing the preparation of the EIA final report before approval by a technical committee.

1.10.2 The Nigerian Urban and Regional Planning Act 1992

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

- Approval of the relevant DCD shall be required for any land development
- A developer shall submit a development plan for the approval of the DCD of local Government, State or Federal Government.
- A developer (whether private or government) shall apply for a development permit in such manner using such forms and providing such information including plans, designs, drawings and any other information, as may be prescribed,
- A developer shall at the time of submitting his application for development submit to an appropriate Control Department a detailed Environmental Impact Statement (EIS) for an application for,

- A residential land in excess of 2 hectares or
- Permission to build or expand a factory or for the construction of an office building in excess of four floors of 5000 square meters of a settable space or
- Permission for a major recreational development.

1.10.3 The Nigerian Minerals and Mining Regulation, 2011

For the purposes of regulating all aspects of the exploitation of Solid Minerals in Nigeria, the Federal Republic of Nigeria as put in place the Nigerian Minerals and Mining Regulation, 2011; to guide/regulate the operations of the Metallurgical Sector.

1.10.4 National Environmental Standards and Regulations Enforcement Agency (NESREA)

The Federal Government of Nigeria through NESREA has developed the following twenty-four (24) Environmental Regulations which have been published in the Federal Republic of Nigeria Official Gazette and are now in force.

The Regulations are:

1. National Environmental (Wetlands, River Banks and Lake Shores) Regulations, 2009. S. I. No. 26. This Regulation provides for the conservation & wise use of wetlands & their resources in Nigeria and ensure sustainable use of wetlands for ecological and tourism purposes and to protect wetland habitats for species of fauna and flora.
2. National Environmental (Watershed, Mountainous, Hilly and Catchments Areas) Regulations, 2009. S. I. No. 27. This makes provisions for the protection of water catchment areas.
3. National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28. The purpose of this Regulation is to provides the legal framework for the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution.
4. National Environmental (Permitting and Licensing System) Regulations, 2009. S. I. No. 29. The provisions of this Regulations enables consistent application of environmental laws, regulations and standards in all sectors of the economy and geographical region.
5. National Environmental (Access to Generic Resources and Benefit Sharing) Regulations, 2009. S. I. No. 30. The overall purpose of these Regulations is to regulate the access to and use of generic resources to ensure the regeneration and sustainability of threatened species.

6. National Environmental (Mining and Processing of Coal, Ores and Industrial Minerals) Regulations, 2009. S. I. No. 31. This Regulation seeks to minimize pollution from mining and processing of coal, ores and industrial minerals.
7. National Environmental (Ozone Layer Protection) Regulations, 2009. S. I. No. 32. These provisions seek to prohibit the import, manufacture, sale and the use of ozone-depleting substances.
8. National Environmental (Food, Beverages and Tobacco Sector) Regulations, 2009. S. I. No. 33. These provides to prevent and minimise pollution from all operations and ancilliary activities of food, beverages and tobacco sector to the Nigerian environment.
9. National Environmental (Textile, Wearing Apparel, Leather and Footwear Industry) Regulations, 2009. S. I. No. 34. The main thrust of this Regulation is to prevent and minimize pollution from all operations and ancilliary activities from the sector to the Nigeria environment
10. National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35. The main objective of the provisions of this Regulation is to ensure tranquility of the human environment or surrounding and their psychological well-being by regulating noise levels.
11. National Environmental (Chemicals, Pharmaceuticals, Soap and Detergent Manufacturing Industries) Regulations, 2009. S. I. No. 36. This Regulation is to prevent and minimize pollution from all operations and ancilliary activities from this Sector in order to protect Nigeria environment.
12. National Environmental (Standards for Telecommunications/Broadcasting Facilities)Regulations, 2010. S. I. No. 11. The main objective of these regulations is to protect the environment and human health, ensure safety and general welfare, eliminate or minimize public and private losses due to activities of the telecommunications and broadcast industry
13. National Environmental (Soil Erosion and Flood Control) Regulations, 2010. S. I. No. 12. The overall objective of these Regulations is to check all earth-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.

14. National Environmental (Desertification Control and Drought Mitigation) Regulations, 2010. S. I. No. 13. This Regulation seeks to provide an effective and pragmatic regulatory framework for the sustainable use of all areas already affected by desertification and the protection of vulnerable lands
15. National Environmental (Base Metals, Iron and Steel Manufacturing/Recycling Industries)Regulations, 2010. S. I. No. 14. The principal thrust of this Regulation is to prevent and minimize pollution from all operations and ancillary activities of the sector in the Nigerian Environment.
16. National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, 2010. S. I. No. 15. The principal thrust of these Regulations is to prevent and minimize the destruction of ecosystem through fire outbreak and burning of any material that may affect the health of the ecosystem through the emission of hazardous air pollutants.
17. National Environmental (Protection of Endangered Species in International Trade)Regulations, 2010. S. I. No. 16. The major objective of this Regulation is to protect species of endangered wildlife from extinction through the prohibition of trade, importation, etc.
18. National Environmental (Domestic and Industrial Plastic, Rubber and Foam Sector)Regulations, 2010. . S. I. No. 17. The principal thrust of this Regulation is to prevent and minimize pollution from all operations and ancillary activities of the Domestic and Industrial Plastic, Rubber and Foam Sector to the Nigerian environment.
19. National Environmental (Coastal and Marine Area Protection) Regulations, 2010. S. I. No 18. This Regulation provides for the regulatory framework for the application of preventive, precautionary and anticipatory approaches so as to avoid degradation of the coastal and marine environment
20. National Environmental (Construction Sector) Regulations, 2010. S. I. No. 19. The purpose of these Regulations is to prevent and minimize pollution from Construction, Decommissioning and Demolition Activities to the Nigerian Environment.
21. National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2010. S. I. No. 20. The purpose of these regulations is to

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

22. National Environmental (Non-Metallic Minerals Manufacturing Industries Sector) Regulations, 2010. S. I. No. 21. The principal thrust of this Regulation is to prevent and minimize pollution from all operations and ancillary activities of the Non-Metallic Minerals manufacturing sector.
23. National Environmental (Surface and Groundwater Quality Control) Regulations, 2010. S. I. No. 22. The purpose of this Regulation is to restore, enhance and preserve the physical, chemical and biological integrity of the nation's surface waters, and to maintain existing water uses.
24. National Environmental (Electrical/Electronic Sector) Regulations, 2010. S. I. No 23. The principal thrust of this Regulation is to prevent and minimize pollution from all operations and ancillary activities of the Electrical/Electronic Sector. This Regulation covers both new and used Electrical/Electronic Equipment (EEE/UEEE)

These Regulations are to ensure that our national development agenda is not at variance with the carrying capacity of our fragile environment.

NESREA has responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources in general and environmental technology including coordination and liaison with relevant stakeholders within and outside Nigeria on matters of enforcement of environmental standards, regulations, rules, laws, policies and guidelines.

1.10.5 Electricity Act

The Electricity Act, Cap 106 of 1990 contains regulations pertaining to permit for electrical installations, placement of overhead lines, construction of substations and switching stations, penalties for breaches of licenses and regulations etc. The specific part and sub parts relevant to the Transmission Line project are stipulated in Part VI: Regulations appertaining to overhead lines and restrictions to placing electric lines above ground.

1.10.6 Mineral Oils (Safety) Regulations

Section 31 (1997) of the regulation states that every permanently placed bulk storage tank containing liquid petroleum shall be installed with a bound wall capable of containing the content of the largest tank plus ten per cent of the volume of the remaining. The tank should be fitted with access way sufficiently large enough to allow easy and vents capable of relieving any excess pressure or vacuum, have provisions made for containing any leakages to prevent soil contamination by oil.

1.10.7 Abia State Ministry of Environment

The Ministry of Environment was established as a regulatory body saddled with the responsibility of managing the environment on behalf of Abia State. In managing the environment, the Ministry tackles all environmental problems ranging from Waste Management, Flood and Erosion Control, forest depletion and degradation and general environmental and atmospheric pollution.

1.10.8 Non-Governmental Organizations Concerned with Conservation of Nature

Some non-governmental organizations internationally acclaimed and concerned with the conservation of the natural resources in Nigeria are the;

- Nigerian Conservation Foundation
- Nature Conservation and Environmental Development Organization
- The Wildlife Conservation Society
- Friends of the Earth; among other Environmental-based NGOs.

1.10.9 Factories Act, Cap F1, LFN 2004

The Factories Act of 1987 No. 16 Part II Health (cleanliness, lighting and sanitary conservation); Part III safety (Construction and maintenance of fencing, vessels containing dangerous liquids, training and supervision of inexperienced personnel, prevention of fire and safety provisions in case of fire); Parts V and VI special provisions and regulations – protective clothing and appliances, notification of accidents and industrial disease.

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

1.10.10 Criminal code

Section 247 of the Nigerian Criminal Code makes it an offence punishable with up to six months imprisonment for any person who:

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

There are also other regulations including:

• Wild Animals Preservation Act Cap 132 LFN 1990;
• River Basins Development Authority Act, 1987; and
• Natural Resources Conservation Act Cap 286 LFN 1990

1.10.11 Land Use Act, 1978

The Nigerian Land Use Act, 1978 was promulgated in March 1978. It vests all land in each state of the federation (except land already vested in the Federal Government or its agencies) in the Governor of the state. It makes the state government the authority for allocating land in all urban areas, for residential, agricultural, commercial and other purposes while it (the Act) confers similar power regarding non-urban areas on the Local Government in such area. The Governor of a State can revoke a right of Occupancy (Statutory customary) for overriding public interest.

The Land-use Act of 1978 states that “it is also in the public interest that the rights of all Nigerians to use and enjoy land in Nigeria in sufficient quality, to enable them to provide for the sustenance of themselves and their families should be assured, protected and preserved”.

1.10.12 Forestry Act

The Forestry Act 1958 which was amended as the Forestry Law CAP 51, (1994) prohibits any act that may lead to the destruction of or cause injury to any forest produce, forest growth of forestry property in Nigeria. The law prescribes the administrative framework for the management, utilization and protection of forestry resources in Nigeria, which is applicable to the mangrove, and other forests of the Niger Delta.

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

1.10.13 Harmful Waste (Special Criminal Provision) Act CAP, LFN 2004

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

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

1.10.14 Water Resources Act, CAP W2, LFN 2004

The Water Resources Act is targeted at developing and improving the quantity and quality of water resources. The following sections are pertinent: Section 5 and 6 provides authority to make pollution prevention plans and regulations for the protection of fisheries, flora and fauna.

Section 18 makes offenders liable, under this Act, to be punished with a fine not exceeding N2000 or an imprisonment term of six months. He would also pay an additional fine of N100 for everyday the offence continues.

1.10.15 National Inland Waterways Authority (NIWA) Act No. 13 of 1997

This Act established the National Inland Waterways Authority (NIWA) with a view to improving and developing inland waterways for navigation, providing an alternative mode of transportation for the evacuation of economic goods and persons, executing the objectives of the national transport policy as they concern inland waterways. The Act also prescribes regulations and sanctions on the use and exploitation of resources of inland waterways such as dredging, sand or gravel, mining and reception of permanent structures within the right-of-way or diversion of water from a declared waterway.

The statutory functions of NIWA include: making regulations for the inland water navigation; development of infrastructural facilities for a national inland waterways; and ensure the development of indigenous technical and managerial skills to meet the challenges of modern inland waterways transportation.

1.10.16 Endangered Species Act, CAP E9, LFN 2004

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

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

1.11 International Guidelines and Conventions

In addition to the national laws/regulations, the United Nations environmental guidance principles adopted during Stockholm Convention on 16 June 1972 was also used as a key tool for supporting this study. The principal objective of this convention was to provide guidelines (27 in number) for protecting the integrity of the global environment and the developmental system. Guideline/principle 17 specifically states that "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 component national authority".

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:

1.11.1 World Bank Group Environmental, Health and Safety Guidelines

The World Bank Group Environmental, Health and Safety Standards emphasises the importance of managing social and environmental performance throughout the life of a project (any business activity that is subject to assessment and management). It provides operational procedures for a project's social and environmental management system as a dynamic, continuous process initiated by management and involving communication between the client, its workers, and the local communities directly affected by the project (the affected communities). The standard therefore applies to projects with social or environmental risks and impacts that should be managed, in the early stages of project development, and on an ongoing basis.

The primary objectives are:

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

In addition, the World Bank has developed specific safeguard operational policies that identify various aspects of the environment that a developmental project may likely impact.
The policies applicable to this project and the potential impacts are discussed below.

Operational Policy/Bank Procedure 4.01: Environmental Assessment:

This policy helps ensure the environmental and social soundness and sustainability of investment projects. It supports the integration of environmental and social aspects of projects in the overall decision-making process.

Environmental assessment is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. It evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation.

An environmental assessment takes into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and trans-boundary and global environmental aspects. The assessment considers natural and social aspects in an integrated way. It also takes into account the variations in project and country conditions; the findings of country environmental studies; national environmental action plans; the country's overall policy framework, national legislation, and institutional capabilities related to the environment and social aspects; and obligations of the country, pertaining to project activities, under relevant international environmental treaties and agreements.

The Bank does not finance project activities that would contravene such country obligations, as identified during the assessment. An environmental assessment is initiated as early as possible in project processing and is integrated closely with the economic, financial, institutional, social, and technical analyses of a proposed project.

An Environmental Impact Assessment (EIA) of the proposed transmission line project has been carried out in order to identify and evaluate potential environmental impacts of the project on its environment, examine project alternatives, choose options with the least adverse impacts on the environment, proffer mitigation measures for the impacts that cannot be eliminated or avoided, and possibly enhance positive impacts as well as document the process of managing adverse environmental impacts throughout project implementation.

Operational Policy 4.04: Natural Habitats

This safe guard policy seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society. The policy strictly limits the circumstances under which any Bank-supported project can damage natural habitats (land and water areas where most of the native plant and animal species are still present). Specifically, the policy prohibits Bank support for projects which would lead to the significant loss or degradation of any Critical Natural Habitats, whose definition includes those natural habitats which are either:

- legally protected,
- officially proposed for protection, or
- un-protected but of known high conservation value.

None of above listed areas was identified in the course of this study. It is therefore not anticipated that the proposed transmission line would pass through or affect any critical natural habitat.

Operational Policy/Bank Procedure 4.36: Forests

The Bank's current forests policy aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development.

In line with the Bank’s current and anticipated approach to forest issues, and in recognition of the fact that forests play an increasingly important role in poverty alleviation, economic development, and for providing local as well as global environmental benefit and services, the proposed project impact on forest resources was planned to be as minimal as possible. The routing and project activities were determined after thorough environmental evaluations that were targeted to minimize impacts on forests and the environment at large.

Operational Policy/Bank Procedure 4.11: Physical Cultural Resources

Cultural resources are important as sources of valuable historical and scientific information, as assets for economic and social development, and as integral parts of a people's cultural identity and practices. The loss of such resources is irreversible, but fortunately, it is often avoidable.

The objective of the Physical Cultural Resources policy is to avoid, or mitigate, adverse impacts on cultural resources from development projects that the World Bank finances. No physical or cultural resources were identified along the proposed project route. The project will therefore have no impact on such resources.

Operational Policy/Bank Procedure 4.10: Indigenous Peoples

The World Bank policy on indigenous peoples underscores the need for Borrowers and Bank staff to identify indigenous peoples, consult with them, ensure that they participate in, and benefit from Bank-funded operations in a culturally appropriate way and that adverse impacts on them are avoided, or where not feasible, minimized or mitigated.

The people along the proposed transmission line route are of the Igbo ethnicity - of Abia State in the South-East area of Nigeria. Their ethnicities are traceable to the same original ethnic inhabitats. These people have lived in their present locality as far as pre-colonial era.

Consultations with these people have been ongoing to ensure that they are aware of the project and familiar with its prospects and aspects. Consultation progressed from the highest recognized authorities in communities’ administrations to the individuals that will be directly affected by the proposed project.

Operational Policy/Bank Procedure 4.12: Involuntary Resettlement

This policy is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts. It promotes participation of displaced people in resettlement planning and implementation, and its key economic objective is to assist displaced persons in their efforts to improve or at least restore their incomes and standards of living after displacement.

The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects.

The proposed project route was chosen after a thorough alternative analysis of various options to ensure that indigenous people are not displaced in the course of the project and its execution. The chosen routing was approved because it provides the path of the most minimal disturbance to the indigenous people. Consequently the project will not involve involuntary resettlement.

1.11.2 World Bank Guidelines on Environmental Assessment

The World Bank's OD 4.01 "Environmental Assessment" of October 3, 1991 categorizes projects according to the level of environmental assessment that is required. These categories are determined by evaluating the nature and extent of environmental impacts the proposed project may have. Category 'A' projects require full Environmental Impact Assessment (EIAs) e.g. dams and reservoir, land clearance and leveling, mineral development, etc. Category 'B' Projects requires EIAs with a lesser scope e.g. electrical transmission, renewable energy, and watershed projects. And Category 'C' projects do not requires any EIAs, e.g. education, technical assistance, nutrition, etc.

This project falls under category 'A' because of its adverse environmental and social impacts thus, it requires a full EIA. The World Bank places emphasis on the incorporation of mitigation measures throughout all the stages of the project.

1.11.3 IFC Environment, Health and Safety Guidelines

The 2007 version of this guideline provides general technical approach towards achieving Good International Industry Practice (GIIP) in the implementation of environmental, health and safety risk potential projects. The guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities / projects by existing technology at reasonable cost.

1.11.4 United Nations Guiding Principles on the Human Environment

The United Nations (UN), concerned about negative environmental trends since its formation, published two major concept documents: Guiding Principles on the Human Environment, 1972 and the Rio Declaration on Environment and Development. Ten of these Guiding Principles were defined as formal declarations that express the basis on which an environmental policy can be built and which provide a foundation for action.

United nations Environmental Guidance principles were adopted during the Stockholm convention on 16th June 1972. The principal objective of this convention was to provide guidelines (27 in number) for protecting the integrity of the global environment and the developmental system.

Guideline/guidelines 17 specifically states that ‘ Environmental impact Assessment, as a national instrument shall be undertaken for proposed activities that are likely to have a significant adverse impacts on the environment and are subject to a decision of a component national authority’.

Other principles relevant to the proposed Project are summarised below.

Principle Two

The natural resources 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 Three

The capacity of the earth to produce vital renewable resources must be maintained or improved/restored as the case may be.

Principle Four

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

Principle Six

The discharge of toxic substances or of other substances and the release of heat, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted in order to ensure that serious or irreversible damage is not inflicted upon the ecosystems.

Principle Seven

States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.

Principle Eight

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

1.11.5 The Rio Declaration on Environment and Development

The UN Conference on Environment and Development met at Rio de Janeiro in June 1992, at which time it reaffirmed the 1972 declaration on the Human Environment, and sought to build upon it. This is with the goal of establishing a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people. It is also to aid work towards international agreements, which respect the interests of all, protect the integrity of the global environmental developmental system, and recognise the integral and interdependent nature of the earth.

The UN thus added additional principles to the originals, the more relevant being:

Principle Ten

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes.

States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle Thirteen

States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle Seventeen

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.

1.11.6 The Equator Principles

The Equator principles are standards that guide the management of environmental and social issues in global finance for development projects. These standards are to be adopted by financial institutions and commit them to desist from financing development projects that do not follow the principles. The Equator principles were modeled after the environment standards of the World Bank and the social policies of the International Finance Corporation (IFC). It was launched in June 2003 and is adhered to by 60 global financial institutions as of April 2008.

The Equator principles state that adopting financial institutions will provide loans to development projects over 10 million US dollars and only under the following circumstances:

<u>Principle 1: Review and Categorization</u>

The risk of the project is categorized in accordance with the environmental and social screening criteria of the IFC. Projects are classified in Category A (significant impacts), Category B (limited impacts) and Category C (minimal or no impacts).

<u>Principle 2: Social and Environmental Assessment</u>

For all category A and B projects, An Environmental Assessment must be prepared to meet certain requirements and satisfactorily address key environmental and social issues.

<u>Principle 3: Applicable Social and Environmental Standards</u>

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

Principle 4: Action Plan and Management System

Based on the Environmental Assessment, Equator banks agree with their clients on how they mitigate, monitor and manage those risks through Social and Environmental Management Plan.

Principle 5: Consultation and Disclosure

The proponent consults with stakeholders (NGOs and project affected groups) and provides them with information on the risks of the projects in a culturally appropriate manner. The process should ensure free, prior and informed consultation for affected communities.

Principle 6: Grievance Mechanism

The Proponent/ borrower will establish a grievance mechanism as part of the management system.

Principle7: Independent Review

An independent review must be conducted for the assessment and consultation process.

Principle 8: Covenants

Covenants linked to compliance are required. If the borrower does not comply with the agreed terms, the financial institution has the right to take corrective action, which if unsuccessful, could ultimately result in the bank canceling the loan and demanding immediate repayment.

Principle 9: Independent Monitoring and Reporting

Over the life of the loan, for Category A and Category B projects, an independent expert is consulted.

Principle 10: Equator Principles Financial Institution (EPFI) Reporting

Each EPFI commits to report publicly (at least annually) about its Equator principles implementation processes and experience.

1.11.7 Montreal Protocol on Substances that Deplete the Ozone Layer

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

1.11.8 United Nations Convention on Biological Diversity

This convention was signed into law during the Rio Earth Summit in 1992. The convention places general obligations on countries to observe sustainable use and equitably share the plants and animals of the earth.

1.11.9 United Nations Convention on Climate Change

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

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

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

1.11.11 Convention on Conservation of Migratory species of Wild Animals

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

1.11.12 Vienna Convention for the Protection of the Ozone Layer

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

1.11.13 United Nations Convention to Combat Desertification

The full name of the convention is: United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in

Africa. The Convention was adopted on 17 June 1994 and entered into force on 26 December 1996.

The Convention calls on developed countries to:

- Actively support the efforts of affected developing country parties to the Convention;
- Provide "substantial financial resources" to assist affected developing Country parties;
- Promote the mobilization of adequate. Timely and predictable financial resources from all official and private sources; and
- Promote and facilitate access to appropriate technology, knowledge and know-how.

Also, desertification- affected countries are obligated to:

- Give priority to combating desertification and drought by allocating adequate resources in accordance with capabilities
- Establish strategies to combat desertification and drought;
- Address the underlying cause of the problem and pay special attention to relevant socio-economic factors;
- Promote awareness and the participation of local population in action to combat desertification and drought; and
- Provide an enabling environment through appropriate laws, policies and action programmes.

Furthermore, the Convention provides guidelines for implementation and coordination of action programmes; information collection, analysis and exchange; research and development; technology transfer and development; capacity building, education and public awareness; mobilizing financial resources; and establishing financial mechanisms.

1.11.14 African Convention on the Conservation of Nature and Natural Resources

The African Convention was adopted on the 15th of September 1968 and entered into force on the 9th of October, 1969. Its objectives are "to encourage individual and joint action for the conservation, utilization and development of soil, water, flora and fauna for the present and future welfare of mankind, from an economic, nutritional, scientific, educational, cultural and aesthetic point of view".

It commits the Parties to adopting "measures necessary to ensure conservation, utilization and development of soil, water, floral and faunal resources in accordance with scientific principles and with due regards to the best interests of the people."

In general, the parties agree to use resources wisely, to manage populations and habitats, to control hunting, capture and fishing, and to prohibit the use of poisons, explosives and automatic weapons in hunting. They also agree to prevent and control water pollution, establish conservation areas and consider ecological factors in development plans.

1.11.15 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.

Other international conventions to which Nigeria is signatory to include, but not limited to:

• 1985 Vienna Convention on the Protection of the Ozone Layer;

• 1987 Montreal Protocol on Substances that deplete the Ozone Layer;

• 1973 Washington Convention on International trade in Endangered Species of Wild Fauna and Flora (CITES),

• 1974 Convention on International Trade on Endangered Species of Wild Fauna and Flora

• 1979 Convention on Conservation of Migratory Species of Wild Animals

• 1972 United Nations Guiding Principles on the Human Environment

• 1996 International Union for Conservation of nature and Natural Resources (IUCN) Guidelines

• 1989 Basel Convention on the Control of Tran boundary Movements of Hazardous Wastes and their disposal;

• 1996 Protocol on the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter

• 1992 Convention on Biological Diversity; and the

• 1992 United Nations' Convention on Climate Change.

CHAPTER TWO
PROJECT JUSTIFICATION

2.1 General

The need for, benefits of, and sustainability of the proposed Steel-Manufacturing Plant and Construction of Transmission Line Project are presented in this chapter. Also included is a summary of the various project alternatives that were considered during project planning.

2.2 Need for the Project: *General*

To achieve uttermost economic development, Nigeria has resorted to various activities (like the use of metallurgical processes) to upsurge infrastructural development and explore income-generating avenues of manufacturing industries; especially with potentials of contributing positively to the socio-economic development of project areas/ location.

The economic growth of a Nation can be traced to the technological and industrial advancement of such Nation; this is as a result of the infrastructural development being linked to such Nation's urbanization. Hence, setting up of a Steel-Manufacturing Plant/Construction of a 132kV Transmission Line has been identified as a major contributor to the advancement of Nigeria's industrialization; although such project engenders pertinent environmental concerns.

Obviously, Nation's development (industrialization and urbanization) is somewhat related to the efforts of manufacturing companies; especially companies dealing in steel-making.
The rate of steel consumption of a Nation is a direct reflection of the economical and infrastructural development of such a Nation and if Nigeria is to increase her Steel Consumption from its current level, massive investment in the metallurgical process of billets (and scrap metals) to manufacture Steel-Bars is required.

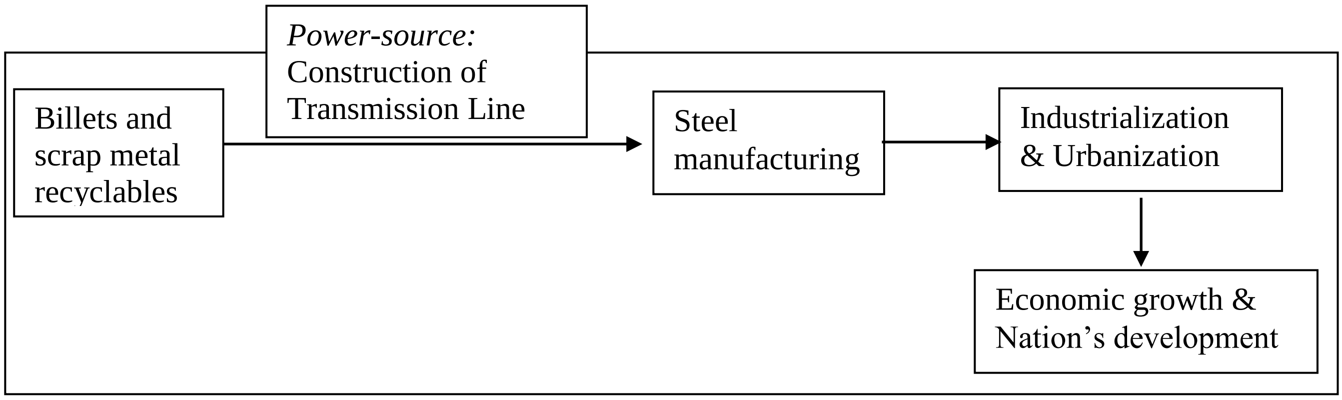


Figure 2.1: Sketch diagram to show Project's Declaration

2.2.1 Need for the Project: *Steel-Manufacturing*

Mineral resources when harnessed and processed by metallurgical engineering (as proposed by Inner Galaxy Steel Company Limited) can provide a vital source of raw materials needed for manufacturing. A major manufacturing-instrument is '**Steel'**.

Steel is a major component needed in any manufacturing company for industrial uses.

Moreso, Steel is the world's most important engineering and construction material. It is the most-widely-used and most-recycled metal material in the world.

Steel is used in nearly every industry in the world, including transportation, home goods, construction, energy and agriculture.

In the travel and transportation industry, steel is used in the manufacturing of essential car parts like engines, transmissions, wheels and car bodies. Over half the weight of the average car comes from steel. It is also used in the making of jet engine parts, anchor chains for ships and submarines, and the undercarriages of airplanes. Steel is also used to create home goods such as washing machines, refrigerators, microwaves and radiators. The weight of the average household appliance is 75 percent steel. It also goes into bottle caps, food cans, paint, chemical and household cleaner containers.

The vast majority of steel usage is in the construction industry. Steel structures are built quickly and relatively cheaply, making it a convenient choice for projects large and small. Steel composes the foundations and frames of office buildings, hospitals, gas stations, grocery stores and apartment homes.

Steel is utilized in the energy industry as well. Oil pipelines, wind turbines, gas wells and transformer cores all use steel in their basic makeup. In the agricultural industry, steel also has many uses. Farm equipment and vehicles such as tractors, forklifts and storage tanks all use steel parts and foundations.

About 75% of the weight of typical household appliances comes from steel. Steel is found in appliances like fridges, washing machines, ovens, microwaves, sinks, cutlery etc.

Steel also accounts of many industry goods like farm vehicles and machinery, storage tanks, tools, structures, walkways, protective equipment.

Thus, Steel applications can generally be useful to construction sector, transport sector, energy sector, packaging sector, appliance and industry sectors.

Steel is both the most widely used and most recycled metal material on earth. From stainless and high temperature steels to flat carbon products, steel's various forms and alloys offer different properties to meet a wide range of applications. For these reasons, as well as the metal's combination of high strength and a relatively low production cost, steel is now used in countless products.

With the usefulness of Steel established, our focal emphasis is forthwith directed to the sourcing/manufacturing of Steel, which has to do with the Setting up of a Steel-Manufacturing Plant (in concert to Construction of a 132kV Transmission Line) project, at Inner Galaxy Steel Company Ltd. Facility-Site.

2.2.2 Need for the Project: *Construction of Transmission Line*

Electricity plays a very important role in the socio-economic and technological development of every nation. The electricity demand in Nigeria far outstrips the supply. It is widely accepted that there is a strong correlation between socio-economic development and the availability of electricity.

Over the years, the problem of erratic power-supply have been identified as a major setback to developmental and industrial advancement in the country, as the power generated and distributed by PHCN (Power Holding Company of Nigeria) have not equal to solving the electric-energy demand of over 170 millions Nigerians. Thus, the need to alleviate this power-problems of distribution, in construction of additional transmission lines to distribute and supply power, as needed for industrial/manufacturing activities.

Having weighed the options of alternatives in provision of the needed power-supply for the proposed steel-manufacturing plant, Transmission of Electricity-source has been identified as a major requisite for the operation of the manufacturing operations/process. To generate enough needed electric power, the option of locating and connecting to the nearest/existing Power Plant in the area became a situatable project-option. The (Afam-Alaoji) Power Plant identified in the project area is close to the Project-Site (Inner Galaxy Stee-Manufacturing) Factory with a distance of 1300m.
The intention of Inner Galaxy Steel Company Ltd. is to evacuate/extend the power supply of the Alaoji Power Plant to power the operations of her Plant. This is the background to the Construction of a 1.3km 132kV Transmission Line from Alaoji Power Plant to Inner Galaxy Steel Company Ltd's Factory/Plant (project site for Steel-manufacturing operations). Both the Transmission Station and the Project-Site are all located in Ukwa-West LGA, Abia State.

This entire Project (Transmission-Line Construction for/and Manufacturing-Plant Operations) for processing Billets (raw material) into finished Steel-Bar products, does however, engenders environmental issues. Thus, the need to carry out this Environmental Impact Assessment (EIA) Study, as has been stipulated by regulatory bodies.

2.3 Benefit/Value of the project

It is envisaged that the project will offer the following benefits:

- ✓ Creation of direct employment.
- ✓ Provision of economic and social linkage due to influx of people to the community.
- ✓ Boost infrastructural/urban development of project location
- ✓ Provision of socio amenities in respect to Cooperate Social Responsibility
- ✓ Provision of Steel-materials for manufacturing industries
- ✓ Support for construction industries.
- ✓ Promote business development of Inner Galaxy Steel Company Ltd.
- ✓ Increase income base of the Local, State and Federal Government.
- ✓ Capacity building for the employees.

- ✓ Raw materials for the construction works of the project-site will be sourced locally thereby enhancing the economic status of the immediate community.
- ✓ Increase in the socio economic growth of the host community.
- ✓ Attraction of more community development through Inner Galaxy Steel Company Ltd.'s Corporate Social Responsibilities (CSR) for the host communities; like the road construction at the community (road leading to the project site).
- ✓ Increase in the income of the host communities and other surrounding communities through direct and indirect employment opportunities, thereby enhancing the socio-economic activities of the area. It will lead to increment in social services and will open up new market opportunities for the communities, as well as improve exchange of regional and inter-state trade and services.

This project will also positively impact on the revenue generation of the area through local taxation and other levies, and increase the availability of steel materials. It will also attract private and government investments in industries and infrastructural development through the road infrastructures that will be developed. Other benefits will arise from the Corporate Social Responsibility (CSR) of the proponent to the Host Communities (Ahala Ukwu Village, Umuahala Community, Obuzor Ukwu Autonomous, and Umuacheke, Umuigwe / Umuogogo Community, Isimiri Umuorie Autonomous).

2.4 Envisaged Sustainability

Envisaged Sustainability Sustainability can be viewed in terms of economic, environmental protection and social stability as well as technical viability. These aspects are further discussed below:

Environmental Protection and Social Stability

Early in the EIA process several visits to the study area were undertaken during which the proposed ROW were thoroughly examined in order to obtain a detailed understanding of the potential impacts and key issues associated with the construction and operation of the transmission line. Issues associated with the construction and operational phases were identified separately (see chapter five).

These impacts (adverse and beneficial) were addressed in consultation with identified stakeholders, through an investigative process based on past similar projects, environmental screening process (using GIS among other tools), as well as an environmental evaluation based on knowledge of the study area. Detailed impact identification, evaluation, and mitigation is provided in chapters 5 and chapter 6.

The project in some ways will impact negatively on the environment. However incorporating the findings of this EIA, and effectively implementing the environmental management plan (EMP) at the planning, design, construction, operation and decommissioning stages of the project will ensure undesirable impacts are mitigated and managed to extents reasonably practicable.

Inner Galaxy Steel Company Ltd. the constructor of the transmission line will make efforts to enhance its relationship with the communities that are in proximity of the planned project. Consultations will be maintained with the local communities during the engineering (e.g. site visits and surveys) and construction efforts as well as during the operational phase to identify concerns as they arise and address these concerns with appropriate remedies.

Economic and Employment Growth

Economic growth and structure of the economy are major driving parameters in electricity demand projections of a country. The transmission line project should help to ease immediate power supply constraint on economic growth and will contribute to a new restructured power sector, reversing the current drain on the national budget.

The project will also provide employment and skill acquisition opportunities for Nigerians through direct and indirect involvement of contractors, consultants, suppliers and other professionals during the permitting, construction and operational phases of the project. Direct employment opportunities will likely include a large portion of the estimated 100 worker positions that will be needed to construct the transmission line towers and to string the lines. Additional direct employment will go to persons that will be employed to provide security at tower sites and other work areas. Indirect employment and associated economic effects will be derived from the fabrication and coating of transmission line tower components in Nigeria.

Asides employment, raw materials (such as cement, wood, nails, roofing sheets etc.) to be used during the construction phase of the project shall be sourced locally thereby yielding economic benefits to host community, Ukwa-West LGA and indeed the entire Abia State.
Contracting for other goods and services required for the construction will be consistent with good business practices, transparent and in line with the Nigerian local content law. Overall the project when operational will stimulate the growth of small, medium and large scale industries in the gridded communities and Nigeria as a whole.

Technical Sustainability

The design of the proposed Transmission Line is tailored with technology, which would facilitate simple operation and maintenance. Also, the proposed project is sustainable in view of the proven power line technology and strict adherence to internationally and nationally accepted engineering practices that shall be adopted at all stages of the development.

Inner Galaxy Steel Company Ltd. have technically sustainable plan for operating the project. The use and adoption of best industrial practices in the design, construction and operational phases of the project and the culture for personal health and safety as well as effective environmental pollution prevention programme would ensure technical viability of the project. The project operations shall also be managed by experienced technical engineers, while the location of equipment such as the manufacturing plants shall be carefully chosen in way that the operations will not have much effect on the host community. The project activities shall also comply with local and national guiding laws.

Financial Sustainability

The high demand for the steel occasioned by the industrial manufacturing activities, makes the business of steel-making a lucrative venture and as such Inner Galaxy Steel Company Ltd. hopes to cash in on this readily available market for good financial gain which the company’s management envisages to continually plough back into growing and expanding the project venture applying the principle of operating with industrial best practice and ensuring environmental compliance towards achieving environmental sustainability. The proponent shall ensure that the project is properly managed in line with the company’s project management and financial discipline principles.

2.5 Project Development Options

Several alternatives to the proposed project have been considered. Also, in fulfilling the requirement for environmental sustainability of the proposed project, attempt was made to evaluate alternatives in order to meet the ultimate objective of the project. Thus, the following alternatives were considered:

- Alternative A: No project option *(Rejected option)*
- Alternative B: Alternative for steel-bars/manufacturing materials from other sources located in distanced states in the country or alternate power-source route. *(Rejected option)*
- Alternative C: Delayed project option. *(Rejected option)*
- Alternative D: Embarking on the project as proposed. *(Adopted option)*

Non-Implementation of the Proposed Project (Alternatives A, B & C)

This means the non-sitting ('no development') of the project-site in Ukwa-West. It implies that the area may be free from impacts associated with the project's operations and at the same time benefits derived would be lost. This option is rejected for this project, since there is an existing technically, environmentally and economically sustainable plan for implementing the project.

The "no development" option will result in zero land take, zero health, safety and environmental impacts. No development options are usually considered in cases where the proposed development will have significant negative impact that cannot be effectively or satisfactorily mitigated.

To maintain the status quo is the do-nothing approach. By not taking any action, Inner Galaxy Steel Company Ltd. will not effectively generate power that will be used in the operation of her steel-manufaturing Plant, thus not effectively providing the needed supply of Steel-Bars for the manufacturing industry.

This can pose a major setback on the industrialization and economic growth of the nation. This option is therefore ruled out because it would neither supply the projected demand for electricity nor optimise the existing infrastructure.

Most impacts of the proposed transmission line can be effectively mitigated to reduce their significance to acceptable levels and in view of the need for more power supply to support economic growth and development in the country, these impacts are not of sufficient import to prevent the implementation of the project.

Full implementation of the Proposed Project (Alternative D)

This ('development') option allows for full implementation of the project after all considerations of environmental and social components. Based on the availability of a nearby power-plant and demand of steels in industrial/infrastructural development and the huge market for the steel product within project location (Abia State), this option is recommended with strict compliance with the recommendations of this EIA study and further guidelines and directives of the Federal Ministry of Environment, and other related regulatory bodies; to ensure this project (setting up of a Steel-manufacturing plant/construction of a 132kV transmission-line) follows an environmentally sustainable routine operations.

The installation of the steel-manufacturing plant and construction of 1.3km 132kV Transmission line is a major development project that could have negative impacts on the biophysical and social environments. However, if duly mitigated and planned the project will enhance the economic potential of the country, while impacting minimally on the affected environment. All the significant impacts identified have been thoroughly investigated during the impact assessment phase. None of these impacts are impossible to mitigate and manage with a detailed EMP in place.

Apart from meeting the need of Steel supply to manufacturing industries, Project implementation is also encouraged by the location-advantage of the project-site; as the site is located close to an already situated *Alaoji* Power Plant, to provide needed power-supply for the operations of the manufacturing plant; by extending a 132kV Transmission Line at the 22nd tower of the situated Transmission Station, which is close the proposed factory with a distance of 1300 meters.

CHAPTER THREE
DESCRIPTION OF PROJECT

3.1 Introduction

This chapter presents detailed description of the proposed project, which is the setting up of a Steel-Manufacturing Plant/Construction of a 132kV Transmission Line at Ukwa-West Local Government Area of Abia State. The project workscope, project sequence of activities, project/process description, operating philosophy as well as the overall implementation schedule for the proposed project are described in this chapter. Inner Galaxy Steel Company Ltd shall be responsible for the overall project Engineering, Procurement and Constructions as well as Project Management, Pre-commissioning, Commissioning and De-commisioning.

3.2 Project Initiation

- Inner Galaxy Steel Company Limited (a registered *private* firm in the business of manufacturing and sale of Steel-products) proposes to set-up/install a steel-manufacturing Plant (for the production-operations of Steels).
- The proposed project-site for the Plant/factory, occupies a landmass of 85 Ha.
- The vast land of the factory/project-site cuts across two (2) Autonomous Communities, as hosts, Located at Ahala-Ukwu Village, Umuahala Community, ObuzorUkwu Autonomous, and Umuacheke, Umuigwe/Umuogogo Community, IsimiriUmuorie Autonomous, in Ukwa-West Local Government Area of Abia State, South-East, Nigeria.
- The operations of the proposed Steel-manufacturing Plant-installation will require the Construction of a 1.3km 132kV Transmission Line (4 double-circuit Tower), to Power Inner Galaxy Steel Company Ltd's production-process/factory activities.
- Located within the area of the proposed factory site of the manufacturing plant is the Afam-Alaoji Power Plant (Transmission Station), thus the Proponent proposes, by compliance to legal requirements, to Construct a 132kV Transmission Line to distribute, evacuate or extend the power-supply of the Power Plant, by connecting at the 22nd tower of the Transmission Station.

- The Power Plant (sub-station) is close to the Proponent's factory-site with a distance of 1300 meters (1.3km).
- The average power-consumption of the proposed project *(Steel-Manufacturing)*, as required for the factory operations of the Steel-Plant is 80MW, at full production-capacity.
- The production-capacity of the proposed project is benchmarked at 10,000 tons of Steel-Bar per month.

3.3 Project Scope of Work: Sequence of Activities

The scope of work of the proposed project would involve the following listed principal activities; which does not however show the interdependencies of the project activities.

- Survey of the proposed project site
- Determine technically feasible alternative transmission line routes or corridors (*based on environmental preferences*).
- Negotiation of final route corridor within corridor with landowners/host communities.
- Clearing of the proposed project factory-site (85 hectares)
- Clearing of vegetation from essential parts of the 1.3km Right of Way (ROW) for the 132kV Transmission Line construction
- Development of access road to the project site
- Establishment of construction camps
- Mobilisation
- Transmission line detail design
- Final design of line and placement of towers (Selection of best-suited structures and foundations).
- Material production (conductor, insulator, line hardware)
- Material testing and shipment
- Tower production
- Tower testing and shipment
- Clear and grub site along transmission line corridor (wayleave)
- Construction of Foundations for tower installation

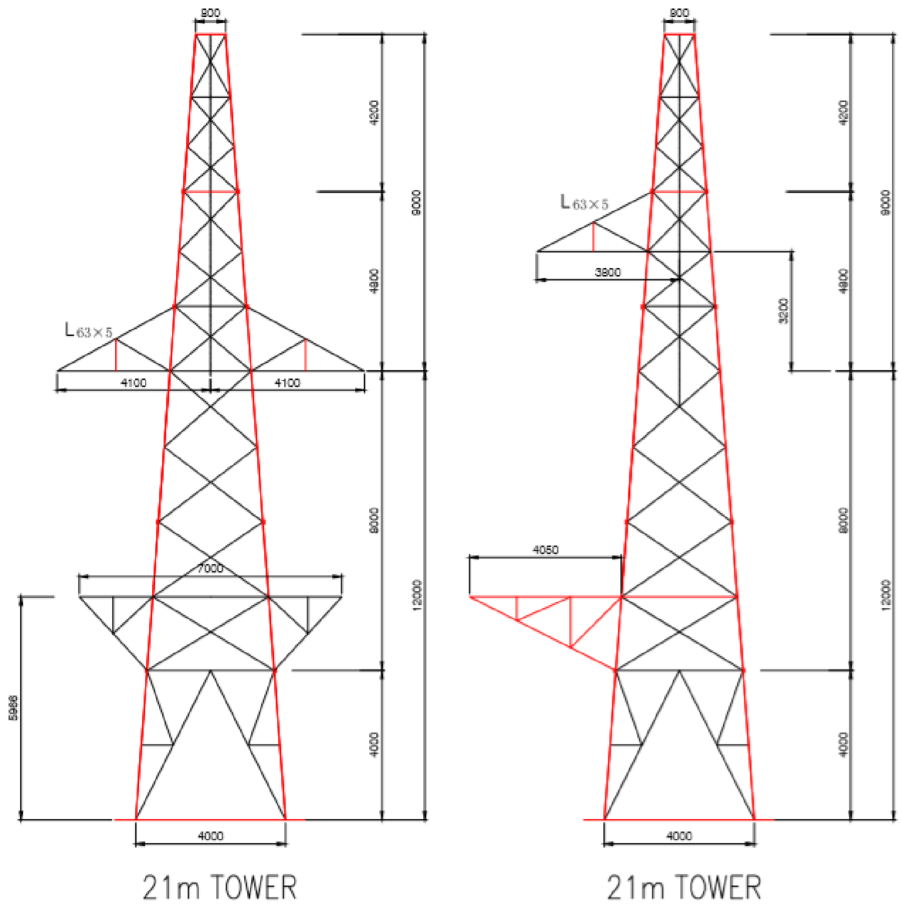
- Tower assembly and erection
- Conductor stringing
- Provision of associated digital communication facilities at the substations to facilitate supervision and maintenance of the transmission line operations
- Commissioning and testing of Transmission Line
- Procurement and supply of all operational materials and machineries
- Installation of the Steel-Manufacturing Plant
- Construction of buildings/production facilities
- Project Waste management/structures
- Provision of needed Safety/security measures
- Commissioning of the steel-manufacturing facility
- Demobilization/de-commisioning
- Rehabilitation of all working areas

3.4 Project Description

3.4.1 Construction-Design of the 1.3km 132kV Transmission Line:

- ♦ The Transmission Line project-phase is designed to be a 132kV extending the power supply of *existing Alaoji-Afam* Power Plant (Transmission Station) to the factory/project site of Inner Galaxy Steel Company Ltd.
- ♦ The proposed Transmission Line is a 4 Double-circuit Steel-structure Tower.
- ♦ The 132kV Transmission Line project is designed to connect at the 22nd Tower of the existing *(already-situated)* Transmission Station (of 330kV).
- ♦ The distance between the 132kV transmission-station tower and the project/factory site of the company is a total (*ROW length*) of 1.3km (close enough to be of service to the proposed steel-manufacturing plant' operation).
- ♦ Project-description Details of Site plan, map of facility layout, and <u>Technical-design drawings</u> *(as seen in Fig. 3.1)* for the proposed Steel-manufacturing plant/Construction of 1.3km 132kV Transmission Line Project by Inner Galaxy Steel Company Limited have been provided as ***Appendix F*** to this report.

Figure 3.1: Design (technical drawings) of Transmission Line Project



132JG1 ANGLE TOWER PARAMETER

VOLTAGE	ITEM	TYPE	SECTION AREA (mm^2)	MAX. STRESS (Kg/mm^2)	MAX. TENSION (Kg)
132KV	CONDUCTOR	LGJ-240	281.1	11.2	3148
	SURGE LINE	GJ-50	49.5	36.0	1782
DESIGN SPAN (m)		LEVEL SPAN	VERTICAL SPAN	RULING SPAN	LINE ANGLE
		350	500	160/400	0。~30。

132JG1 ANGLE TOWER BASE PARAMETER

ITEM		ELEVATION (m)
		21
TOWER BOTTOM (mm)	WIDTH	4055
	DIAGONAL	5734
TOWER BASE (mm)	WIDTH	6800
	DIAGONAL	9616
FOOT BOLT	TENSION BASE	4M30
	COMP. BASE	4M30
DISTANCE BETWEEN FOOT BOLT (mm)		200
TOTAL WEIGHT (Kg)		7808.5

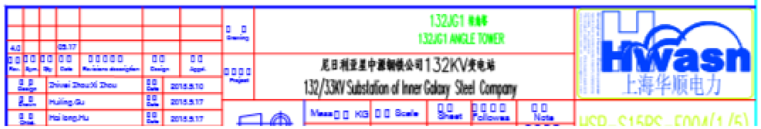


Figure 3.1: Design (technical drawings) of Transmission Line Project (Cont.d.)

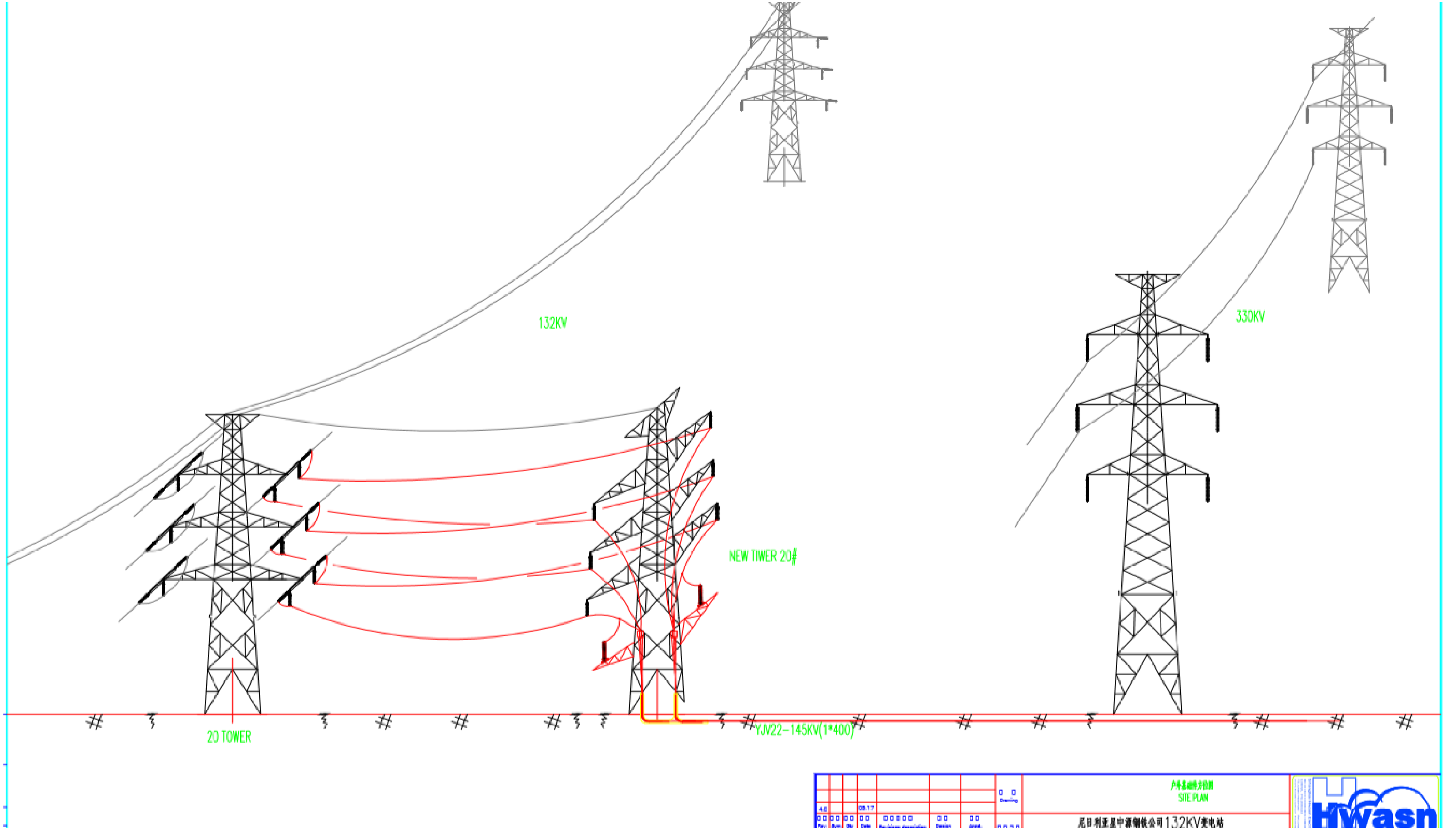
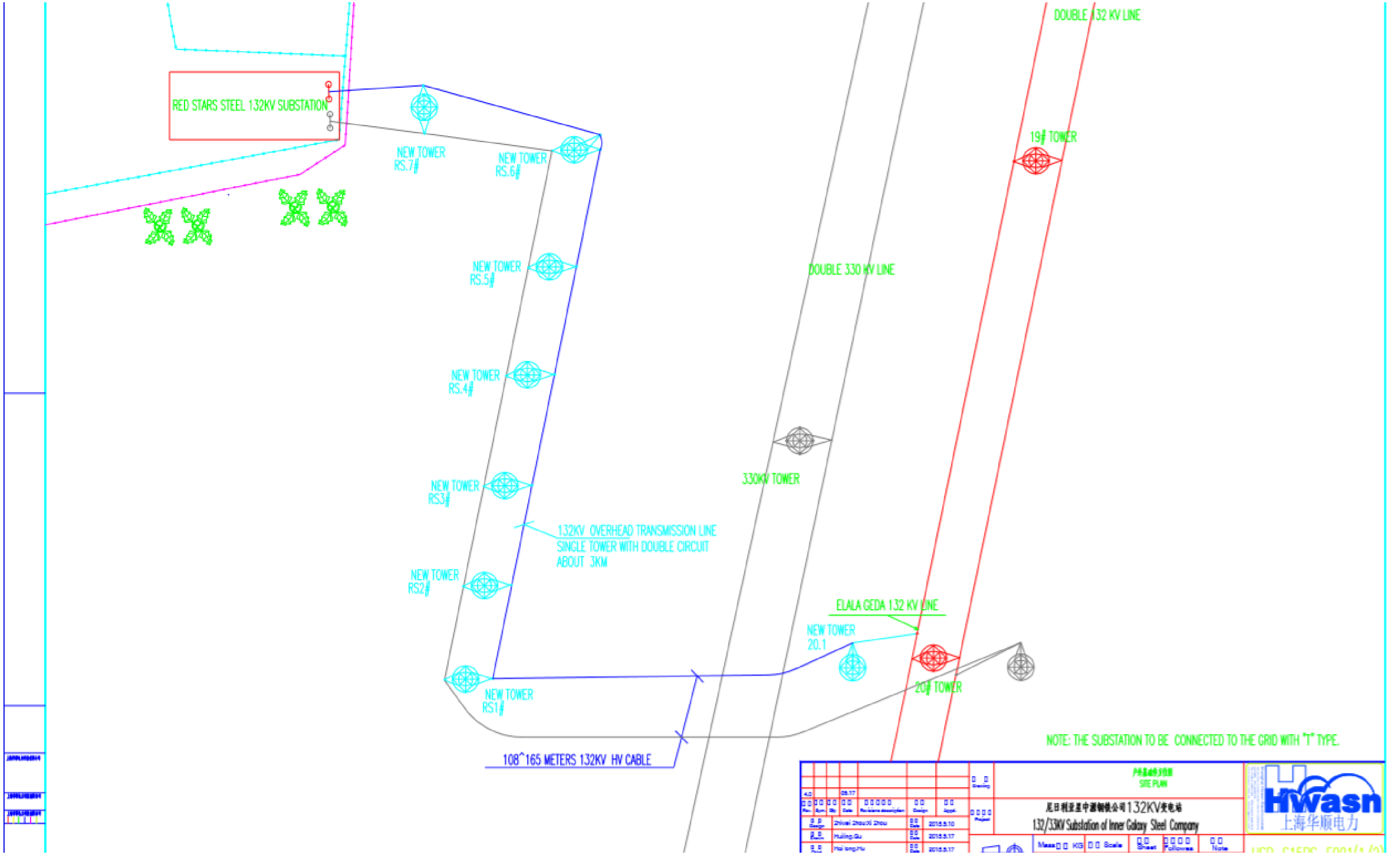


Figure 3.1: Design (technical drawings) of Transmission Line Project (Cont.d.)



- The Foundation Design for the transmission towers is based on the principle of safety, reliability, economy and reasonability. Three foundation types (mass concrete, pad and pile foundations) shall be used in the proposed project. The mass concrete, and pad foundation types shall be used for foundations with small and large loads respectively under normal soil condition while the pile foundation shall be used in areas where the mass concrete and pad foundations are considered unsuitable.

- The Tower Type/Design is designed to meet the requirements of the conceptual design for a 132kV transmission line and shall be in line with the TCN (Transmission Company of Nigeria) requirements. The standard tower type from experiences of local operation shall be used in view of economy, suitability and short completion schedule. Furthermore, the tower design will be such of self supporting type of vertical configuration and the towers designated as suspension towers, tension towers, transposition towers and special towers. The requirement of transposition and special towers does not arise for this transmission line.

- In ensuring the Strength of the Towers, rolled steel section, flats, plates, bolt and nut bars will, consist of steel. High strength (tensile) steel where approved shall be used where required.

- In ensuring protection and Earthing System Design, the proposed project, the transmission line structure shall be grounded so as to obtain a low resistance to ground. The resistance value permitted at the tower is in accordance with the TCN standard, to protect the line and towers. The earth wire conductor shall be used as lightning protection measure for the transmission line. The Towers and the ground-wires are a major part of the earthing Transmission Line system. The ground wires are clamped electrically to the towers. The towers are connected with the earth in and around the foundations. The system is used for lightning protection, earthing faults and during maintenance works to earthen the individual electrical circuits. Where necessary, TL towers are equipped with earthing installations to conduct failure and induction currents as well as currents from lightning strikes into the earth.

- Thus, here, the proponent intend to make the connection via underground to the first tower to avoid the line crossing over the 330kV Transmission Station due to the proximity of the 330kV to the 132kV Transmission Line.

♦ Geotechnical investigation for the project is proposed to be carried out side by side with the construction activities; especially as regards to the type/size of the tower-foundation construction.

♦ Prior to construction works, selective clearing of ROW and access corridor will ensure that only trees, vegetation, debris, roots, and other material interfering with the construction process are cleared from the site. Vegetation shall be cleared only along ROW and areas marked for construction of access roads. Any debris shall be collected and disposed of through the use of an approved waste disposal contractor. Topsoil shall only be stripped in the areas of tower foundations, associated access roads, and marshalling yards. Care shall be taken to avoid mixing topsoil and subsoil.

♦ Proper Tower-Erecting Standards will be applicable to the project, to ensure that all towers shall be vertical within a tolerance at the tower top of 0.3% of the tower height before conductor erection. The bolt tightening torque shall be submitted to the assigned engineer for approval. Proper precautions shall be taken to ensure that towers are not strained or damaged in any way during erection. After erection all towers shall be cleaned of all foreign matter.

♦ The Wire-Stringing methodology in the project will ensure that Stringing of conductor and related operations shall be performed during daylight hours.

♦ Stringing of Conductor shall not be performed until 28 days after finished concrete works for foundations or as approved. The tightening of the tower bolts has to be completed and inspected.

♦ During stringing (and sagging) a reliable radio connection or some other approved means of communication shall be kept to coordinate operations within the group of line-men and operator of puller- tensioners.

- When the stringing of the conductor / earth-wire is about to be carried out the requisite notice to the appropriate authorities of the date and time at which the work shall be conducted will be made (Road authorities, Telecommunication utility, Power distribution utilities, Water authorities, Power Plant operators, private power distribution utilities, etc.). If necessary the traffic shall be controlled and guided.
- By appropriate routing and earthing and by protective measures it shall be ensured, that neither persons nor animals, nor installations are endangered by the inductive effect from the Transmission Line. This applies equally to construction, undisturbed normal operation and to disturbed faulty operation of a Transmission Line.
- All necessary arrangements with communities or landowners before entering private land for the transport of materials, and access to the site from the road shall be made. Clearance shall be provided by trimming of trees and other vegetation to obtain enough clearance from the nearest conductors in order to protect them from damages during construction and later operation of the Transmission Line.
- Clearing operations shall be conducted in such a way as to prevent damage to existing structures and installations and to those under construction, as well as to provide for the safety of employees and the public and avoid any risk during crossing process.
- Where necessary, scaffolding shall be provided at such times as may be convenient to the requisite authorities.
- Before conductor stringing, the tension towers should be properly anchored. Conductors shall not be pre-stressed above sagging tension during the pulling operation. The puller- tensioners should be set to maintain sufficient tensions to clear all obstructions by 2 to 3 m yet remaining considerably below the sagging tension. This clearance shall be confirmed by observation. Conductor joints are not permitted at spans crossing over Transmission Line. Working Clamps are installed to tighten the conductors to the cross-arm.

- To avoid loss of minimum ground clearance, the conductors shall be tensioned to a higher tension than the nominal design tension. The placing of tensioning and pulling equipment during the stringing operation shall be such that the combination of loads on a tower cross-arms multiplied by the appropriate overload factor, shall not be more than the maximum design load of the tower. When stringing is finished, final tensioning (sagging) will start.

- The Operations of the Transmission Line will be by Inner Galaxy Steel Company Ltd. (*the Proponent,* who will also bore the financial costs of the project); with technical assistance of TCN Engineers. The operability philosophy is to ensure the safety requirements and avoid undue line failures by proper design for weather - lightning and wind. Additionally, the monitoring of electrical parameters and protection of the Transmission Line during operation, a quick response to emergency situations should be implementable, which is buttressed through prior training and adequate stock of replacement parts. The operations of the transmission line should be such that the system can function or perform satisfactorily even when prevalent conditions are off-design such as component malfunction on one of the circuits and/or high electrical currents. The various parameters that can cause system failure should be monitored in a way that they are easy to understand. Best practices are to be considered in evaluating access to and viewing of operating data, manipulation of controls, removal and replacement of equipment and components of the Transmission Line.

- Embankments, Levelling and Drainage: The top surface of the concrete slabs for single or raft foundations shall be slightly inclined to the outer edge to drain off water. Ditches for rain water shall surround every structure and shall be designed to drain water away from the structure (e.g. into the next available natural pond) or into a small basin erected close by.

- For Fault-Detection, Response System and Control, Transmission Stations makes use of protective devices which have the ability to instantly detect a fault on the transmission line. The control switch, indication light, ammeter, voltage meter and alarm window will be on the control panels in the substations. A control panel will be located in the control rooms of both stations. For the new 132kV overhead lines, a set of kWh metering will be in the substations. An audio; and visual alarm system will be on the control panel in the substations. Premonition and fault signal for all equipment will be at the substation to synchronise the 132kV line from Afam-Alaoji Power Plant Station.

- Effective and functional communication system shall be installed to facilitate supervision and maintenance of the operation of the project and communication channel between Tower Station and the Factory Site.

Generally, in consideration of the conceptual design of the Transmission Line Project, the following constitute part of the required materials, as stipulated by TCN (Transmission Company of Nigeria) to be provided by the proponent (Inner Galaxy Steel Company Ltd):

- ✓ 4 double circuit 132kV steel structure Tower
- ✓ 132/33kV 100mVA Transformer
- ✓ 132kV steel vertical frame
- ✓ 33kV steel vertical frame
- ✓ Steel core aluminium strand
- ✓ Standard DC power supply (DC charger and 110V)
- ✓ 132kV Transformer
- ✓ 33kV Transformer
- ✓ 11kV Transformer
- ✓ 132kV control equipment with panel
- ✓ 33kV control equipment with panel

The above and design-basis have formed part of the needed provision for the approval of the project by TCN.

3.4.1.1 Design Basis (Safety prospect) of the Transmission Line

The design intent of the proposed power transmission facilities is to develop environmentally sustainable facilities that satisfy applicable regulations, industry standards and codes; thus the design of the transmission line took into consideration several constraints along the proposed route.

Furthermore, the design, construction and operation of this project shall be conducted in order to:

- protect the safety, health and security of project and operations employees, suppliers' employees, customers, the public and other involved parties;
- maintain environmental integrity;
- comply with applicable laws and regulations;
- apply sound geo-science, engineering, technical and commercial best practices;
- focus on flawless execution with minimum re-works;
- meet the reasonable aspirations of the project-impacted communities;
- maximize Nigerian content consistent with the project objectives;
- achieve facility performance objectives.

The Project Objectives can be summarized as follows:

- *Safety and Security* - nobody gets hurt during project planning and execution. Safety and security are the project's highest priorities and are everyone's responsibility;
- *Quality* - quality is the foundation of safe, operable & reliable facilities;
- *Business Conduct and Controls* - we will conduct our business with the highest level of integrity;
- *Environment/Regulatory/Permitting* - project design and work are performed in a manner that meets the high performance expectations of Nigeria;
- *Community Relations* - foster an effective, productive relationship with communities;
- *Operability & Reliability* - ensure facilities meet business objectives (O&M Costs, operating performance, plant durability, operational flexibility, reliability, and availability) to ensure safe, environmentally sound, and cost effective operations;
- *Nigerian Content* – foster continued development of Nigerian-based industry with a view to meet FGN requirements outlined in the applicable Nigerian Content Legislation;
- *Stakeholder* - stakeholder alignment is necessary for project success;
- *Commercial Agreements* - execute commercial agreements and secure fiscal terms to achieve project schedule.

Safety Criteria

The design of the Transmission Line system (routes and layouts) have been carried out taking into consideration corporate safety rules to assure safety, prevent accidents and reduce risks level to as low as practicable. Further safety and operability studies would be carried out on final transmission route, tower foundations and general technical drawings to verify safety systems and integrity of installations to possible changes in environmental conditions.

The concept and basic design of the proposed Transmission Line facilities and system are based on TCN specifications and are in line with national and international Standards and Codes. These cover various aspects as electrical, mechanical, civil, transmission and distribution lines.

The Construction HSE-Management System is to be established prior to construction based on the above philosophy and the requirements of following at minimum:

- OHSAS18001:2007- Occupational Health and Safety Management Systems Requirements;
- ISO9001:2008- Quality management systems: Requirements
- ISO14001:2004- Environmental management systems: Requirements with guidance for use;
- Local Norms, Rules and Regulations for Health, Safety and Environmental Protection;
- Environmental Guidelines and Standards for Petroleum Industry in Nigeria, Ministry of Petroleum Resources- "Revised Edition 2002";
- Workmen’s Compensation Decree/1987;
- Electrical Regulations/1988.

The objectives and strategies for the construction phase of the Project are aligned with the overall Project Objectives and Strategies (POS). Construction Objectives are:

- Improve Project Safety, health, security, environmental protection/performance, particularly during construction
- Assure Project Quality
- Reduce Project Life-Cycle Costs
- Reduce Project Schedules

- Properly plan logistics to ensure minimum rework caused by poor engineering/construction coordination
- Properly plan the contracting and procurement activities while supporting field construction requirements to ensure the reduced schedule and cost impacts are realized.
- Enhance Management of Risk
- Involve local communities in the construction process
- Foster an effective relationship with communities

These objectives will be achieved through:

- Effective collaboration within the Project Team
- Involvement of all Project Team members as active participants in, contributors to, and owners of the process
- Ownership and stewardship by specific project team members
- Inclusion of the Program as an integral part of the culture and work processes for the Project
- Early use of construction knowledge and experience during planning and design to ensure the Construction Execution Plan is consistent with design, practical, cost effective and conforms to the overall project goals of safety, quality, cost, schedule, execution and site-management resources.
- A systematic approach for incorporating construction expertise in detailed engineering, procurement and other execution activities to:

- Foster interface communications
- Reduce project cost by fostering a fit-for-purpose construction philosophy
- Forecast labor requirements, assess availability and produce proactive plans around the forecast
- Actively promote preassembly and modularization
- Identify and resolve issues, as well as identify and capture opportunities

Special attention shall be given to work at height and during tower erection and conductor stringing.

Supervision of the Project will be two (2) major stages:

1. Engineering Surveillance, and
2. Construction Surveillance

3.4.1.2 Maintenance prospect of the Transmission Line

The Transmission Line will be maintained by the proponent (Inner Galaxy Steel Company Ltd.), with technical assistance from TCN. The Transmission Line shall be designed to facilitate maintenance – e.g., climbing aids, use of wedge clamps instead of compression clamps, use of steel (and not copper) ground wires.

When Transmission Line is to be maintained, the downtime should be minimal, and failed or faulty components are to be replaced as needed and expeditiously. Any component of the transmission line that appears in multiples are to be identical and from the same manufacturer. All components must be safe, of good quality, of required design capacity and readily available.

The tower structures and foundations are to be safe and easily accessible by any means employed. Access to the line (conductors, insulators and line hardware) and its accessories has to be safe and easy, but restricted to avoid undue access.

3.4.1.3 Management Strategy for Temporarily Site-Construction Utilities and Equipments:

Throughout the construction period, bottled drinking water will be imported to the job site by means of a tractor trailer truck for use by construction labor. Non-potable water for construction purposes will be obtained from the onsite wells at the adjacent Power Project site which will be installed.

Temporary portable sanitation units will be employed for construction labor. The Project will be responsible for pump-out and disposal of all sanitary waste. The Project will also be responsible for the management and disposal of all office wastes, construction wastes and construction labor camp wastes generated as a result of the Project.

The management and disposal of all construction generated waste streams will be conducted in accordance with all applicable Nigerian waste management regulations including project waste management and disposal standards. To ensure compliance with this commitment, the Project will contractually require its contractor to develop and implement a Waste Management Plan (WMP) consistent with its waste management standards and practices. To further ensure compliance, the Project will conduct periodic assessments of the contractor's waste management activities.

Construction lighting will be accomplished by relying on mobile light towers, mainly required to illuminate the site each night for security.

Temporary diesel electric generators will be used to provide office lighting and service other light loads. It is expected that temporary construction power will be provided by the project contractor using tow behind diesel generators for the construction period.

Temporary offices facilities essentially construction trailers will be established. Connex boxes will be used to store, dispense and secure consumables, small tools and small equipment.

The Transmission Line laydown area will be provided. This area will be used during all the stages of the Project. It will aid in keeping materials dry and to provide a surface suitable for vehicle traffic. Later during the construction phase, construction materials and equipment like foundation reinforcement steel or steel tower metal bars will be stored in the area.

Security at the lay-down area is expected to consist of a combination of expatriate security managers and local national guards some of whom will be recruited from the host communities. Perimeter security, entry control points as well as roving security patrols will likely be used.

Fuel shall be purchased locally at fuel stations and suppliers. Shortages in the local market shall be taken into consideration and planning shall avoid any shortage. All sorts of fuels used in TLine construction processes will be stored at specified equipment staging areas. Where practical, refueling will be conducted at the staging areas. Fuel shall be stored in

special protected storage areas, such as shelters, protected against rain, with restricted personnel access, good illumination, concrete foundation and bunds to avoid any unexpected spills and soil contamination.
If refueling along the right-of-way is required, fuel will be trucked in using appropriate equipment.

Gases for welding are supplied to site in steel bottles and must be stored open air in a safe, sun protected bottle holder secured at all times by chains / restraining straps.

Various on-site equipment to be used during the execution of the construction works will include: Graders, Water Trucks, Bulldozers, Front End Loader, Vehicles, Concrete Mixers, Excavators, Water Pumps, Mechanical Tools, Pedestal Rollers, Tipper Trucks, etc.

3.4.1.4 Mobilisation

The following items and personnel will be mobilized during the process:
• Fence and Security provision
• Construction of marshalling yards and lay-down areas set-up
• Construction and setup of office
• Construction vehicles / machines / equipment mobilization
• Construction material provision
• Infrastructure for operation of construction site
• Drainage set-up
• Communication provision
• Manpower mobilization
• Coordination between the power projects

Personnel to be mobilized will include:
• National labour
• Local labour (engagement of community members)
• National experts
• Foreign experts´

Generally, the proposed project-activities is set to be in two (2) major phases:

1. Construction of the 1.3km 132kV double-circuit Transmission Line, for extension of power supply to factory-site *(as have been detailed above)*; and next is the

2. Installations of the steel-manufacturing Plant, (operations of the factory-site) for production of Steel-Bar, with the use of billets *(as now discussed below)*.

3.4.2 Provision of Steel-Bar Products by a Steel-Manufacturing Plant

Metallurgical Processes of the Iron and Steel-Manufacturing industry has made the industry remain as one of the important *basic* industry, driving Infrastructural Development in Nigeria; this is because of the high demand of steel-utilization in manufacturing industries for various industrial and construction uses attributable to quest for economic and urban development.

Most of the iron and steel production in Nigeria use steel scraps and iron ore as the major raw materials. The recycling of steel scraps reduces the usage of imported pig iron produced from natural iron ore. However, the demand of iron and steel in the manufacturing industries have increased and far exceeded the production capacity of the intermediate iron and steel production, which led to the increasing volume of imported intermediate products.

In order to bridge the gap between the required production-capacity of industries and the availability of needed Steel-resources (as raw material), Inner Galaxy Steel Company Ltd, (a *privately owned* steel-manufacturing company) have decided to acquire a 85 hectare of land for the setting up of a Manufacturing-Plant, to Produce Steel-Bars, and increase supply of needed steel-material; required for increased industrial-development and various construction uses of manufacturing industries.

Essentially, the company (project-proponent) inorder to accelerate the availability of Steels, proposes to use the source of **billet**, as major raw material to be processed by the steel-manufacturing Plant. The major source of the billet will be imported suppliers.

However, the Plant in producing Steel-Products will require *heavy*-Power-Source. This will necessitate the immediate Construction of a 132kV Transmission Line, extending power (electric supply) from *an already situated* Power Plant to provide needed power-source (electric energy) for the steel-Plant operations.

Therefore, the nature of the project is in response to the need to contribute to infrastural development by the provision of industrial steel-products, thus, the project proponent proposes to basically set-up a manufacturing plant which produces steel from billet, and to consequently construct a 132kV transmission line for powering (extending electric supply from *Alaoji* Power Plant) to the steel-manufacturing plant.

The central objective of the project is to set up a Steel Manufacturing Plant / Construction of 1.3km 132kV Transmission Line which will enable the company to produce Steel Bars from **billets**.

With steel-products produced, the economic gains and income of the project locations is set to increase, due to industrial development, provision of social amenities and job opportunities in the area.

Other benefits of the project will be to alleviate poverty through employment creation to the local people and the improvement in the standard of living of the host communities in general through infrastructure development such as grading of local road networks near the site.

This will not only have positive economic multiplier effect but will also reduce importation of pig iron and/or the intermediate steel products; as the project-proponent (commercial company) has its primary business-interest in the manufacture and sale of steel-product from the processed billet. The steel will be sold locally to the manufacturing industry.

3.4.2.1 Raw Materials for the steel-manufacturing project

The table below gives an overview of the major Raw Material, Uses, Source and Description to the Project's activities/operations.

Table 3.1: Project's Raw Materials, Sources and Description

S/N	RAW MATERIALS	SOURCES	DESCRIPTION/USES
1.	Billet	Foreign/Imported supplies	Billets are supplied to the Manufacturing Plant to Produce Steel-Bar. The Plant is proposed to produce 10,000 tons of Steel-Bar per month.
2.	Scrap metal	Local alternatives	Scrap metals gathered or collected from local suppliers can be handy in manufacturing of Steel.
3.	Water	Borehole supply	Ground water sources are drilled within the project facility to supply needed water for all production and domestic uses.
4.	Electricity/Power	Alaoji Power-Plant	Construction of a 132kV Transmission Line to extend the Power-Supply to the Steel-Plant. Expected total power generation is proposed to be 40mW (Mega Watt) while the usage at the first stage will be 15mW.
Other available Materials On-Site at Project Location			
5.	Diesel storage surface tanks	Procured by the project-proponent	*Quantity*: 2 (two) *Capacities*: 33,000 ltrs and 11,000 ltrs each.
6.	Alternative Power-generating sets	Procured by the project-proponent	*Quantity*: 4 (four) *Capacities*: 80, 100, 350, and 500 KWs each.

3.4.2.2 Production Process*:*

The whole project nature will involve the construction of the Steel Manufacturing Plant, its components and manufacturing of Steel Bars from billet.

The proposed Plant will operate based on the Electric Arc Furnace (EAF) Steel Manufacturing Technology from billet. Before steel rolling, the cast steel produced by electrical furnace will be heated to a higher temperature, so that it can be rolled successfully. So the main function of this furnace is beforehand heating cast steel before rolling and it will be powered by natural gas.

The proposed Plant will consist of two plants, one is for smelting the billets and processing it into cast steel, the main equipment to be used is the medium frequency EAF. The other Plant will consist of processing the scraps into deformed bars. The main machine in this plant is the steel rolling mill.

Billet will be melted by electricity into steel ingot with 2 tons weight each bar. Then the steel ingot will be rolled into finished product through natural gas burning as a source of fuel. At the first phase yearly consumption of natural gas is above 40,000,000 cubic meters and the air pressure should be 10BAR. Hence, the company have applied to the Nigeria Gas Company (NGC) for the acquiring Liquefied Natural Gas for its production works as an essential fuel. Should this not be available, alternative source of fuel will be heavy oil or coal as a substitute.

3.4.2.3 Expected Processed Product:

Inner Galaxy Steel Company Limited has proposed to undertake the production of building materials which includes the following:

1. Deformed steel bar,
2. Angle steel bar,
3. I-Steel,
4. Z-steel,
5. Coiled reinforced bar and related products

3.4.2.3.1 Project' Expected Processed Product: The Nature and Importance of **Steel**

A fundamental distinguishing property of Steel is its great strength which depends partly upon the carbon content.

Most steels have carbon contents far lower than 2.11%. This figure marks the critical maximum where in the processing of the material, at 900° C, a complete phase change can occur. Above this level of carbon content, an iron-carbon alloy becomes more brittle taking on the type of performance associated with cast irons. The manipulation of the carbon content is carried out by controlled removal by oxidation.

This range of iron-carbon steels are referred to as plain carbon steels as the only other element present is manganese, present in up to 1.6% by weight and left in the metal from de-oxidation and de-sulphurisation processes. The addition of any other elements will bring the metal into the metallurgical category of alloy steels. (The general term alloy steels in the industry refers to those steels, which have contributions from other elements amounting to 5% by weight and over.) Different grades and types of steel are used for a wide range of applications.

Steel is a widely used material; architects and designers employ it in a variety of situations from structural elements to lightweight cladding components, furniture, ironmongery and fixings. Different applications have different requirements of the material. A wide range of steels is therefore available with varying properties achieved by alloying and processing. It is in the proponent's interest to grasp some of technology associated with this. Steel offers a number of advantages which are largely a result of the inherent characteristics of the material.

The distinct advantages of the use of steel in modern building construction are summarised as follows:

- the modular nature of its fabrication - a "kit of parts"
- the potential for rapid erection
- it is prefabricated off-site to a high degree of tolerance
- economic long spans can be achieved
- it permits adaptation in the future, and can be re-used
- it makes a positive contribution to a thermally efficient building
- steel or composite frames are lighter than concrete equivalents

Steel has important properties, such as resilience, crack resistant and ductility which distinguish it from other materials. Thus, Steel has a number of properties that distinguish it from other materials such as ceramics, because it is resilient; it can sustain loading and deflection without incurring brittle behaviour; it is tough, a property which describes the ability to resist the propagation of cracks; it is ductile, which means that it will deform plastically prior to fracture; and it shows some resistance to impact damage.

An understanding of its origins and the techniques required to refine it are useful in appreciating its structural performance as well as how to prevent corrosion.

As with all large-scale manufacturing processes, the production or iron and steel generates by-products. On average the production of 1 tonne of steel results in 200 kg (EAF) to 400 kg (BF/BOF) of by-products.

The main by-products produced during iron and crude steel production are slags (90%), dusts and sludges. The worldwide average recovery rate for slag varies from over 80% for steelmaking slag to nearly 100% for iron making slag.

There are three main types of marketed iron making or BF slags, categorized by how they are cooled – air-cooled, granulated, and pelletized (or expanded).

Air-cooled slag is hard and dense and is especially suitable for use as construction aggregate. It is also used in ready-mixed concrete, concrete products, asphaltic concrete, road bases and surfaces, fill, clinker raw material, railroad ballast, roofing, mineral wool (for use as insulation) and soil conditioner.

Granulated slag forms sand-sized particles of glass and is primarily used to make cementitious material. Concretes incorporating granulated slag generally develop strength more slowly than concretes that contain only Portland cement – the most common type of cement – but can have better long-term strength, release less heat during hydration, have reduced permeability, and generally exhibit better resistance to chemical attack.

Pelletised or expanded slag has a vesicular texture (like volcanic rock) and is most commonly used as a lightweight aggregate. If finely ground, it also has cementitious properties.

Steel making slag (BOF and EAF) is cooled similarly to air cooled BF slag and is used for most of the same purposes. As the production process varies at this stage depending on the type of steel being made, the resulting slags also have diverse chemical properties making them more difficult to use than iron making slags. Some of the recovered slag is used internally in the steelmaking furnace or sinter plant, while approximately 50% of the recovered slag is used externally in construction applications, primarily roads.

Gases from iron-and steelmaking, once cleaned, are almost fully reused internally. Coke oven gas contains about 55% hydrogen and may prove an important hydrogen source in the future. It is fully reused within the steelmaking plant, and can provide up to 40% of the plant's power.

Dust and sludge are collected in the abatement equipment (filters) attached to the iron-and steelmaking processes. Sludge is produced from dust or fines in various steelmaking and rolling processes and has high moisture content. The dust and sludge removed from the gases consist primarily of iron and can mostly be used again in steelmaking.

3.4.2.4 Main-Features of the Project-Site Facilities will include:

- Factory area for situation of the steel-plant
- Offices/admin building
- Warehouse/storage area
- Sales/marketing/distribution section
- Workshop
- Security/Guard house
- Road/Car-park yard
- Clinic
- Rest room/Toilet
- Residential building

3.5 Project Waste Management

The proposed project would result in the generation of certain quantities of solid and liquid wastes. Inner Galaxy Steel Company Ltd. recognises the need to minimise waste generation in the course of the proposed project implementation and to handle such wastes in accordance with industry and international best practices and in line with its policies on health, safety and environment. The waste items that would be generated during the proposed project include solid wastes (used drums, plants, excavated soil, packing materials, waste rags, rubbish/garbage etc) and liquid wastes (waste water, used engine oil, etc). Detailed inventory of the waste type and sources and planned management practices are documented in chapter 7 (Environmental Management Plan).

However, the proposed project shall adopt the following main principles in terms of operations environmental philosophy:

- **Use of resources:** efficient use of chemicals, material, natural resources and energy sources, aimed at resource conservation and minimization of discharges;
- **Emission to air:** minimization through abatement at source of gaseous emissions that have the potential for negative impact on the environment;
- **Discharge to water:** minimization through abatement at source of aqueous effluents which have the potential for negative impact on the environment;
- **Solid waste:** Correct handling, treating and disposing of solid wastes to avoid/eliminate liabilities in the future and to meet the requirements for due diligence;
- Use of Best Available Technology Not Entailing Excessive Costs (BATNEEC) and good international industry environmental practices.

Details on Waste Management Plan for the Project is presented in Chapter 7 of this report.

3.6 Proposed Project Contingency/Emergency Plan

In the event of an emergency, Inner Galaxy Steel Company Ltd.' emergency plan clearly identifies the actions to be taken. This includes communication facilities to be used, the individual responsibilities of key personnel and the procedures for reporting such events to the authorities, and arrangement of logistics for extra labour as may be needed.

The emergency plan is based upon the location and level of the event. This takes care of the possibility of explosion and fire emergency plan. The plan requires that the factory site be designed and facilities put in place in such a manner as to prevent fire outbreak. This plan covers all phases of project development with the inclusion of catchment systems in all designs in order to minimize domino effects.

The contingency plan has been developed from a six-point strategy for environmental protection based on the following parameters:

- Safe working practices.
- Preventive measures to contain operational and accident, and personnel injuries.
- Understanding of the risk.
- An effective emergency response organization with sufficient trained personnel and equipment to deal with the defined threat / hazard.
- A training and maintenance program to ensure an efficient response
- Co-operation with those who may share the risk and can participate in the response.

The emergency plan clearly identifies the actions necessary in the event of an emergency. These include communication network, the individual responsibilities of key personnel and the procedures for reporting to the authorities, and arranging the logistics of extra labour as may be needed. Details on the plan are presented in Chapter 7 (Environmental Management Plan).

3.7 Safety Philosophy

Whilst the risk of significant fire or explosion is high for such an industry, reasonable and practicable measures will ensure the safety of the facility. The following are measures that will be adopted by the proponent.

3.7.1 Implementation of the Principles of Process Safety Management (PSM)

According to United State Occupational Safety and Health Administration (*OSHA*, *1992*) Process Safety Management programs are divided into elements; which are:

Employee Participation: PSM is not a management program that is handed down by management to their employees and contract workers; it is a program involving everyone. The key word in PSM is participation — which is much more than just mere communication. All managers, employees and contract workers are responsible for the successful implementation of PSM. Management must organize and lead the initial effort, but the employees must be fully involved in its implementation and improvement because they are the people who know the most about how a process really operates, and they are the ones who have to implement recommendations and changes. Specifically, PSM is fundamentally a line responsibility.

Process Safety Information: Complete and accurate written information concerning process chemicals, process technology, and process equipment is essential to an effective process safety management program and to a process hazard analysis. The compiled information will be a necessary resource to a variety of users including the team performing the process hazard analysis as required by PSM; those developing the training programs and the operating procedures; contractors whose employees will be working with the process; those conducting the pre-startup reviews; as well as local emergency preparedness planners, and insurance and enforcement officials. The information to be compiled about the chemicals, including process intermediates, needs to be comprehensive enough for an accurate assessment of the fire and explosion characteristics, reactivity hazards, the safety and health hazards to workers, and the corrosion and erosion effects on the process equipment and monitoring tools.

Process Hazards Analysis: A Process Hazard Analysis (PHA), or Process Hazard Evaluation (PHE), is one of the most important elements of the process safety management program. A PHA is an organized and systematic effort to identify and analyze the significance of potential hazards associated with the processing or handling of highly hazardous chemicals. A PHA provides information that will assist employers and employees in making decisions for improving safety and reducing the consequences of unwanted or unplanned releases of hazardous chemicals. A PHA analyzes potential causes and consequences of fires, explosions, releases of toxic or flammable chemicals, and major spills of hazardous chemicals. The PHA focuses on equipment, instrumentation, utilities, human actions (routine and non-routine), and external factors that might affect the process.

Operating Procedures: Operating procedures describe tasks to be performed, data to be recorded, operating conditions to be maintained, samples to be collected, and safety and health precautions to be taken. The procedures need to be technically accurate, understandable to employees, and revised periodically to ensure that they reflect current operations. The process safety information package helps to ensure that the operating procedures and practices are consistent with the known hazards of the chemicals in the process and that the operating parameters are correct. Operating procedures should be reviewed by engineering staff and operating personnel to ensure their accuracy and that they provide practical instructions on how to actually carry out job duties safely. Also the employer must certify annually that the operating procedures are current and accurate.
Operating procedures provide specific instructions or details on what steps are to be taken or followed in carrying out the stated procedures. The specific instructions should include the applicable safety precautions and appropriate information on safety implications. For example, the operating procedures addressing operating parameters will contain operating instructions about pressure limits, temperature ranges, flow rates, what to do when an upset condition occurs, what alarms and instruments are pertinent if an upset condition occurs, and other subjects. Another example of using operating instructions to properly implement operating procedures is in starting up or shutting down the process. Operating procedures and instructions are important for training operating personnel. The operating procedures are often viewed as the Standard Operating Practices (SOPs) for operations. Control room personnel and operating staff, in general, need to have a full understanding of operating procedures. In addition, operating procedures need to be changed when there is a change in the process. The consequences of operating procedure changes need to be fully evaluated and the information conveyed to the personnel. For example, mechanical changes to the process made by the maintenance department (like changing a valve from

steel to brass or other subtle changes) need to be evaluated to determine whether operating procedures and practices also need to be changed. All management of change actions must be coordinated and integrated with current operating procedures, and operating personnel must be alerted to the changes in procedures before the change is made. When the process is shut down to make a change, then the operating procedures must be updated before starting the process.

Employee Training: All employees, including maintenance and contractor employees involved with highly hazardous chemicals, need to fully understand the safety and health hazards of the chemicals and processes they work with so they can protect themselves, their fellow employees, and the citizens of nearby communities. Training informs employees about the chemicals they work with and familiarize them with reading and understanding Material Safety Data Sheets (MSDSs). However, additional training in subjects such as operating procedures and safe work practices, emergency evacuation and response, safety procedures, routine and non-routine work authorization activities, and other areas pertinent to process safety and health need to be covered by the employer's training program. In establishing their training programs, employers must clearly identify the employees to be trained, the subjects to be covered, and the goals and objectives they wish to achieve. The learning goals or objectives should be written in clear measurable terms before the training begins. These goals and objectives need to be tailored to each of the specific training modules or segments.

Contractors: Employers who use contractors to perform work in and around processes that involve highly hazardous chemicals have to establish a screening process so that they hire and use only contractors who accomplish the desired job tasks without compromising the safety and health of any employees at a facility. In addition, the employer must ensure that the contractor has the appropriate job skills, knowledge, and certifications (e.g., for pressure vessel welders). Contractor work methods and experience should be evaluated. Considering that contractors often perform very specialized and potentially hazardous tasks, such as confined space entry activities and non-routine repair activities, their work must be controlled while they are on or near a process covered by PSM. A permit system or work authorization system for these activities is helpful for all affected employers. The use of a work authorization system keeps an employer informed of contract employee activities.

Pre-Startup Safety Review: For new or modified processes, the employer must fully evaluate the initial startup procedures and normal operating procedures before the pre-startup review to ensure a safe transfer into the normal operating mode. For existing processes that have been shut down for turnaround or modification, the employer must ensure that any changes other than "replacement in kind" made to the process during shutdown go through the management of change procedures. Piping and Instrumentation Diagrams (P&IDs) will need to be updated, as necessary, as well as operating procedures and instructions. If the changes made to the process during shutdown are significant and affect the training program, then operating personnel as well as employees engaged in routine and non-routine work in the process area may need some refresher or additional training.

Mechanical Integrity of Equipment: Equipment used to process, store, or handle highly hazardous chemicals has to be designed, constructed, installed, and maintained to minimize the risk of releases of such chemicals. This requires that a mechanical integrity program be in place to ensure the continued integrity of process equipment. Elements of a mechanical integrity program include identifying and categorizing equipment and instrumentation, inspections and tests and their frequency; maintenance procedures; training of maintenance personnel; criteria for acceptable test results; documentation of test and inspection results; and documentation of manufacturer recommendations for equipment and instrumentation.

Management of Change (MOC): To properly manage changes to process chemicals, technology, equipment and facilities, one must define what is meant by change. In the process safety management standard, change includes all modifications to equipment, procedures, raw materials, and processing conditions other than "replacement in kind." These changes must be properly managed by identifying and reviewing them prior to implementing them. For example, the operating procedures contain the operating parameters (pressure limits, temperature ranges, flow rates, etc.) and the importance of operating within these limits. While the operator must have the flexibility to maintain safe operation within the established parameters, any operation outside of these parameters requires review and approval by a written management of change procedure. Management of change also covers changes in process technology and changes to equipment and instrumentation. Changes in process technology can result from changes in production rates, raw materials, experimentation, equipment unavailability, new equipment, new product development, change in catalysts, and changes in operating conditions to improve yield or quality. Equipment changes can be in materials of construction, equipment specifications, piping pre-arrangements, experimental equipment, computer program revisions, and alarms and interlocks.

Incident Investigation: Incident investigation is the process of identifying the underlying causes of incidents and implementing steps to prevent similar events from occurring. The intent of an incident investigation is for employers to learn from past experiences and thus avoid repeating past mistakes. The incidents that one expects employers to recognize and to investigate are the types of events that resulted in or could reasonably have resulted in a catastrophic release. These events are sometimes referred to as "near misses," meaning that a serious consequence did not occur, but could have. Employers must develop in-house capability to investigate incidents that occur in their facilities. A team should be assembled by the employer and trained in the techniques of investigation including how to conduct interviews of witnesses, assemble needed documentation, and write reports. A multi-disciplinary team is better able to gather the facts of the event and to analyze them and develop plausible scenarios as to what happened, and why. Team members should be selected on the basis of their training, knowledge and ability to contribute to a team effort to fully investigate the incident.

Emergency Preparedness: Each employer must address what actions employees are to take when there is an unwanted release of highly hazardous chemicals. Emergency preparedness is the employer's third line of defense that will be relied on along with the second line of defense, which is to control the release of chemical. Control releases and emergency preparedness will take place when the first line of defense to operate and maintain the process and contain the chemicals fails to stop the release. In preparing for an emergency chemical release, employers will need to decide the following:

- Whether they want employees to handle and stop small or minor incidental releases;
- Whether they wish to mobilize the available resources at the plant and have them brought to bear on a more significant release;
- Whether employers want their employees to evacuate the danger area and promptly escape to a preplanned safe zone area, and then allow the local community emergency response organizations to handle the release; or
- Whether the employer wants to use some combination of these actions.

Employers, at a minimum, must have an emergency action plan that will facilitate the prompt evacuation of employees when there is an unwanted release of a highly hazardous chemical. This means that the employer's plan will be activated by an alarm system to alert employees when to evacuate, and that employees who are physically impaired will have the necessary support and assistance to get them to a safe zone. The intent of these requirements is to alert and move employees quickly to a safe zone.

Compliance Audits: An audit is a technique used to gather sufficient facts and information, including statistical information, to verify compliance with standards. Employers must select a trained individual or assemble a trained team to audit the process safety management system and program. A small process or plant may need only one knowledgeable person to conduct an audit. The audit includes an evaluation of the design and effectiveness of the process safety management system and a field inspection of the safety and health conditions and practices to verify that the employer's systems are effectively implemented. The audit should be conducted or led by a person knowledgeable in audit techniques who is impartial towards the facility or area being audited. The essential elements of an audit program include planning, staffing, conducting the audit, evaluating hazards and deficiencies and taking corrective action, performing follow-up and documenting actions taken.

Hot Work: Hot work is any process that can be a source of ignition when flammable material is present or can be a fire hazard regardless of the presence of flammable material in the workplace. Common hot work processes are welding, soldering, cutting and brazing. When flammable materials are present processes such as grinding and drilling become hot work processes. The hot work permit provides a step-by-step check list for hot work fire safety and serves as a reminder to contractors of their fire prevention responsibilities before, during, and after any hot work is conducted. A permit must be issued for hot work operations conducted on or near a covered process. The permit must be kept on file until completion of the hot work.

3.8 Decommissioning approach and Environmental Rehabilitation Plan

Site Clean up

Upon completion of the construction/installation and pre-commissioning tests of the proposed TL project, all work sites shall be thoroughly cleaned with the complete dismantling and removal of every temporary facility. In addition, de-vegetated areas that are not required for operations and maintenance works shall be re-vegetated

Site Decommissioning

Equipment and structures that are certified safe will be reused. The transmission line and facilities shall be decommissioned and abandoned in accordance with FMENV Guidelines for infrastructures with particular reference to power transmission lines as at the time of decommissioning. The transmission wires, towers and substation facilities shall be dismantled and removed from positions. Adequate re-vegetation shall also be carried out along the transmission route, access roads and substations where applicable.

Generally, decommissioning activities shall be planned and executed with a combined team to be drawn from FMEnv, MMSD, TCN, Inner Galaxy Steel Company Ltd. and other relevant bodies and/or as practiced during the time of decommissioning.

Project/Facility Decommissioning

The life span of the facility is expected to be fifty (50) years. At the end of the project life the following decommissioning and abandonment plan shall be adopted.

- The project shall be disconnected from all sources of water.
- All vessels containing water and other chemicals shall be vented for safe dismantling.
- Stored materials and useful components shall be removed for reuse or sale.
- A competent contractor shall be appointed to undertake dismantling, demolition and disposal. Disposal of all waste materials shall be through authorized routes.
- The surface water drainage system will continue to operate throughout the decommissioning phase.
- The site shall be leveled and left without any environmental risk.
- The Environmental Regulators shall inspect the site and certify compliance with statutory site abandonment procedures.

Site Reclamation after Completion

After completion of all construction works all temporary structures, laydown areas, temporary roads, temporary drains and ditches, etc. shall be removed. Material used for these structures shall be recycled or disposed off. Temporary erosion controls shall be maintained (or replaced if necessary) until vegetation covers approximately 70% of disturbed areas.

After the site has been cleared of construction material and other debris, topsoil shall be reapplied and watered. Where subsoil's are severely compacted, the underlying layers shall be loosened or scarified with a plough or rake before applying topsoil. Re-vegetation plan shall be based on federal, state, and local guidelines and specifications for site stabilization.

The effectiveness of the reclamation work will be evaluated after initial seeding and when planting works are finished. Areas where seeding is not effective or where further planting works are required will be identified and remediated also.

3.9 Project Schedule

See Table 3.1 below, as outlined project execution schedule incorporating the following as a minimum; as detailed in **Section 3.3: Project Scope of Work/Sequence of Activities.**

The proposed transmission line construction shall be completed within 36 months. A Gnatt chart showing a schedule of activities for the project is shown in Figure 3.2 below.

The 2nd phase of the project life solely depend on the output from the 1st phase of operational activities.

Table 3.1 GANTT CHART (Project Implementation Plan) for Steel-Manufacturing

	Timeline	Jun-Aug 2015				Sept –Dec 2015					Jan-Aug 2016				Sept-Dec 2016			
	Months	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1	Contract award / signing																	
2	Inception meeting / project planning																	
3	Literature Review/desktop search																	
4	Fieldwork Plan/Mobilization																	
5	Field Sampling/ Field Work Report																	
6	Draft report																	
7	EIA approval process																	
8	Site Preparation																	
9	Operational test-running: *Manufacture of Steels*																	

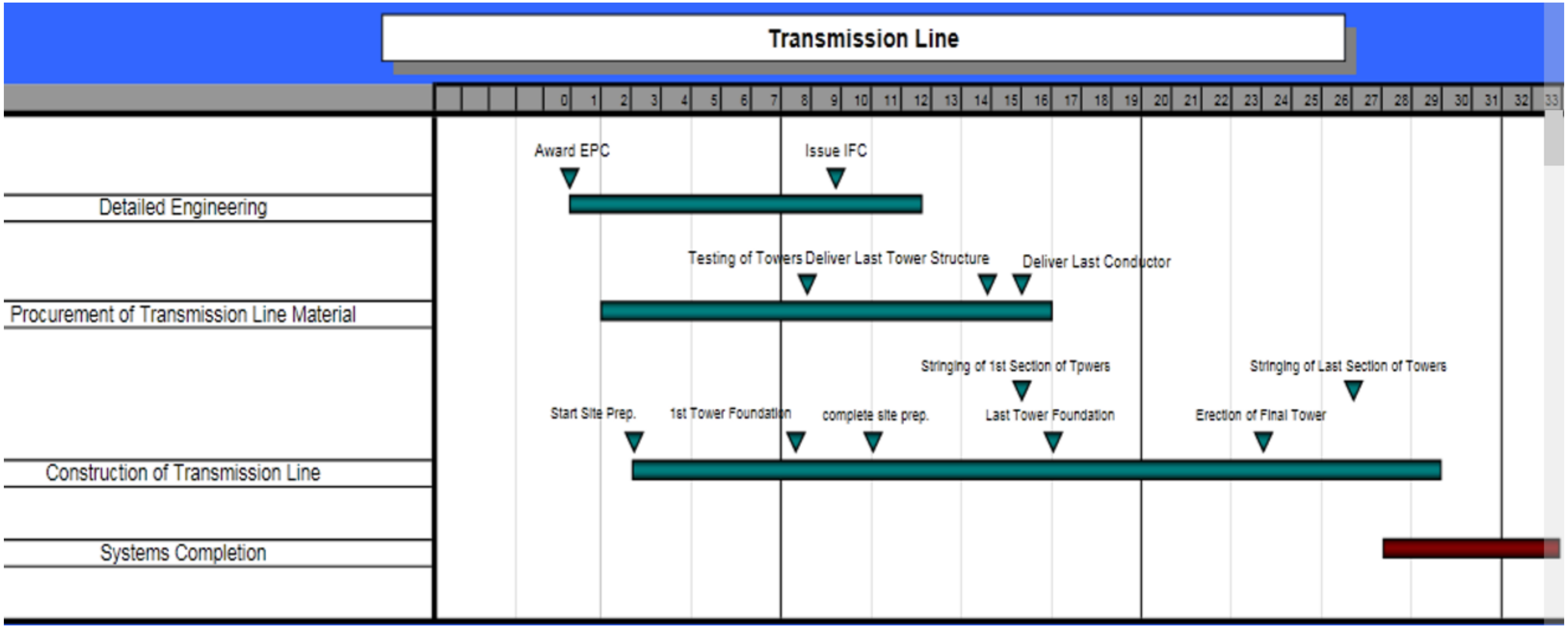


Figure 3.2: Project Schedule for the Transmission Line

CHAPTER FOUR
DESCRIPTION OF EXISTING ENVIRONMENTAL CONDITIONS

4.1 Introduction

The existing environmental condition (physico-chemical, biological, socio-economic and health) characteristics of the proposed project area are herein presented. The environmental characteristics are required to establish the existing environmental status of the proposed project area and also serve as a reference data for future studies and environmental monitoring. The data will also be used as a baseline for which the anticipated impacts of the proposed project would be determined for appropriate mitigation measures to be put in place.
The summary of existing conditions presented in this chapter is based on information from literature as well as findings of a two season field sampling programme, laboratory analyses and socio-economic and health surveys specifically for this EIA. The data acquired will be used in the project design, operation and in making general management decisions as well as in the assessment of the potential and associated impacts of the proposed project activities on the host environment (ecological and socio-economic).

This Chapter describes all relevant physical, chemical, biological, economical, social and cultural factors existing in the project area, against which subsequent changes can be detected through monitoring. In order to identify the potential impact and changes to the natural and socioeconomic environments, it is essential to have a thorough understanding of the nature of the existing environment prior to commencement of the proposed project activities. This translates as a need to characterize the existing baseline environmental and socioeconomic conditions including establishing the prevailing conditions for a range of media through primary monitoring, undertaking focused surveys and the collection of secondary information from various published sources. All baseline data have been gathered in such a way that the importance of the particular area to be affected can be placed in the context of the region or surroundings and that the effects of the proposed changes can be predicted.

It is important after the scoping exercise to measure the baseline levels of those environmental parameters which are likely to be affected by the project. Thus, the planning of the baseline survey should flow naturally from the short-list of impacts which is the output of the scoping exercise. Thus, the exhaustive inventories of the geology, soils and of all plant and animal species in the project area which may not be necessary can be avoided.

This baseline study is not confined to an inventory of the main components within the environment rather it was developed through the study of existing documents, and where existing data were not relevant or incomplete, they were complemented by conducting field survey. Existing data in form of maps, reports, studies, research papers etc. were obtained from governmental departments including the Federal Ministry of Environment (FMEnv), Ministry of Mines and Steel Development (MMSD), National Environmental Standards and Regulations Enforcement Agency (NESREA), Abia State Environmental Protection Agency, Universities, Research Institutes, and even Non-Governmental Organization (NGOs).

4.2 Methodology of Baseline Data Acquisition

A multi-disciplinary approach was employed in the acquisition of environmental conditions data of the proposed project area. The environmental condition for the proposed project was obtained through desktop research, field observation, sampling and measurements as well as laboratory analyses of biological, chemical and physical characteristics of sampled environmental components.

Baseline data acquisition involved a multidisciplinary approach and was executed within the framework of Richflood International Limited (RIL) management system approach. Elements of this approach include literature research, designing and development of field sampling strategy to meet regulatory requirements; confirmation of the sampling design and locations by Inner Galaxy Steel Company Ltd; pre-mobilization activities (job hazard analysis, sampling equipment/materials calibrations and checks) and mobilization to field; fieldwork implementation, sample collection (including field observations), handling, documentation and storage protocols and procedures, demobilization from field, transfer of sample custody to the laboratory for analysis.

A detailed description of baseline data acquisition ***including pictures of sample collection*** and handling methodologies are presented in **Appendix A**.

4.2.1 Desktop and Literature Research

Desktop research involved a detailed search of relevant textbooks, research publications, and journal articles. The demographic pattern and wildlife characteristics were also complemented with information acquired from relevant literature. The data generated from this process include maps, demographic data, and meteorological data of the area.

Literature research was carried out in order to obtain relevant background information on the soil, water, and air of the study area. Further research was also conducted at the end of the field data gathering exercise in order to compare literature information with generated field data and for additional information on the study area. Generally, literature research involved consulting relevant environmental management/EIA textbooks, researches in environmental issues as well as technical presentations. Specific examples of previous EIA studies consulted in generating *relative project-based data* for describing the existing environment of the project area include: *Environmental Impact Assessment of PHCN's 58km QIT – Ikot Abasi Transmission Line (2012): Fugro Nigeria Limited.*

4.2.2 Environmental Reconnaissance Field Survey/Site Visit

A field reconnaissance visit was carried out to the project area and host communities (Ahala Ukwu Village, Umuahala Community, Obuzor Ukwu Autonomous, and Umuacheke, Umuigwe / Umuogogo Community, Isimiri Umuorie Autonomous) by the EIA study team lead to firm up sampling strategies, identifies representatives of the host communities that will join the team as local labour and identify options for logistic planning in order to have a hitch-free field campaign. The consultation process that has started at this reconnaissance visit will be maintained throughout the various phases of the study and project execution.

In order to effectively characterize the ecology of the study area, a two season comprehensive field data gathering exercise was carried. ***The wet season field exercise was carried out on the 27th to 29th of October, 2015, while the dry season field exercise was on the 25th to 27th of February, 2016.***

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

4.2.3 Sample-Collection Methodology and Preservation

In a bid to capture sufficient environmental data to enable a good impact assessment afterwards, sampling strategic plan based on considerations which include, but not limited to: sampling to obtain baseline data on the specific environment of the study area and sampling strategy that will allow for good coverage of the study area was adopted.

The study team was grouped into separate sub-teams for the various aspects of the field data gathering exercise. The different sub-teams were;

(a) Soil sampling/biodiversity (vegetation and wildlife) study team
(b) Socio-economics/Health Risks study team
(c) Surface water /Sediment studies team
(d) Air Quality and Meteorological Study team, and
(e) Geology and Hydrogeology study team.

Field assistants/guides (local labour) were also engaged to assist the different sub-teams. Detailed methodologies of field data gathering are presented in ***Appendix A.***

A multi-disciplinary approach was employed in the acquisition of environmental baseline data of the project area. The environmental baseline data for the EIA Study of the project was obtained through desktop research, field observation, sampling and measurements as well as laboratory analyses of biological, chemical and physical characteristics of sampled environmental components. The demographic pattern and wildlife characteristics were also complemented from information acquired from literature, relevant textbooks, research publications and articles, questionnaires distributed and Focus Group Discussions

(FGD). The data generated from this process include maps, demographic data, and meteorological data of the area.

The DPR recommended methods of sample preservation shown in Table 4.1 below were adopted. Samples were transferred into proper preservation containers and transported to the laboratory where they were placed in freezers for chemical analysis. These freezers were set to recommended temperature levels and in refrigerator for microbiological analysis. All samples were analyzed for using international standards and procedures approved by the Federal Ministry of Environment.

Table 4.1: DPR Recommended Preservatives for Various Constituents adopted by Richflood International Ltd.

S/N	PARAMETER	REQUIRED VOLUME (ml)	CONTAINER	PRESERVATION	MAXIMUM HOLDING PERIOD
1	pH	35	P,G	Cool 4^{o}C Detect On site	6 Hours
2	Electrical Conductivity	100	P,G	Cool 4^{o}C	24 Hours
3	Colour	50	P,G	Cool 4^{o}C	24 Hours
4	Odour	200	P,G	Cool 4^{o}C	24 Hours
5	Turbidity	100	P,G	Cool 4^{o}C	7 Days
6	Total Dissolved Solids (TDS)	50	P,G	Filter on site Cool 4^{o}C	24 Hours
7	Total Suspended Solids (TSS)	50	P,G	Filter on site	6 Months
8	Total Hardness	100	P,G	Cool 4^{o}C HNO_3 to pH<2	7 Days
9	Acidity and Alkalinity	100	P,G	Cool 4^{o}C	24 Hours
10	Salinity as CI	50	P,G	None Required	7 Days
11	Chemical Oxygen Demand (COD)	50	P,G	2ml H_2SO_4 per liter	7 Days
12	Biological Oxygen Demand (BOD)	1000	P,G	Refrigeration at 4^{o}C	6 Hours
13	Surfactants as (MB AS)	250	P,G	Cool 4^{o}C	24 Hours
14	Dissolved Oxygen (DO)	300	G only	Detect on site	No Holding

15	Ammonia	400	P,G	Cool 4°C H_2SO_4 to pH<2	24 Hours
16	Oil & Grease	1000	G only	Cool 4°C H_2SO_4 or HCL to pH<2	24 Hours
17	Nitrate (NO_3)	100	P,G	Cool 4°C H_2SO_4 to pH<2	24 Hours
18	Sulphate (SO_4^{2})	50	P,G	Cool 4°C	7 Days
19	Carbonate (CO_3) free CO_2 & HCO_3	-	P,G	-	-
20	Cyanides	500	P,G	Cool 4°C NaOH to pH 12	24 Hours
21	Phosphorus	-	-	40mg, $HgCl_2$ per liter 4°C	7 Days
22	Phenolics	500	G only	Cool, 4°C, H_2PO_4 to pH<4.1g $CuSO_4$/litre	24 Hours
23	Chromium	100	P,G	HNO_3 to pH<2	-
24	Arsenic	100	P,G	-	6 Months
25	Cadmium	100	P,G	-	6 Months
26	Cobalt	-	P,G	-	6 Months
27	Copper	-	P,G	-	6 Months
28	Iron	-	P,G	-	6 Months
29	Mercury	100	P,G	Filter, HNO_3 to pH<2	38 Days (Glass)
30	Lead	100	P,G	HNO_3 to pH<2	6 Months
31	Nickel	100	P,G	-	6 Months
32	Zinc	100	P,G	-	6 Months
33	Vanadium	100	P,G	-	6 Months
34	Calcium	100	P,G	None Required	7 Days
35	Magnesium	100	P,G	-	6 Months

Where P = Plastic and G = Glass

Source: DPR, 2002

4.2.4 Geographical Positioning

Positioning at each sampling station during the fieldwork activities was achieved with the aid of a hand held *Garmin* Global Positioning System (GPS) V, (model CZ 99052-20). At each sampling station, coordinates at which sampling actually took place were documented as presented in the Table (4.2) below*; with details attached in Appendix B.*

Table 4.2: Geo-Referenced Sample-Coordinates from the Project-Location *(during Field Survey/Site-Visit, Feb.2016)*

SAMPLES	LOCATION DESCRIPTION	COORDINATES		ELEVATION (m)
		LATITUDE (N)	LONGITUDE (E)	
		AIR QUALITY		
AQ_1	Point 1 (Entrance Gate)	N 04^0 53.951'	E 007^0 14.433'	8.8
AQ_2	Point 2 (Administrative Block)	N 04^0 53.858'	E 007^0 14.487'	21.4
AQ_3	Point 3 (Equipment Storage Store)	N 04^0 53.903'	E 007^0 14.515'	16.9
AQ_4	Point 4 (Beside Rolling Mill Section)	N 04^0 53.077'	E 007^0 14.662'	18.0
AQ_5	Point 5	N 04^0 53.999'	E 007^0 14.867'	16.0
AQ_6	Point 6	N 04^0 53.935'	E 007^0 14.937'	14.9
AQ_7	Point 7 (Angle Tower)	N 04^0 53.879'	E 007^0 14.060'	14.3
AQ_8	Point 8 (Tower 3)	N 04^0 53.854'	E 007^0 14.162'	10.8
AQ_9	Point 9	N 04^0 53.825'	E 007^0 14.258'	12.2
AQ_{10}	Point 10	N 04^0 53.732'	E 007^0 14.240'	8.2
AQ_{11}	Point 11	N 04^0 53.728'	E 007^0 14.102'	22.4
AQ_{12}	Point 12	N 04^0 53.757'	E 007^0 14.099'	10.7
AQ_{13}	Point 13	N 04^0 53.786'	E 007^0 14.039'	19.1
AQ_{14}	Point 14	N 04^0 53.885'	E 007^0 14.960'	15.5
AQ_{15}	Point 15	N 04^0 53.929'	E 007^0 14.874'	13.3
AQ_{15}	Point 16 (Control I)	N 04^0 54.404'	E 007^0 13.874'	30.9
AQ_{15}	Point 17 (Control II)	N 04^0 55.167'	E 007^0 15.558'	33.5
AQ_{15}	Point 18 (Control III)	N 04^0 54.380'	E 007^0 15.332'	29.0
		GROUND WATER		
GW_1	(Borehole) Inner Galaxy Steel Co. Limited	N 04^0 53.829'	E 007^0 14.495'	4.1
GW_2	(Bore hole) Ahala ukwu Community	N 04^0 53.397'	E 007^0 14.842'	29.8

GW_3	(Bore hole) Umuacheke Community CONTROL	N 04^0 55.167’	E 007^0 15.558’	33.5
SURFACE WATER				
SW_1	(Upstream Lake)	N 04^0 53.847’	E 007^0 14.276’	4.8
SW_2	(Downstream Lake)	N 04^0 53.938’	E 007^0 14.958’	13.2
SW_3	(Amulo Stream) Upstream	N 04^0 53.118’	E 007^0 14.940’	13.0
SW_4	(Amulo Stream) Downstream	N 04^0 53.087’	E 007^0 14.968’	13.4
SW_5	Uzozo Stream-Upstream	N 04^0 54.268’	E 007^0 14.911’	21.5
SW_6	Uzozo Stream-Downstream	N 04^0 54.260’	E 007^0 14.910’	28.9
SOIL SAMPLE				
SS_1	Point 1 (Entrance Gate)	N 04^0 53.951’	E 007^0 14.433’	8.8
SS_2	Point 2 (Administrative Block)	N 04^0 53.858’	E 007^0 14.487’	21.4
SS_3	Point 3 (Equipment Storage Store)	N 04^0 53.903’	E 007^0 14.515’	16.9
SS_4	Point 4 (Beside Rolling Mill Section)	N 04^0 53.077’	E 007^0 14.662’	18.0
SS_5	Point 4 (Beside Rolling Mill Section)	N 04^0 53.999’	E 007^0 14.867’	16.0
SS_6	Point 5	N 04^0 53.935’	E 007^0 14.937’	14.9
SS_7	Point 7 (Angle Tower)	N 04^0 53.879’	E 007^0 14.060’	14.3
SS_8	Point 8 (Tower 3)	N 04^0 53.854’	E 007^0 14.162’	10.8
SS_9	Point 9	N 04^0 53.825’	E 007^0 14.258’	12.2
SS_{10}	Point 10	N 04^0 53.732’	E 007^0 14.240’	8.2
SS_{11}	Point 11	N 04^0 53.728’	E 007^0 14.102’	22.4
SS_{12}	Point 12	N 04^0 53.757’	E 007^0 14.099’	10.7
SS_{13}	Point 13	N 04^0 53.786’	E 007^0 14.039’	19.1
SS_{14}	Point 14	N 04^0 53.885’	E 007^0 14.960’	15.5
SS_{15}	Point 15	N 04^0 53.929’	E 007^0 14.874’	13.3
SS_{16}	Point 16 (Control I)	N 04^0 54.404’	E 007^0 13.874’	30.9
SS_{17}	Point 17 (Control II)	N 04^0 55.167’	E 007^0 15.558’	33.5

SS_{18}	Point 18 (Control III)	N 04^0 54.380’	E 007^0 15.332’	29.0
VEGETATION STUDY				
VEG_1	Point 1	N 04^0 53.878’	E 007^0 14.060’	15.7
VEG_2	Point 2	N 04^0 53.854’	E 007^0 14.162’	11.3
VEG_3	Point 3	N 04^0 53.759’	E 007^0 14.097’	12.3
VEG_4	Point 3	N 04^0 53.931’	E 007^0 14.874’	14.4

KEY: AQ= Air Quality, SW= Surface Water, GW= Ground Water, SS=Soil Sample, VEG= Vegetation.

Source: Richflood Field Works, 2016

4.2.5 Air Quality and Meteorological Study

The level of air pollutants, such as CO_2, NO_x, SO_x, etc. in the project area was assessed. The emission of gaseous pollutants in the air is measured by the Study-team with the aid of equipment (digital hand-held) specified for sampling/analysis of air quality parameters; as well as taking the readings of the meteorological data in the project area.

The climate and meteorology (weather) conditions study of the proposed project/study area was carried out in two phases: macro- and micro-climatic data.

The Ambient Air Quality Study was collected from ten (10) sample-distribution points. Noise level was also monitored, from same sample points.

The Table below shows the list of Equipment used for the studies/field survey exercise.

Table 4.3: List of Specific *(Field-work Sampling)* Equipment

S/N	ENVIRONMENTAL COMPONENT/ PARAMETER MEASURED	EQUIPMENT-MODEL/ METHODOLOGY
1	Air Quality Parameters *(NO_2, SO_2, H_2S, NH_3, O_2, NO, CO)*	Altair 5X Multi Gas Detector
1.1	CO_2 Measurement Reading	EXTECH EasyView 80 CO_2 Analyzer
2	Noise Monitoring *(at different time intervals)*	EXTECH Sound Level Meter
3	Meteorological Data-Readings (of Wind speed, RH%, Temperature, etc.)	Digital Air Flow Meteorological Meter, Model AM-4208 MEXTECH Microprocessor handheld Digital Anemometer

4	Water Sample Insitu Analysis *for PH, TDS, Temperature and Conductivity* readings	EXTECH (Conductivity, Salinity, TDS) Meter and Hanna Waterproof pH Meter; and Use of Sterile McCartney bottles
4.1	Dissolved Oxygen	Model DO-5509 LUTRON Dissolved Oxygen Meter
5	Soil sample collection	Soil auger
5.1	Insitu Analysis/Readings for Soil sample	Model HI-145 HANNA Soil Temperature Meter
6	Geo-Referenced Coordinates of all sampling/station points	Garmin GPS 72H Meter
7	Vegetation, Land use/cover, Fauna/Wildlife	Transects, key informant interviews, Focus Group Discussion (FGD), Direct observations, and Environmental baseline survey from existing literature
8	Socio-economics and Health studies	Key informant interviews, FGD, direct observation, Administration of structured questionnaires, physical examination of volunteers, Walk-through survey and collection of secondary data

4.2.6 Water Sampling/Methodology

At specified sampling station, water samples were collected, in compliance to TOR' stated number of sample-collection. Six (6) samples of Surface water was collected from a (2km away) stream in the project locality; and Three (3) samples of Ground water were collected from host-community's borehole water-source. Samples were collected using a two-litre plastic container that have been pre-treated by washing in dilute hydrochloric acid and rinsed with distilled water. At the sample collection point the plastic container was rinsed with the relevant sample to be collected. Water samples were taken by submerging the container below the surface and allowing it to overflow. The samples for heavy metals studies were preserved with nitric acid. Samples for hydrocarbon analysis were collected in glass bottles. Samples for microbiological analysis were collected in sterile glass bottles and stored in ice-packed containers and in the refrigerator.

The groundwater samples were collected in clean new plastic bottles for physico-chemical analysis. Samples for microbiological analysis were collected in Mc Cartney bottles while samples for heavy metals were collected in glass bottles acidified with concentrated sulphuric acid. After each collection, the container lid was replaced immediately to avoid oxygen contamination.

Precisely, samples for the determination of physico-chemical parameters were collected into plastic bottles after rinsing with portion of the water samples to be collected. The sample containers were well corked and placed in ice chest for transportation to the laboratory. Samples for the determination of heavy metals were collected in plastic bottles after rinsing with portions of the water samples. Samples for microbiology were placed in sterile McCartney bottles. The samples were stored/preserved in Lab-specified containers in an ice-packed cooler and transported to Richflood Laboratory for analysis, with Quality Assurance procedures; in accordance with the Federal Ministry of Environment for ex-situ analysis. Global Positioning System (GPS) was used to locate the coordinates of the sampling points, as presented in table 4.2 above.

In- Situ Analysis: During the field work, fast changing parameters (pH, dissolved oxygen (DO), total dissolved solids (TDS), temperature, electrical conductivity (EC) and turbidity) were sampled/analyzed in the surface and ground water samples.
See detailed sample-analysis/lab result of samples and parameter-description of the water quality at subsequent section of this chapter.

4.2.7 Soil Sampling/Methodology

Field protocols were carried out to meet the needs of the baseline study and for information that were adequate and suitable for achieving valuable results.
The major considerations for soil sample distribution and sampling pattern were:

- Adequate coverage of representative and/or probable soil morphological types within the study area;
- Capturing the possible effects of existing land use patterns on soil environment; &
- Establishing the potential impact (s) of the operation of the project on the soil environment, including the land use patterns in the area.

From the field sampling plan, which was based on the facility map and reconnaissance visit to the area, a total of about fifteeen (15) soil sample stations were established, spreading within and around the project location. At each of the sample stations (SS) and soil depth level, the soil samples were bulked together to give a composite sample. The soil samples from different sample stations and soil depth levels were, on each occasion, collected in polythene bags and labeled accordingly. Samples for physico-chemical analysis shall be collected into coded plastic bags, while glass containers with screw cap, lined with Teflon and sterile plastic bottles were used to collect samples for microbiology analysis respectively. Soil samples for microbiological analyses were collected in sterilized aluminium foils and preserved in iced cooler and transported to the laboratory.

4.2.8 Vegetation Study

Assessment of the vegetation around the project area was carried out in four (4) transects. The transects were also orientated such as to increase the probability of including most plants occurring in the area. To facilitate vegetation monitoring in future and assess magnitude of change due to the project, efforts were made to locate transects in sites where the impacts are likely to be felt and close to the soil sampling stations. All plant species found along each transect were as much as possible identified, counted and listed in the field. Taxonomically difficult forms (which could not be immediately identified with certainty) were collected, properly labelled, pressed and subsequently transported to the Laboratory for further keying and identification.

Vegetation study of the study area was carried out by taking a walk round the site and its environment. Stopovers were made at 50m intervals for closer survey. Plant species were carefully observed and identified. The objective of these is to ascertain vegetation types available in the site and identify economic trees/plants. The assessment of the vegetation types found in the area are as detailed in subsequent chapter/section of this document.

4.2.9 Fauna Study

Investigations into the wildlife species resident around the project area were conducted using a combination of conventional methods. The combinations of techniques are considered quite appropriate, since the major objective was to provide a comprehensive checklist of wild animals’ characteristic by the area and highlight their conservation status. The methods fall into two major categories. (a) Indirect method namely: (i) Interview technique which involves interacting with indigenous hunters and peasant farmers who are conversant with the terrain, wildlife habitat and diversity. (ii) Use of evidence of animal presence or occupation. (b) Direct Method which involves direct search of animals in the area under question to physically spot them, either by probing their habitat, hide outs, and/or using binoculars to locate and identify them.

As at the time of this audit, there was no evidence of wildlife in the study area; this could be as a result of the *gradual/selective* land clearing at the study area, as wildlife tend to withdraw from areas with no vegetation, or with human population and sound effect.
However, the mixture of forest and grassland provide habitat for a range of species like large mammals as well as more localised species including athropods. Literature reviews some expected fauna at project area, as detailed in subsequent section of this report.

4.2.10 Socio-economic and Health Studies

Socio-economic information is also a very important aspect of gathering baseline data and the EIA studies. The socio-economic aspect of the EIA elucidates the impact of the project on the host community in terms of economic conditions of the members of the host community. The targets of interests include those socio-economic receptors in the host community which are sensitive to perturbation or impact from the operation of the project. These receptors are usually considered fundamental to the survival and quality of life of the people who live in the area. Consequently, socio-economic elements for investigation as related to the EIA studies include but not limited to the following concerns:

- Identification of settlements, permanent or temporary in the area;
- The population of the members of the area;
- The occupation and thus source of income of the people;
- Farmlands, fishing areas, ranches, workshops, etc from where the people depend for their livelihood;
- Available infrastructures in the areas, including their status and capacities;
- Identification of welfare services/facilities provided by operating industrial concerns in the project environment;
- Health facilities in the area; and
- The peoples’ perceptions of the Project.

Pictures of Consultations, briefings, meetings, FGDs, and Questionnaire administration are presented in Appendix E.

4.2.11 Quality Assurance and Quality Control (QC) Measures

The integrity of ecological baseline data is significantly dependent on the quality control and assurance measures put in place and implemented by resource persons involved in carrying out the representative field data sampling and laboratory/statistical analysis of the samples. All field sampling methods and procedures followed international standards and as stipulated by the environmental regulatory body *(Federal Ministry of Environment)*. The following quality control measures were embarked upon by the company resource persons while carrying out the field and laboratory work.

Field work QC:

Specific mechanisms of QC adopted include:

- Establishment of a station numbering system and pre-labeling of all samples holding containers, prior commencement of field work
- Design and use of appropriate fieldwork recording forms
- Establishing criteria for accuracy of positioning requirements
- Duplicate samples: one duplicate sample was taken for each of the field.
- Calibration of field equipment: All field equipment (except for new ones) were calibrated at the beginning of the measurements (initial calibration)
- Daily meeting was held at each day to assess progress and performance (in the morning prior to work commencement and in the evening at the completion of each day's work).
- Chain of custody document was prepared for each sample starting from the field to final analyses in the laboratory.

In soil sampling;

- A stainless steel soil auger and Munsell soil colour chart were used to collect and describe soil samples.
- Soil samples were collected in properly labeled black polythene bags, aluminium foils, and core samplers and properly stored.
- Soil samples for microbiology (MCB) and oil and grease analysis were kept in ice-filled coolers before transportation to the laboratory for analysis.

In Air Quality and Noise Level sampling:

- Calibration status of the equipment was ascertained before usage.
- Also measurements were made at approximately 1.5m above the ground and away from buildings.
- A new battery was loaded into the meter.
- Sampling points were taken at safe distances in open spaces and from the individual carrying out measurement to prevent reflections.
- Several samples were taken at each sampling location to reduce errors.

Data Quality Management:

To ensure preservation of the integrity of data collected, data coding forms for use in the field were designed in such a way that field data could be directly entered into computer data sheets. Since the analysis may be required in legal proceedings, it is essential to establish sample authenticity. Samples must be properly sealed and labelled. All data collected were labelled and the following information provided among others:

- Identification code or sample number
- Date and time of sampling
- Description of sample
- Methods of sampling
- Particulars of any photographs taken

4.2.12 Health, Safety, Environment (HSE) Management System at Field work:

Prior to the field study, all personnel were certified medically fit to embark on the field study. A well stocked first aid box and a certified first aider was also handy in the field in case of minor injuries in the field, prior to onward referent to the retainer-ship clinic. A bus was the field vehicle used by the personnel in carrying out the field work.

All personnel were properly kitted in their working and protective gear. Safety briefings were also given by the company's safety officer every morning prior to the commencement of field sampling. All personnel were intimated not to litter the environment, and not to dabble into community issues that do not concern them. Personnel were advised to always work in pairs and should avoid being alone. There were no incidences of near misses or injuries throughout the period of the field work.

4.2.13 Laboratory Analysis

After the fieldwork exercises, study samples were transported to Richflood Laboratory, Abuja for necessary and adequate analyses. Samples were analyzed using standard analytical methods (DPR, 2002; APHA, 1982). The synoptic descriptions of the laboratory analytical methods and procedures employed for the various physical, chemical and biological parameters as well as the detection limits of these parameters are documented in this report. Also documented are synopsis of the QHSE plan adopted in both field data collection and laboratory analysis.

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

Other QA/QC measures adopted are:

- the use of trained personnel at all phases of the study;
- written analytical standard operating procedures were followed during analyses and
- routine auditing and checking of analyses results, including control solutions and midpoint standards, were introduced into every batch or ten samples as applicable.

A summary of data collection and analytical methods together with test equipments employed for the study are shown in Table 4.4 below, while discussions and details are provided in *Appendix C*.

Table 4.4: Method of Analysis, Richflood Lab –Inner Galaxy Test Methodology

PARAMETER	METHOD
PHYSICOCHEMICAL ANALYSIS	
Colour	APHA, AWWA,WEF, 2120 B
Odourless	Sensory
Temperature	APHA, AWWA,WEF, Method 2550 B
pH	Electrometric
Electrical Conductivity	APHA, AWWA,WEF, Method 2510 B
Total Dissolved Solids	Electrometric
Total Suspended Solids	Photometric
Total Hardness	APHA, AWWA,WEF, Method 2340 C
Dissolved Oxygen (DO)	APHA, AWWA,WEF, Method 4500-O G
Chemical Oxygen Demand (COD)	APHA, AWWA,WEF, Method 5220 D
Nitrate (NO_3^-)	APHA, AWWA,WEF, Method 4500- NO_3^- B
Nitrite (NO_2^-)	APHA, AWWA,WEF, Method 4500- NO_2^-
Sulphate (SO_4^{2-})	APHA, AWWA,WEF, Method 4500- SO_4^{2-} E
Phosphate (PO_4^{3-})	APHA, AWWA,WEF, Method 4500 -P C
Ammonia (NH_3)	APHA, AWWA,WEF, Method 4500 – NH_3
Potassium (K)	APHA, AWWA,WEF, Method 3111 B
Zinc (Zn)	APHA, AWWA,WEF, Method 3111 B&C
Copper (Cu)	APHA, AWWA,WEF, Method, 3111 B&C
Iron (Fe)	APHA, AWWA,WEF, Method 3111 B&C
Magnesium (Mg)	APHA, AWWA,WEF, Method 3111 B
Vanadium (Vn)	APHA, AWWA,WEF, Method 3111 B
Nickel (Ni)	APHA, AWWA,WEF, Method 3111 B
Lead (Pb)	APHA, AWWA,WEF, Method 3111 B
Total Bacteria Count	APHA, AWWA,WEF, Method 9215 B
Total Coliform Count	APHA, AWWA,WEF, Method 9221 B
Faecal Coliform	APHA, AWWA,WEF, Method 9230 B
Salmonella Spp	APHA, AWWA,WEF, Method 9260 B
Shigella Spp	APHA, AWWA,WEF, Method 9260 E

Key: APHA= American Public Health Association; AWWA= American Water Works Association; WEF= Water Environment Federation

Source: Richflood Laboratory, 2016

4.3 Environmental Conditions/Environmental Resources of the Project Area

Description of Existing Ecological Baseline Conditions studies covered climate/ meteorology, geology and hydrology, as well as water resources, soil and vegetation physical, chemical and biology characteristics.

4.3.1 Climate and Meteorology

An overview of the climate and meteorological data (relative humidity, ambient air temperature, rainfall and wind) of the study area are presented in the subsequent sections. Climatic and meteorological information described are primarily on literature/desktop research and climatic data information obtained from Nigerian meteorological Agency (NIMET) as well as fieldwork/site survey Meteorological Observations.

Meteorological data are a set of information, which describes the characteristics of the atmosphere. When these data are available for a day or a period during the day, they are taken as describing Weather characteristics. However, when they are available over a long period of time (usually up to 40 years), their averages are accepted as describing the Climate of the place from which they are collected. The parameters of the environment commonly measured include solar radiation, sunshine hours and temperature, precipitation (mainly rainfall), humidity, vapour pressure, evaporation and evapotranspiration, and wind speed and direction. Of all these, temperature is the most often reported in Nigeria as in the other parts of the world. This is because of its well-established influence on most other parameters that are measured. The observation and collection of Nigerian meteorological data started in 1892 as an agricultural station under the then Public Works Department. It was about forty years later that a full-fledged Meteorological Department was established in the country. The Nigerian Meteorological Department started operations in 1937 as the main agency responsible for all forms of weather-observations in the country. Several ministries have supervised the Department's activities, including the Ministry of Communications in 1952, Transport in 1953 and the recent Ministry of Aviation. The movements of the Department from one Ministry to the other over the years are without doubt, connected with the multi-sectoral relevance of the data they generate. Today, there is the **Nigerian Meteorological Agency (NIMET)**, the primary outlet of meteorological data in the country.

As the study of the weather and climate, **Meteorology** has to do with the understanding of the physical, dynamic, and chemical state of the earth's atmosphere, and the interactions between it and the underlying earth's surface. To effectively monitor the weather, the Nigerian Meteorological Services Department maintains a network of weather-observation stations across the country. Over the years the work-load of these stations have increased tremendously, first as the number of airports increased and second, as it became appreciated that greater spread and number of stations are needed to generate representative data on the meteorological characteristics of the country. The data collected from these stations are processed and the resulting information have operational applications for a wide range of socio-economic activities. Thus, meteorological statistics have several users which include large-scale farmers, foresters, fish farmers, the Civil and Military Aviation Departments, marine and other shipping firms, land transport establishments such as the railways in temperate zones, the construction industry, utility and energy distribution agencies, mining and energy extraction agencies, manufacturers and the general public. Some of the key areas where the interpretation of meteorological information is relevant include the following industries/sectors: Agriculture/Fishery, Forestry, Aviation, Marine Rigs, Land Transport, Construction, Utilities & Energy Production, etc.

General Sources and Methods of Compiling Meteorological Statistics: The Nigerian Meteorological Agency is the primary outlet of meteorological data in the country. The various stations from which the data come include: Rainfall stations, Agromet stations, Synoptic stations, Upper Air stations, Climate stations, Marine, Ozone, Background pollution monitoring (BAPMON) station. Methods of taking weather observations can be in the following forms:

- Direct reading of the basic meteorological elements from their respective measuring instruments at predetermined intervals.
- Extracting the elements' values from autographic charts wound round clock-driven devices, e.g. temperature, pressure, etc.
- Visual observation of the parameters by the observer, e.g. cloud amount.
- Estimating the parameters' values from satellite pictures.
- Deriving the parameters' values from some of the observed basic ones.

There are three principal types of climatological observatories, according to NIMET: Synoptic Stations, Agricultural Stations and Climatological Stations.

4.3.1.1 Climatic Condition/Meteorological analysis of Project area:

There are two seasons in the year, namely: the rainy season and the dry season. The rainy season begins in March and ends in October with a break in August usually referred to as the “little dry season.” The dry season which lasts for four months begins in November. Heavy thunderstorm are characteristic of the onset of the rainy season. The total rainfall decreases from 2200mm in the ie south to 1900mm in the north. The hottest months as are January to March when the mean temperature ts is above 27^{o}C. The relative humidity is usually high throughout the year, reaching a maximum during the rainy season when values above ninety per cent are recorded.

The description of the climatic and meteorological conditions in the proposed project location of Inner Galaxy Steel Co. Ltd is essential for sound understanding of the potential as well as the associated environmental and social impacts of the proposed project. Hence, the following section of the report provides a brief summary of the climatic and meteorological conditions in and around the proposed project site. The information presented here was collected from Nigerian Meteorological Service and other ancillary data sources *(like the field data-gathering equipment used by RIL)*.

Climate and weather elements comprise of temperature, pressure, wind, atmospheric humidity and precipitation (rainfall) amongst others. These elements are influenced by the north-easterly air mass of Sahara origin (the tropical continental air mass) and the humid maritime air mass blowing from the Atlantic (the tropical maritime air mass); accounting for seasonal weather conditions in the country. The two air masses blowing from nearly opposite directions meet along a slanting surface (the Inter-Tropical Front) where they continually rub against each other.

The area about this front is called the Inter-Tropical Discontinuity (ITD) or the Inter-Tropical Convergence Zone (ITCZ). The influence of the north-easterly air mass causes dry season while that of the humid maritime air mass causes the rainy season.

The following subsections discuss climate elements such as sunshine, temperature, atmospheric pressure, wind, relative humidity, cloud and rainfall in the study area.

Relative Humidity

Relative humidity is the ratio of the amount of water vapour in the air at a specific temperature to the maximum amount that the air could hold at that temperature, expressed as a percentage. For example, a reading of 100 per cent relative humidity means that the air is totally saturated with water vapor and cannot hold any more, creating the possibility of rain.

During the dry season, the Ukwa-West area records low relative humidity values (20 per cent in the afternoons at higher elevations and northern locations, but about 30 percent in the extreme south). The rather low values coupled with high afternoon temperatures, account for the desiccating effect of the dry season. During the rainy season, afternoon relative humidity values rise everywhere to above fifty percent.

Cloud

Solar radiation, temperature and humidity have direct relationship with cloud development and thus precipitation. Cloud formation is preceded by upward movement of humid air, which leads to its expansion (against the diminishing resistance of the lowering pressure of the surrounding atmosphere), and cooling. This cooling will lead to immediate condensation in saturate air or to eventual condensation if the cooling is sufficiently prolonged. As the rainy season approaches in Ukwa-West area, there is a trend towards increased cloudiness. Decline in sunshine hours becomes more intense as the rainy season progresses and reaches its lowest values in the month of September.

Rainfall

The hydrological cycle depends fundamentally on the inter-relationship between the circulation of the ocean, terrestrial water bodies and the atmosphere. Water is withdrawn from these water bodies into the atmosphere by the process of evaporation which is dependent on factors such as air/ temperature, wind strength and humidity.

Two main seasons exist in the Ukwa-West area, the dry season which lasts from November to March and the rainy season which begins in April and ends in October with a short period of reduced rains in August commonly referred to as “August break”. Temperature in the dry season ranges from 20 to 38°C, and results in high evapotranspiration, while during the rainy season temperature ranges from 16 to 28°C, with generally lower evapotranspiration. The average monthly rainfall ranges from 31 mm in January to 270 mm in July, with the dry season experiencing much reduced volume of rainfall unlike the rainy season, which has high volume of rainfall. Average annual rainfall varies from 1,500 to 1,650 mm. These climatic conditions are responsible for the development of thick lateritic soils in the area.

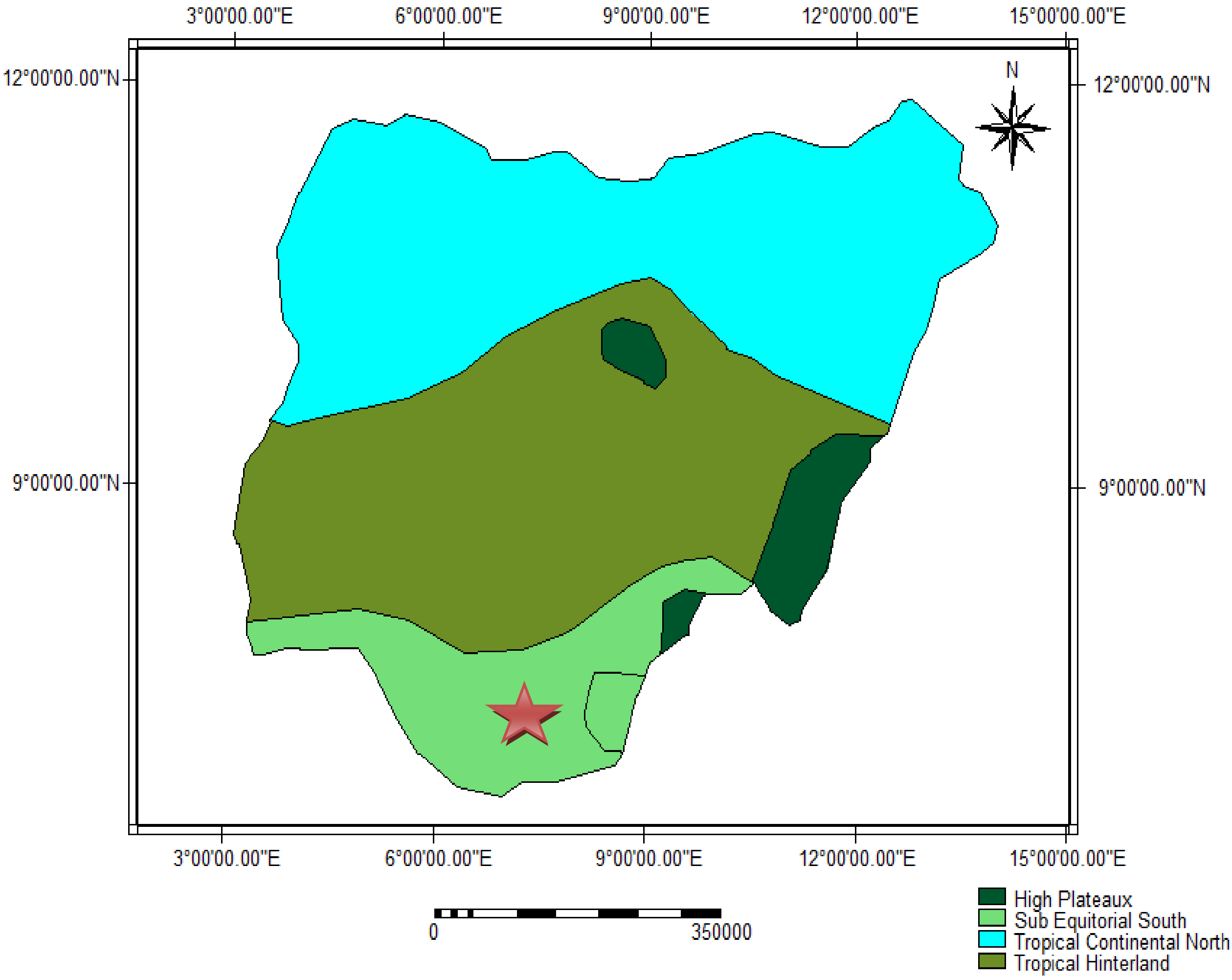


Figure 4.1a: Rainfall Map of Nigeria showing Study Area Location

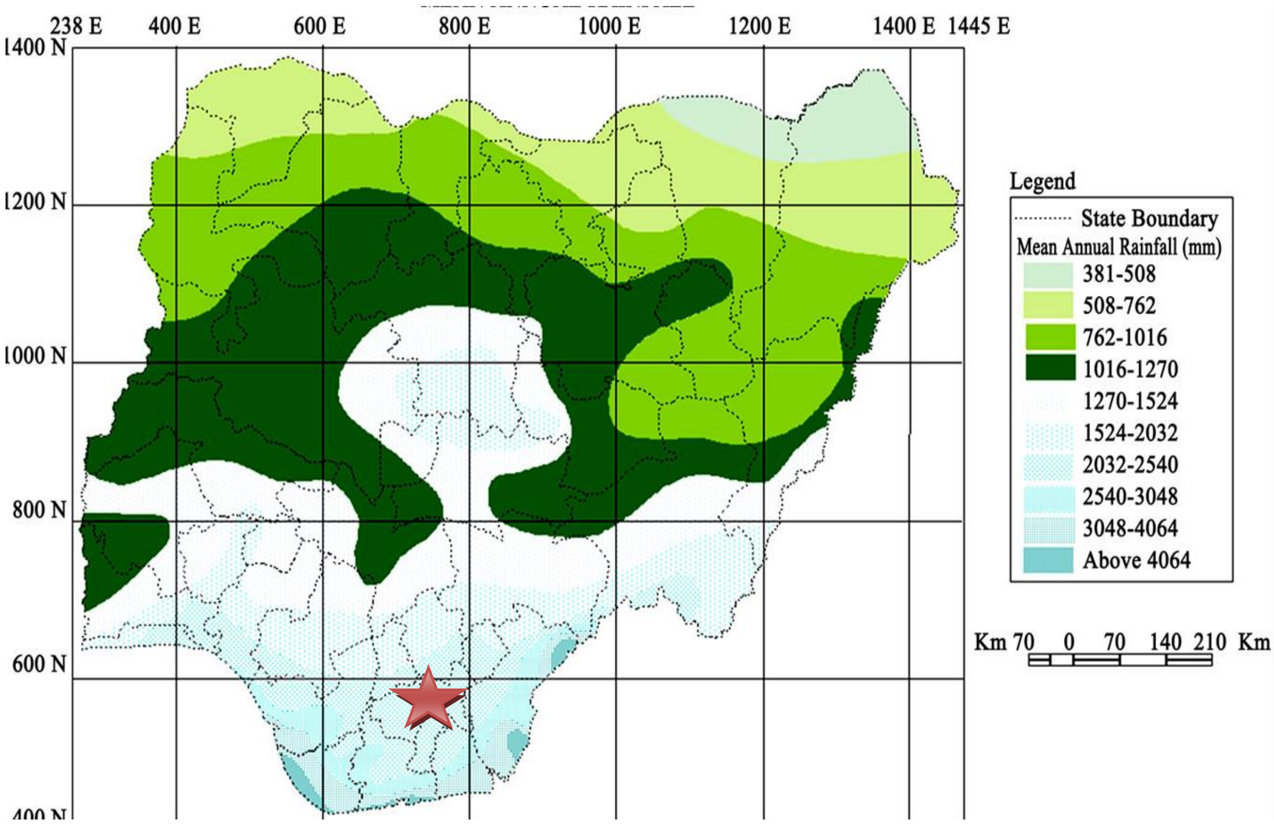


Figure 4.1b: Rainfall Map of Nigeria showing Study Area Location

Air Temperature

Temperature is a dominant climate factor that varies from place to place over a period of time at a given location. The spatial distribution of temperature over the earth is influenced by; amount of insulation received, nature of surface, distance from water bodies, relief, nature of the prevailing winds and ocean current.

During the dry season the temperature in the Ukwa-West area varies between 30^0C and 37^0C. The period is characterized by high diurnal ranges when temperature drops of as high as 17^0C may be recorded between the highest and the lowest temperature in a day. During rainy season, temperatures drop especially between July and August.

Atmospheric Pressure

Pressure is the weight of air on the ground. Variations in atmospheric pressure are closely related to air temperature, water vapor content and vertical and horizontal air movements. Cool or cold air subsides; increasing its pressure on the air and the earth beneath it, but warm air expands and rises relative to its surrounding, thus decreasing pressure locally.

The months of May through August witness a rise in atmospheric pressure with a gradual decline in September. The lowest recorded values occur in October to April. This corresponds to rainfall pattern for those months.

Sunshine Pattern

According to information in the National Atlas of the Federal Republic of Nigeria, 1978, the general pattern of sunshine hours in Nigeria, is lowest in the coastal areas and highest in the extreme north-east the generally lower sunshine hours in the south are due to greater amount of cloudiness and rainfall, characteristic of the southern part of the country.

Available data for the Ukwa-West area indicate that the highest sunshine hours (10-11 hours) are usually in November and December, whist the lowest (3-4 hours) occur in August. Annually, the Ukwa-West area is exposed to about 2,500 sunshine hours.

4.3.1.2 Field Observation of Meteorology data

In addition to meteorological data obtained from literature, meteorological parameters such as, wind speed, wind direction, humidity, atmospheric pressure, and temperature were observed and the seasonal variability in the parameters reflects the weather regime experienced at any given location in Nigeria during the year as is determined primarily by geographical location in relation to the fluctuating position of the Inter-Tropical Convergence Zone.

Table 4.5 (a&b) below gives an account of the Field Observation of Meteorological Data of the Project area, as documented during (Wet & Dry seasons) Site visit to the project location

Table 4.5a: Meteorological data obtained during Wet Season field observation

S/N	TEMPERATURE (^{0}C)		DEW POINT (^{0}C)		WET BULB (^{0}C)		REL. HUMIDITY (%RH)		WIND SPEED (M/S)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1.	30.8	29.1	23.4	22.4	25.8	25.0	68.1	66.2	0.0	0.0
2.	29.8	29.5	23.3	22.4	25.1	24.3	68.8	64.1	0.0	0.0
3.	32.8	31.9	23.8	22.8	26.1	25.2	59.3	57.2	0.0	0.0
4.	30.4	30.1	23.3	22.7	25.3	24.7	66.8	64.7	0.0	0.0
5.	30.5	30.3	23.6	23.2	25.5	25.1	67.3	65.2	0.0	0.0
6.	30.7	29.4	24.8	22.8	26.0	24.6	75.2	65.2	0.0	0.0
7.	32.2	31.6	23.5	23.2	26.7	25.4	61.5	55.3	0.0	0.0
8.	36.7	31.6	29.6	21.2	30.7	24.3	77.7	42.0	0.0	0.0
9.	38.1	31.6	29.6	21.2	30.7	24.3	77.7	41.5	0.0	0.0
10.	32.3	32.3	23.9	23.3	26.1	25.6	61.6	59.8	0.0	0.0
11.	32.5	32.4	25.0	22.5	26.9	25.0	64.8	56.2	0.0	0.0
12.	31.8	31.8	23.4	23.3	25.7	25.5	60.9	60.0	0.0	0.0
13.	30.8	28.0	21.2	20.1	24.2	23.1	30.9	29.9	0.0	0.0
14.	29.7	29.0	25.4	23.2	30.9	29.8	59.2	54.3	0.0	0.0
15.	27.6	27.0	30.1	30.0	25.4	23.2	61.0	60.9	0.0	0.0
16.	33.2	33.0	26.8	24.5	28.2	26.0	69.2	57.8	0.0	0.0
17.	34.8	34.8	25.7	25.1	27.9	27.5	58.9	56.0	0.0	0.0
18.	36.0	34.8	26.3	23.0	28.4	25.9	59.2	51.3	0.0	0.0
19.	34.4	34.4	25.5	24.7	28.4	26.7	61.4	55.0	0.0	0.0
20.	36.3	35.2	25.6	20.0	26.5	24.5	54.9	46.7	0.0	0.0
21.	32.0	31.9	24.4	23.7	26.6	25.8	63.3	62.0	0.0	0.0
22.	38.2	37.9	23.3	18.5	27.1	23.0	48.1	39.7	0.0	0.0
23.	35.5	35.2	23.5	22.5	26.6	25.6	56.3	49.3	0.0	0.0
24.	30.3	30.3	24.0	23.7	25.6	25.3	69.3	67.8	0.0	0.0
25.	31.9	31.7	24.2	23.6	26.2	25.7	64.4	62.3	0.0	0.0
26.	31.4	31.2	23.2	22.8	25.6	25.0	64.5	61.0	0.0	0.0
27.	30.1	30.0	23.2	22.0	23.4	23.1	63.9	60.1	0.0	0.0

Source: Richflood Fieldwork (October, 2015)

Table 4.5b: Meteorological data obtained during Dry Season field observation

S/N	TEMPERATURE (^{0}C)		DEW POINT (^{0}C)		WET BULB (^{0}C)		REL. HUMIDITY (%RH)		WIND SPEED (M/S)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1.	37.8	37.6	38.9	38.7	25.8	25.0	68.3	66.2	1.0	0.0
2.	36.8	34.8	35.8	35.1	25.1	24.3	65.8	54.1	0.0	0.0
3.	33.6	33.0	33.9	33.4	26.1	25.2	59.3	57.2	0.0	0.0
4.	34.7	33.1	34.4	33.4	25.3	24.7	56.8	54.7	0.0	0.0
5.	34.3	34.3	34.0	33.8	25.5	25.1	67.3	65.0	1.1	1.0
6.	36.1	35.8	34.1	34.1	26.0	24.6	75.2	65.2	0.0	0.0
7.	35.0	34.7	36.0	35.3	26.7	25.4	61.5	55.3	0.0	0.0
8.	35.8	35.3	35.6	34.9	30.7	24.3	71.7	48.0	1.1	1.0
9.	34.1	30.0	33.1	32.1	30.7	24.3	77.7	51.5	0.0	0.0
10.	33.9	32.9	31.1	28.9	26.1	25.6	71.6	59.8	0.0	0.0
11.	37.4	35.1	37.6	35.3	26.9	25.0	64.8	56.2	1.0	0.0
12.	38.4	38.0	37.5	37.4	25.7	25.5	66.9	60.0	0.0	0.0
13.	37.8	37.1	34.9	34.6	24.2	23.1	60.9	59.9	0.0	0.0
14.	37.2	37.2	36.1	36.1	30.9	29.8	59.2	54.3	0.0	0.0
15.	36.3	36.1	36.7	36.0	25.4	23.2	61.0	60.9	0.0	0.0
16.	33.2	33.0	30.8	29.5	28.8	26.0	63.2	60.8	1.1	1.0
17.	32.8	30.8	32.7	30.1	29.9	27.5	78.9	66.0	1.1	1.0
18.	32.1	31.8	26.3	23.0	28.4	26.9	69.2	64.3	1.1	1.0

Source: Richflood Fieldwork (February, 2016)

4.3.2 Air Quality Characteristics and Noise Level

The atmosphere is a layer of gases that is held in its place by gravity. These layers of gases constitute what is known as air. Air is a mixture of gases, composed mainly of nitrogen, and oxygen with small amounts of carbon dioxide, noble gases and water vapour essential to support life on earth.

The term “Air Quality” means the state of the air around us.

Good *Air Quality* refers to clean, clear, unpolluted air. Clean air is essential to maintaining the delicate balance of life on this planet — not just for humans, but wildlife, vegetation, water and soil.

‘Ambient Air Quality’ refers to the quality of outdoor air in our surrounding environment. It is typically measured near ground level, away from direct sources of pollution.

Poor *Air Quality* is a result of a number of factors, including emissions from various sources, both natural and “human-caused.” Poor air quality occurs when pollutants reach high enough concentrations to endanger human health and/or the environment.

Our everyday choices, such as driving cars and burning wood, can have a significant impact on air quality. Regional air quality is affected by how air behaves as a result of the interaction of topography and weather, and by the emission sources themselves.

The amount and kind of pollutants that are released into the air play a major role in determining the degree of air pollution in a specific area.

However, other factors are involved, mainly:

- topography (terrain), such as mountains and valleys;
- weather, such as wind, temperature, air turbulence, air pressure, rainfall and cloud cover; and
- the physical and chemical properties of pollutants.

Air pollution comes from many different sources: stationary sources such as factories, power plants, and smelters and smaller sources such as dry cleaners and degreasing operations; mobile sources such as cars, buses, planes, trucks, and trains; and naturally occurring sources such as windblown dust, and volcanic eruptions, all contribute to air pollution. Air Quality can be affected in many ways by the pollution emitted from these sources. These pollution sources can also emit a wide variety of pollutants.

Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution. Pollutants of major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide. Outdoor and indoor air pollution cause respiratory and other diseases, which can be fatal.

At the project area, the pollutants commonly monitored in relation to air quality are; nitrogen dioxide (NO_2), sulphur dioxide (SO_2), suspended particulate matter (SPM), ammonia (NH_3), hydrogen sulphide (H_2S), carbon monoxide (CO), etc. The observed air quality data of the study area is presented in Table 4.6. Generally, recorded measurements indicated that the ambient air was free from pollution by these measured parameters as at the time of study as well as compared well with national limits for air quality standards.

Table 4.6a: In-Situ Gaseous Air Quality Readings at Project Location, Wet Season

S/N	Sample Location	O_2 ppm	CO ppm	CO_2 ppm	NO_2 ppm	NO ppm	H_2S ppm	SO_2 Ppm
1	AQ_1 (Entrance Point)	21.9	0.00	0.00	0.01	0.01	0.00	0.01
2	AQ_2 (Temporary Admin/Resident)	20.80	0.00	0.00	0.01	0.01	0.00	0.01
3	AQ_3 (Temporary Diesel Storage)	20.80	0.00	0.00	0.01	0.01	0.00	0.01
4	AQ_4 (Block Molding Point)	20.80	0.00	0.00	0.00	0.00	0.00	0.00
5	AQ_5 (Fabricating Point)	20.80	0.00	0.00	0.01	0.01	0.00	0.00
6	AQ_6 (NGC Pipeline)	20.80	0.00	0.00	0.00	0.00	0.00	0.00
7	AQ_7	21.9	0.00	0.00	0.00	0.00	0.00	0.00
8	AQ_8	20.80	0.00	0.00	0.00	0.00	0.00	0.00
9	AQ_9	20.80	0.00	0.00	0.00	0.00	0.00	0.00
10	AQ_{10}	21.00	0.00	0.00	0.00	0.00	0.00	0.01
11	AQ_{11}	20.80	0.00	0.00	0.00	0.00	0.00	0.00
12	AQ_{12}	20.80	0.00	0.00	0.00	0.00	0.00	0.00
13	AQ_{13} Proposed Transmission Line (Middle Wing)	20.80	0.00	0.00	0.00	0.00	0.00	0.00
14	AQ_{14} Proposed Transmission Line (Right Wing)	20.80	0.00	0.00	0.00	0.00	0.00	0.00
15	AQ_{15} Proposed Transmission Line (Left Wing)	20.80	0.00	0.00	0.00	0.00	0.00	0.00

16.	AQ_{16}	20.80	0.00	0.00	0.00	0.00	0.00	0.00
17.	AQ_{17}	20.80	0.00	0.00	0.00	0.00	0.00	0.00
18.	AQ_{18}	20.80	0.00	0.00	0.00	0.00	0.00	0.00
19.	AQ_{19} (Substation)	20.80	0.00	0.00	0.00	0.00	0.00	0.00
20.	AQ_{20}	20.80	0.00	0.00	0.00	0.00	0.00	0.00
21.	AQ_{21}	20.80	0.00	0.00	0.00	0.00	0.00	0.00
22.	AQ_{22} (Proposed Rolling Mill Factory)	20.80	0.00	0.00	0.00	0.00	0.00	0.00
23.	AQ_{23} (Temporary Store Room)	20.80	0.00	0.00	0.00	0.00	0.00	0.00
24.	AQ_{24} (Proposed Permanent Office/Residential Building)	20.80	0.00	0.00	0.00	0.00	0.00	0.01
25.	AQ_{26} (Temporary Warehouse)	20.80	0.00	0.00	0.00	0.00	0.00	0.01
26.	AQ_{27} (Umuahala Community) CONTROL	21.9	0.00	0.00	0.01	0.01	0.00	0.00
27.	AQ_{28} (Umuogogo Community) CONTROL	21.9	0.00	0.00	0.01	0.01	0.00	0.00

Source: Richflood Field Works, October, 2015

Table 4.6a: In-Situ Gaseous Air Quality Readings at Project Location, Dry Season

S/N	Sample Location	O_2 Ppm	CO ppm	CO_2 ppm	NO_2 ppm	NO ppm	H_2S ppm	SO_2 ppm	CO_2 ppm
1	AQ_1 (Entrance Point)	21.9	0.00	0.00	0.01	0.00	0.00	0.01	463
2	AQ_2 (Admin/Resident)	20.80	0.00	0.00	0.01	0.00	0.00	0.01	481
3	AQ_3 (Equipment Storage Section)	20.80	0.00	0.00	0.01	0.00	0.00	0.01	480
4	AQ_4 (Beside Rolling Mill Section)	20.80	0.00	0.00	0.00	0.00	0.01	0.02	468
5	AQ_5	20.80	0.00	0.00	0.01	0.01	0.00	0.00	447
6	AQ_6	20.80	0.00	0.00	0.00	0.00	0.00	0.00	475
7	AQ_7 (Angle Tower)	21.9	0.00	0.00	0.00	0.00	0.00	0.00	455
8	AQ_8 (Tower 3)	20.80	0.00	0.00	0.00	0.00	0.00	0.00	411
9	AQ_9	20.80	0.00	0.00	0.00	0.00	0.00	0.00	402
10	AQ_{10}	21.00	0.00	0.00	0.00	0.00	0.00	0.01	477
11	AQ_{11}	20.80	0.00	0.00	0.00	0.00	0.00	0.00	475
12	AQ_{12}	20.80	0.00	0.00	0.00	0.00	0.00	0.00	419
13	AQ_{13}	20.80	0.00	0.00	0.00	0.00	0.00	0.00	511
14	AQ_{14}	20.80	0.00	0.00	0.00	0.00	0.00	0.00	450
15	AQ_{15}	0.80	0.00	0.00	0.00	0.00	0.00	0.00	453

16.	AQ_{16} (Ahala Ukwu Community) CONTROL I	20.80	0.00	0.00	0.00	0.00	0.00	0.01	413
17.	AQ_{17} (Umuacheke Community) CONTROL II	20.80	0.00	0.00	0.00	0.00	0.00	0.01	401
18.	AQ_{18} (Umuigwe / Umuogogo Community) CONTROL III	21.9	0.00	0.00	0.00	0.00	0.00	0.01	421

Source: Richflood Field Works, February, 2016

From the (2) Tables above, it is obvious that the baseline condition of the Project site, in terms of air quality has not been distrupted, as sampled air parameters are seen to be at 0.00pm across the air quality parameters.

Suspended Particulates: Particulates are tiny solid or liquid particles in the air. These particles are seen as smoke or haze. Other pollutants as gas or vapour are not visible except in the case of nitrogen dioxide which is a brownish gas. Particles may carry any or all of the other pollutants dissolved in or adhering to their surfaces (Bernard 1990). Particles raging from aggregate of a few molecules to pieces of dust, readily visible to the naked eye are commonly found in the atmosphere. High concentrations of suspended particulate matter (SPM) are known to irritate the mucous membranes and may initiate a variety of respiratory diseases. Fine particulates may cause cancer and aggravate morbidity and mortality from respiratory dysfunctions (CCDI, 2001).

Sulphur Oxide: It is also produce from the combustion of sulphur-containing fuels, smelting, and manufacture of sulphuric acid, incineration of refuse as well as production of elemental sulphur. The gas is known to be a harsh irritant, and is capable of aggravating asthma, bronchitis and emphysema. It can also cause coughing and promote impaired functions in the human system (CCDI, 2001). Also sulphuric acid aerosols (formed from dissolved sulphur dioxide) will readily attack the insulators to be installed on the towers, especially those containing carbonates such as marble, limestone, and mortar. This might pose a problem to the proper functioning of the transmission line in areas with high concentrations. Recorded values were however, consistent with their natural environment and compared well with the FMENV limits for air quality pollution.

Nitrogen Oxides: Nitrogen oxides are a family of highly reactive gases called nitrogen oxides or oxides of nitrogen, which are formed during combustion processes. Nitrogen oxides (NOx) are produced from natural sources, motor vehicles and other fuel combustion processes in the air to produce photochemical smog. NO_2 results when fuel is combusted at high temperatures and occurs mainly from motor exhaust and stationary sources such as electric utilities and industrial boilers (SIEP, 1995). It is the only oxide of nitrogen that has been shown to have significant human health effects, with exposure to concentrations higher than 0.5ppm (1mg/m3) triggering changes in pulmonary function in human health (SIEP, 1995). NO2 levels in the study area for both seasons were generally below equipment detection limit and compliant with FMENV regulatory limit for human exposure.

Hydrocarbons: Hydrocarbons (CxHy) are organic compound consisting entirely of carbon and hydrogen, they can be straight-chain, branched chain, or cyclic molecules. They are mainly grouped into aliphatic and aromatic organic compounds. The majority of hydrocarbons found naturally occur in crude oil, where decomposed organic matter (fossil) provides an abundance of carbon and hydrogen which when bonded can catenate to form limitless chains. Hydrocarbon vapour in the atmosphere arises from fugitive emissions, vents organic chemical production, and distribution of natural gas, transportation and processing of crude oil. Others are incomplete combustion of fuels, particularly where fuel to air ratios are too high. Most members of this group are significantly toxic and exposure to high concentrations in the atmosphere (about 100ppm or more) could result in interference with oxygen intake (Canter, 1977) and acute leukaemia (SIEP, 1995). Hydrocarbon concentrations were below equipment detection limit of <0.01% for both seasons in the study area. This implies that the atmospheric environment is free of hydrocarbon pollution.

Hydrogen Sulphide: Hydrogen Sulphide (H_2S) is a toxic, odorous and corrosive gas, which is rapidly oxidized to SO_2 in the atmosphere. Its presence in the atmosphere could result from storage tank and process vents. Exposure to concentrations in excess of 500 ppm can be fatal (SIEP, 1995). Data indicates that exposures to even relatively low concentrations of H_2S are hazardous. The recorded level of H_2S within study area was below equipment detection limit of <0.1ppm for both seasons indicating absence of the pollutant gas.

4.3.2.1 Noise Characteristics at Project area

Noise is a periodic fluctuation of air pressure. The range of sound pressures encountered is very large and to keep numbers in manageable proportion, noise levels are measured in decibels (dB). In addition to causing disturbances, excessive noise can damage health and have physiological effects. Environmental noise concerns in the study area are related to disturbances to personnel and terrestrial life. Effects on personnel generally relate to annoyance / nuisance and negative effects on health caused by both short and long-term sound levels. Prolonged exposure to noise frequencies higher than regulatory limits can either cause temporary hearing loss (temporary threshold shift), which disappears in a few hours or days, or permanent loss (permanent threshold shift) SIEP, 1995). Noise can also be stressfull and cause stress related damage on health. Disturbance of terrestrial life (fauna) by noise may be of significance particularly where noise sensitive species are present. The major source of noise expected in the study on course the proposed project will be generated by automobile engine, noise producing work equipment, human noise and noise from other mechanical equipments and processes. Noise impact is dependent on the proximity to the source and sensitivity of the receptor. The WHO has recommended (level to prevent community annoyance) a limit value of 55dB for 16 hours exposure.

Table 4.7a: Noise (dB) Monitoring For the Project Area, Wet Season

S/N	Sample Location	Time	Average Noise (dB)
1	Point 1	10:45am	54.4
2	Point 2	10:55am	60.9
3	Point 3	11:05am	72.0
4	Point 4	11:25am	86.9
5	Point 5	11:45am	56.3
6	Point 6	11:57am	55.4
7	Point 7	12:09pm	50.2
8	Point 8	12:26pm	42.0
9	Point 9	12:47pm	49.7
10	Point 10	1:00pm	41.2
11	Point 11	1:11pm	55.1
12	Point 12	1:29pm	54.4
13	Point 13	1:43pm	53.2
14	Point 14	1:59pm	54.3

15	Point 15	2:13pm	53.3
16.	Point 16	2:23pm	43.7
17.	Point 17	2:37pm	56.7
18.	Point 18	2:45pm	51.9
19.	Point 19	2:55pm	41.7
20.	Point 20	3:14pm	67.5
21.	Point 21	3:31pm	63.4
22.	Point 22	3:45pm	51.2
23.	Point 23	3:58pm	49.8
24.	Point 24	4:24pm	53.4
25.	Point 27	4:58pm	54.7
26.	Point 28	5:22pm	67.2
27.	Point 29	6:02pm	73.2

Source: Richflood Field Works, October 2015

Table 4.7b: Noise (dB) Monitoring For the Project Area, Dry Season

S/N	Sample Location	Time	Average Noise (dB)
1	Point 1	10:00am	71.2
2	Point 2	10:35am	64.0
3	Point 3	10:55am	52.7
4	Point 4	12:18pm	45.5
5	Point 5	12:45pm	45.5
6	Point 6	1:17pm	40.3
7	Point 7	1:38pm	40.0
8	Point 8	1:56pm	51.1
9	Point 9	2:17pm	45.5
10	Point 10	2:34pm	40.3
11	Point 11	2:50pm	40.2
12	Point 12	2:34pm	47.8
13	Point 13	2:49pm	45.1
14	Point 14	3:18pm	48.0
15	Point 15	3:41pm	40.2
16.	Point 16	5:23pm	59.7
17.	Point 17	5:39pm	66.7
18.	Point 18	5:58pm	61.9

Source: Richflood Field Works, February, 2016

4.3.3 Regional Geology Description and Basin-Formation of Project area

Nigeria is underlain by two major rock units: basement complex and sedimentary rocks. The sedimentary rocks of Nigeria were deposited in six (6) major basins and crop out over one half of the surface area of Nigeria. From a tectonic perspective the basins can be classified into two broad groups: marginal sag basins (comprising the Niger Delta and the Dahomey Embayment) and intra-continental basins (comprising the Benue Trough, Nupe, Southern Chad, SE Iullumeden). Generally, the Precambrian rocks of Nigeria may be grouped into three principal subdivisions. These are the ancient gneiss migmatitie complex, the schist belts and the plutonic series plus affiliated minor rocks which bear imprints of Liberian (~2700Ma), Eburnean (~2000Ma), and Pan African (~650Ma) tectonic events, The latter being the most widespread. Older ages >3.0Ga have more recently been indicated from some. Such relict signatures tend to reinforce the assertion that this Precambrian terrain may have been part of an Archaean proto shield which was later affected by Proterozoic crustal activities and subsequent evolvement of the Phanerozoic basins. Overlying these older assemblages are sedimentary sequences of Cretacecous to Tertiary ages deposited in five basins notably Mid-Niger basin, Benue Trough, Anambra Basin all of Cretaceous ages and the Sokoto (Illumeden Basin), Chad and the Niger Delta basin of Tertiary and Tertiary to Recent ages respectively. The banded iron formation of Nigeria generally occurs in metamorphosed folded bands, associated with Precambrian basement complex rocks which include low grade metasediments, high grade schist, gneisses and migmatites.

Regionally, the Project/study area, Abia State, falls within the Niger Delta Basin, also referred to as the Niger Delta province; which is an extensional rift basin located in the Niger Delta and the Gulf of Guinea on the passive continental margin near the western coast of Nigeria with suspected or proven access to Cameroon, Equatorial Guinea and São Tomé and Príncipe. This basin is very complex, and it carries high economic value as it contains a very productive petroleum system. The Niger delta basin is one of the largest subaerial basins in Africa. It has a subaerial area of about 75,000 km^2, a total area of

300,000 km^2, and a sediment fill of 500,000 km^3. The sediment fill has a depth between 9–12 km. It is composed of several different geologic formations that indicate how this basin could have formed, as well as the regional and large scale tectonics of the area. The Niger Delta Basin is an extensional basin surrounded by many other basins in the area that all formed from similar processes. The Niger Delta Basin lies in the south westernmost part of a larger tectonic structure, the Benue Trough. The other side of the basin is bounded by the Cameroon Volcanic Line and the transform passive continental margin.

The Niger Delta Basin was formed by a failed rift junction during separation of the South American plate and the African plate, as well as the opening of the South Atlantic. Rifting in this basin started in the late Jurassic and ended in the mid Cretaceous. As rifting continued several faults formed, many of them thrust faults. Also at this time we have the deposition of the syn-rift sands and then shales in the late cretaceous. This shows that there was a regression in the early basin. By this time the basin has been undergoing extension by high angle normal faults and fault block rotation. Then at beginning of the Paleocene there was a large transgression. Then in the Paleocene the Akata formation was deposited. In the Eocene the Agbada formation was deposited. This caused the underlying shale Akata Formation to be squeezed into shale diapirs. Then in the Oligocene the Benin formation was deposited and it still being deposited today. The overall basin is divided into a few different zones due to its tectonic structure. There is an extensional zone, which lies on the continental shelf, which is caused by the thickened crust. There is a transition zone, and then there is a contraction zone, which lies in the deep sea part of the basin.

The sediment fill in the Niger Delta basin is characterized by three major depobelts. These three cycles show that the basin experienced an overall regression throughout time as the sediments go from deep sea mud sized grains to fluvial denser sand sized grains. The lithologies of the area experience changes due to several factors. One factor would be the types of sediment coming through the delta, which could be influenced by sea level, or maybe volcanic activity in the area. The type of environment of deposition will also change the sediment type. The early Cretaceous sediments were thought to be from a tide dominated system that were deposited on a concave shoreline, and throughout time the shoreline has become convexed and it is currently a wave dominated system.

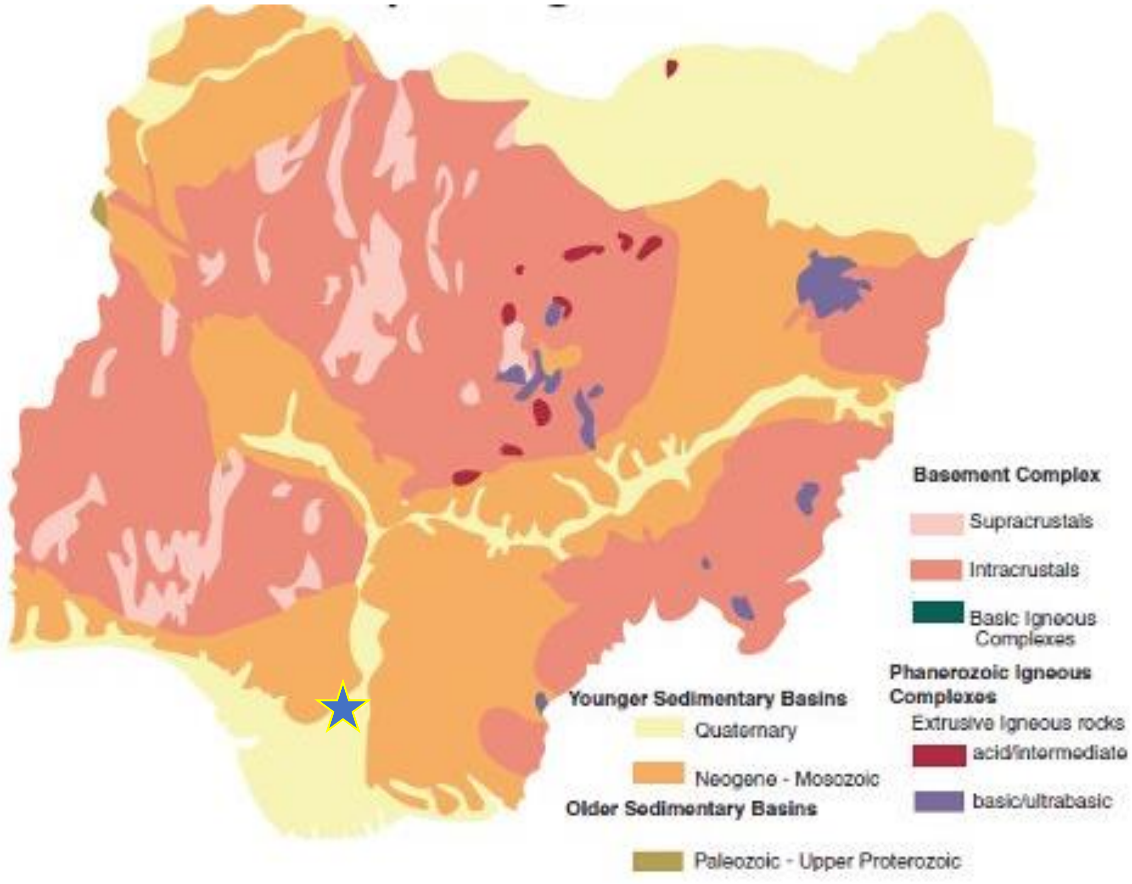


Figure 4.2: Simplified Geology Map of Nigeria (showing the Younger Sedimentary Basin of Project location)

Basement: The oceanic basement rock is the oldest rock in the basin and is basaltic in composition. It is of the pre-rift time period. Also closer to the coast you have precambrian continental basement.

Cretaceous: There is a section of rock in this basin from the middle to late cretaceous that there is not much information on due to extreme depth. It is believed to be composed of sediments from a tide dominated coastline, and there are believed to be several layers of shales, although there distribution is not known.

Akata Formation: The Akata Formation is Palecene in age. It is composed of thick shales, turbidite sands, and small amounts of silt and clay. It is the mobile formation that is squeezed into shale diapirs in the basin that is formed from being over pressured and not being dehydrated properly. The Akata formation formed during lowstands in sealevel and in oxygen deficient conditions. This formation is estimated to be up to 7000 meters thick.

Agbada Formation: It is a marine facies defined by both freshwater and deep sea characteristics. This is the major oil and natural gas bearing facies in the basin. The hydrocarbons in this layer formed when this layer of rock became subaerial and was covered in a swamp type of environment that contained lots of organics. It is estimated to be 3700 meters thick.

Benin Formation: The Benin Formation is Oligocene and younger in age. It is composed of continental flood plain sands and alluvial deposits. It is estimated to be up to 2000 meters thick.

The land portion of the Niger Delta province is delineated by the geology of southern Nigeria and south-western Cameroon. The northern boundary is the Benin flank-an eastnortheast trending hinge line south of the West Africa basement massif. The north-eastern boundary is defined by outcrop of the Cretaceous on the Abakaliki High and further east- south-east by the Calabar flank—a hinge line bordering the adjacent Precambrian.

Beginning in the Paleocene and through the recent, the Akata Formation formed during lowstands in the terrestrial organic matter and clays were transported to deep water areas characterized by low energy conditions and oxygen deficiency it is estimated that the formation is up to 7,000 meters thick. The formation underlies the entire delta, and is typically over-pressured.

Deposition of the overlying Agbada formation, the major petroleum-bearing unit, began in the Eocene and continues into Recent. The formation consists of paralic siliciclastics over 3700 meter thick and represents the actual deltaic portion of the sequence. The clastics accumulated in delta-front, delta-topset, and fluvio-deltaic environments. In the lower Agbada Formation, shawl and sandstone beds were deposited in equal proportions, however, upper portion is mostly sand with only minor shale interbeds. The Agbada Formation is overlain by the third formation, the Benin Formation, a continental latest Eocene to Recent deposit of alluvial and coastal plain sands that are up to 2000 m thick (Wright et al, 1985).

Generally, the study area has two main rock types. These are the basement complex rocks of the pre Cambrian age which are made up of the older and younger sand in the northern parts of the state, and the younger and older sedimentary rocks of both the tertiary and secondary ages in the southern parts.
Nigeria is endowed with diverse of rock types, both crystalline (igneous and metamorphic) and sedimentary rocks. The former forms what is commonly referred to as the Basement Complex of Nigeria where the latter forms the sedimentary terrain (sedimentary basins).

The Basement Complex: The Basement Complex of Nigeria is made up of crystalline (igneous and metamorphic) rocks which are sometimes referred to as hard rocks. The Nigeria basement is part of pan-African mobile belt and it is located between Congo and West African cratons. The Basement Complex rocks are exposed in almost equal proportion as the Nigerian sedimentary basins, thus covering nearly half of the total surface area of the country. Thus, because of its diverse nature and areal extent, various researchers have concentrated and worked on different parts of the country where the basement outcrops. For instance, McCurry (1976) reviewed the geology of the northern Nigeria and he divided the Paleozoic and Precambrian rocks of the region into four major groups namely:

i) The Basement Complex (*sensu stricto*), otherwise referred to as Older Metasediments
ii) Younger Metasediments
iii) The Older Granite Series
iv) Volcanic Rocks.

Later work by Ajibade *et al.* (1987) resulted in the subdivision of the basement complex rocks of Nigeria into four blocks as follows:

a. The North-Western Basement Complex
b. The North-Central Basement Complex
c. The South-West Basement Complex
d. The Eastern Basement Complex.

Similarly, Rahaman (1976) reviewed the basement geology of the south-western Nigeria and he summarised the Precambrian rocks of the region into five major groups, namely:

i) Migmatite-gneiss complex which comprises biotite and biotite hornblende gneisses, quartzites and quartz schist and small lenses of calc-silicate rocks.

ii) Slightly migmatised to unmigmatised paraschists and metaigneous rocks which consist of pelitic schists, quartzites, amphibolites, talcose rocks, metaconglomerates, marbles and calc-silicate rocks.

iii) Charnochitic rocks

iv) Older Granites which comprise rocks varying in composition from granodiorite to true granites and potassic syenites.

v) Unmetamorphosed dolerite dykes believed to be the youngest.

The mode of occurrences, evolution, tectonic and geological history, and phases of metamorphism, deformation (folding) and igneous activity (igneous intrusions) of these basement rocks have been discussed extensively by Rahaman (1996) and other studies.

The Sedimentary Basins: The sedimentary basin consists of sedimentary rocks which were derived from pre-existing rocks (igneous or metamorphic rocks, or even sedimentary rocks) deposited within the depressions in the crust of the Earth’s surface. The Nigerian sedimentary basins like the Basement Complex, cover roughly fifty percent of the total surface area of the country. They, both inland and coastal basins, are grouped into seven relatively small basins and these are:

i) Anambra Basin

ii) Benue Trough

iii) Bida (or Mid-Niger or Nupe) Basin

iv) Chad (or Bornu) Basin

v) Dahomey Basin

vi) Sokoto Basin

vii) The Niger Delta Basin

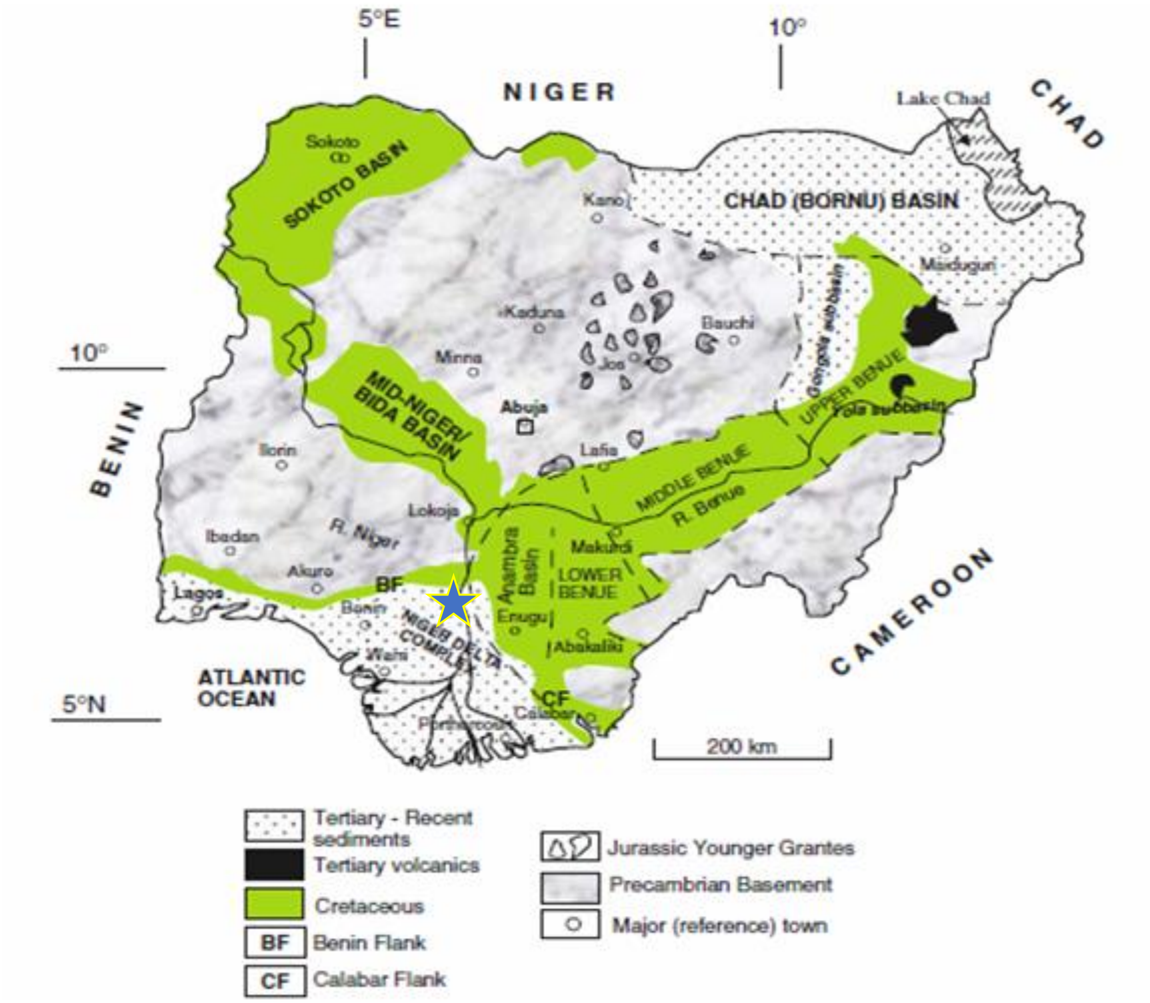


Fig. 4.3: Geological Map of Nigeria (Showing the Tertiary Sediments of Project area)

The geology of the project area, Abia State, is made up of the basement complex and the sedimentary layers. The basement complex is essentially non-porous and water can only be contained in the crevices of the complex. This basement complex primarily underlies the sedimentary layers which consist of Cretaceous, Tertiary and Quaternary sediments deposited in the coastal basin.

The project area lies on the sediments of Albian age called the Asu River formation. The Asu River group sediments are predominantly Shale and comprise the Abakaliki Shale, Uomba formation, Arurfu Limestone and two other unnamed formations. The rock unit within the project area is the Abakaliki Shale, it consists mainly of poorly bedded shale, occasionally sandy and there are lenses of sandstone and sandy limestone. The sediments are folded with axes of folds stretching north-east to south west. The Abakaliki shale is associated with lead Zinc mineralization and minor basic intrusions, the intrusions are responsible for the formation of slate which is sometimes called baked shale. Within the project area paleontologically, the Abakaliki shale is characterised by species of Mortoniceras and Elobiceras, Radiolaria and Echinoids. All these result in the formation of fossiliferosus limestone as found within the project area.

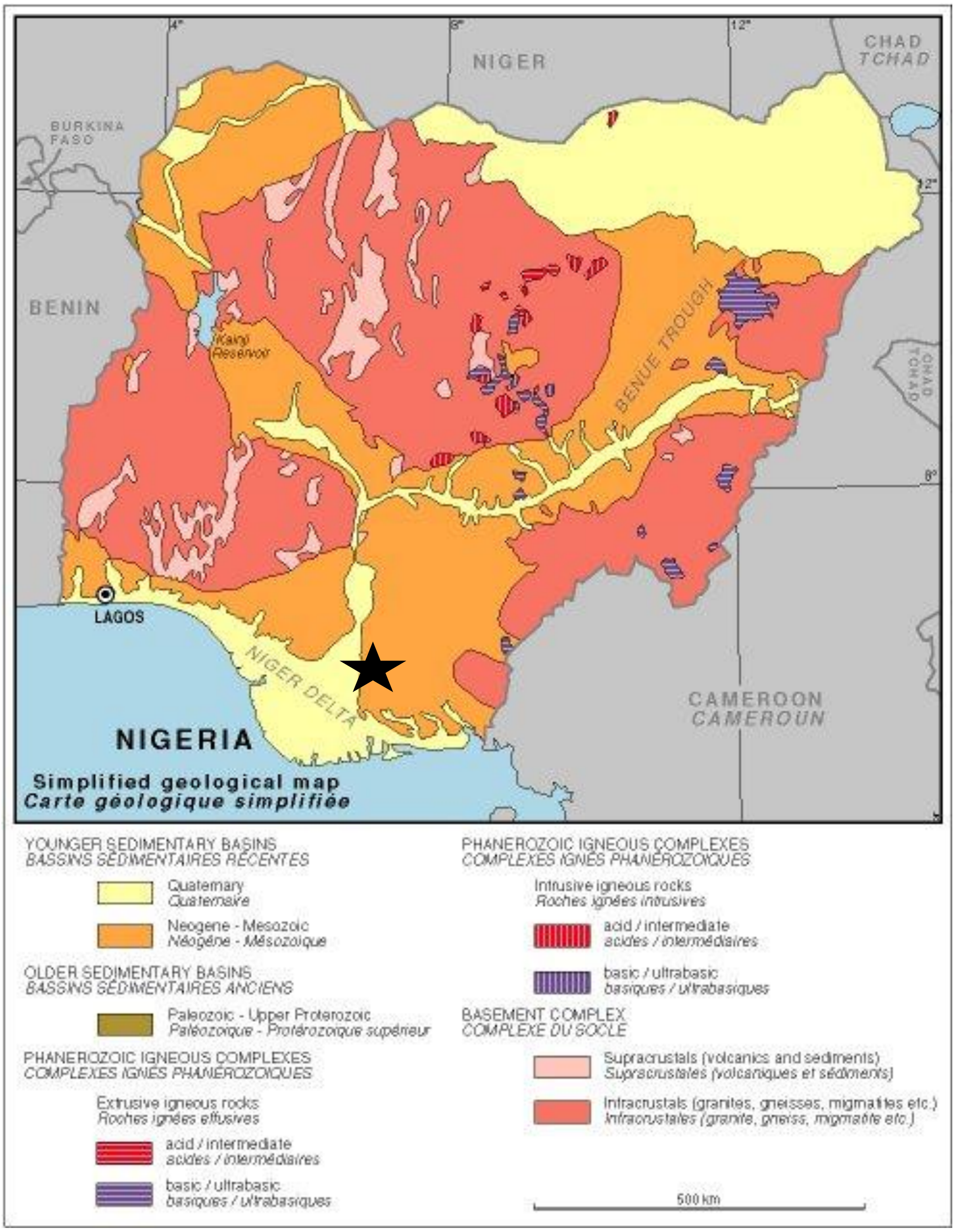


Fig 4.4: Geology of Nigeria showing the project area, Abia State

4.3.4 The Mineral Resources of the Area

The Ukwa-West LGA is known to be a Lead-Zinc district. The minerals available in the hydrothermal veins intruding into the Asu River Group and the Eze-Aku Formation include Galena (PbS), sphalerite (ZnS), pyrite (FeS), siderite, chalcopyrite, bornite malachite and azurite in the Ishiagu, Abakaliki, Ameka, Enyigba and Ameri areas. Numerous occurrence of this area located south of Abakaliki at Abakaliki and east of Abakaliki. Lengths of veins in this district reach 2km with widths up to 17metres and depth up to 150 meters. Closely related to these mineral deposits are the salt brines. Other mineral resources include coal in the Afrikpo area and stone aggregates in the Ezea- agu area.

In the study area there are possibilities of encountering lead-zinc- baryte mineralization, which can lead to the pollution of the environment. The Cretaceous igneous activity related to the lead-zinc mineralization has been observed to intrude the formation near Amaseri. Thus it is possible that there are lead-zinc baryte veins in the vicinity of the dolerite dyke trending North-East-South-West.

Toxic geochemical elements often associated with polymetallic sulphide deposits like we have in the Abakaliki-Ishiagu Lead-zinc district include Cadmium (Cd), Stibnium (Sb), Lead (Pb), zinc (Zn), Mercury (Hg), Arsenic (As), Copper (Cu) and Sulphur (S). Monitoring of the concentrations of these elements will help in safe usage and disposal of these water bodies.

The Precambrian Era comprises all of geologic time prior to 600 million years ago. The Precambrian was originally defined as the era that predated the emergence of life in the Cambrian Period. It is now known, however, that life on Earth began by the early Achaean and that fossilized organisms became more and more abundant throughout Precambrian time.

4.3.5 Hydrogeology and Drainage

Typically, most river basin consists mainly of basement complex rocks of the older granite type and also the undifferentiated types. These rocks in many places have been greatly weathered in-situ and hence there are several pockets of weathered sand and sandy clay lenses within the basin, some of these pockets of weathered materials appear on the surface in several areas. The sand pockets form good aquifers for underground water which recharge the river in the area in the dry season.

The project area is hydrogeologically barren except when there are sandstone beds and fractures, however, there are presence of numerous streams resulting from seepages from the famous Escarpment and this make major part of the project area swampy during the peak of the wet season. The shale in the project area is impermeable hence the rate of infiltration is low resulting in huge accumulation of water in abandoned mining pits forming artificial lakes. The area is well drained due to the presence of the Aki and Ochi Rivers which are tributaries of the Ivo River all flowing north.

Abia State has a variety of land forms, despite the fact that it is dominated by flat and low-lying land, generally less than 120m above sea-level. The low-lying plain is the inland extension of the coastal plain from the Bight of Benin. The central part of the state is characterized by undulating land with many hills. The highland areas are part of the Enugu – Nsukka – Okigwe cuesta. This area has an average height of between 120m and 180m above sea-level. From Okigwe (Imo State), this escarpment extends in a west-east direction and, on getting to Afikpo (Ebonyi State), veers south-eastwards to Arochukwu where it terminates.

There are nine main geological formations from south to north. These include: The Benin formation (or Coastal Plain Sand), the Bende-Ameki Group, the Nkporo Shale Group, the Nsukka formation (Upper Coal Measures), the Igali sandstone (False- bedded Sandstone), the Eze-Azu Shale Group and the Asu River Group. The principal rivers in Abia State are the Imo River and its tributary, the Aba River. Imo River originates from the northwestern part of the state and flows southwest through Abia and Imo state territories towards the Atlantic Ocean, passing through the southern parts of Ukwa-West and Ukwa-East local government areas. Other important rivers include lgwu, Azurnini Blue River and Kwalbo River.

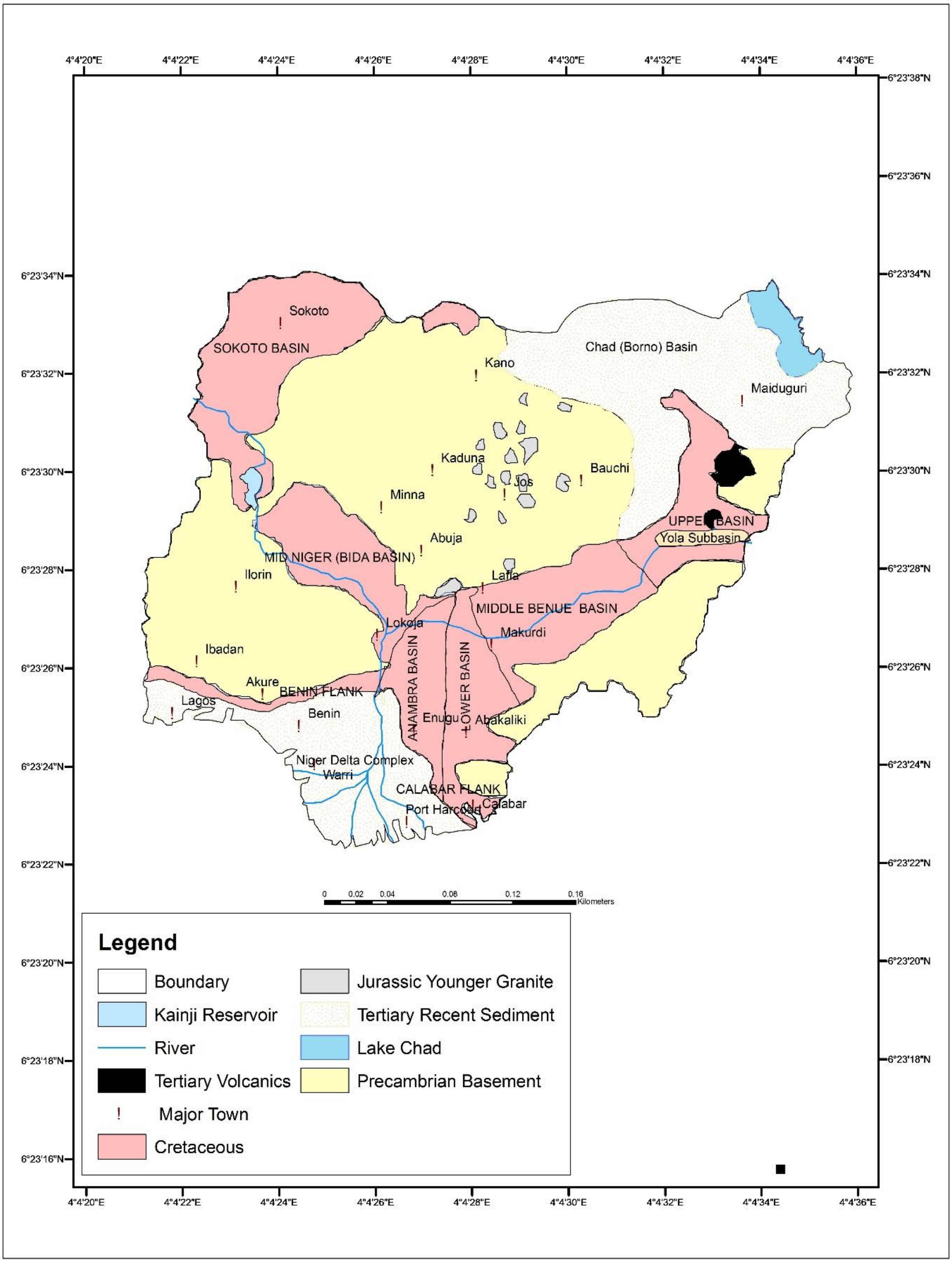


Figure 4.5 Hydro-Geology Map of Nigeria

4.4. Water Resources and Quality

Water is a chemical substance with the chemical formula H_2O. Its molecule contains one oxygen and two hydrogen atoms connected by covalent bonds. Water is a liquid at ambient conditions, but it often co-exists on earth with its solid state, ice, and gaseous state (water vapor or steam).

Water covers 70.9% of the earth's surface, and is vital for all known forms of life on earth, it is found mostly in oceans and other large water bodies, with 1.6% of water below ground in aquifers and 0.001% in the air as vapor, clouds (formed of solid and liquid water particles suspended in air), and precipitation. Oceans hold 97% of surface water, glaciers and polar ice caps 2.4%, and other land surface water such as rivers, lakes and ponds 0.6%. An essential element for livelihood, domestic, industrial and agricultural activities, we have to depend upon only 0.62% of water found in fresh water lakes, rivers and groundwater supplies, irregularly and non-uniformly distributed over the vast area of the globe. A very small amount of the earth's water is contained within biological bodies and manufactured products.

Water as a natural resource is essential for life. Humans, plants and animals require water for various biological functions. In fact, the reactions that make up life such as the synthesis of proteins and nucleotides (molecule of life) occurred in the aqueous medium. Water is the medium in which all living processes occur. An adult human has water content of 65 – 70%. Water helps to regulate body temperature. Imagine the process of glucose oxidation that liberates 8000 KJ of energy which is utilized by the body for performing essential, had this energy been dissipated as heat, the body temperature would have risen by 26^{o}C and would have resulted in death. Water also dissolves nutrient and distributes them to cells, supports structures and removes wastes products. Water is the most important of all oxides and in some respects the most important of all compounds in the world.

Nigeria is blessed with numerous rivers as well as coastal and inland sedimentary structures that store copious groundwater resources. According to the 2008 State of the Environment Report (Federal Ministry of Environment, 2008), the total surface water resources potential for Nigeria is estimated to be 267.3 billion cubic metres while the groundwater potential is put at 51.9 billion cubic metres, giving a total of 319.2 billion cubic metres. In addition, the number of relatively large dams completed or under construction in Nigeria is put at about 160 with a total active storage of 30.7 billion cubic metres

In Nigeria, there are abundant natural sources of water which includes; ocean, ground water, rivers and streams, lakes and ponds, wetlands, and the reservoirs. There are four principal surface water basins in Nigeria; the Niger River, the Lake Chad, the West Coast (sometimes referred to as the southwestern littoral basins), and the West Central Coast (also known as the southeastern littoral basins) (Fig. 4.6). The Niger Basin has an area of 584,193 km^2 within the country, which is 63 percent of the total area of the country, and covers a large area in central and northwestern Nigeria. The most important rivers in the basin are the Niger and its tributaries Benue, Sokoto and Kaduna. Lake Chad Basin located in the northeast with an area of 179,282 km^2, or 20 percent of the total area of the country, is the only internal drainage basin in Nigeria. Important rivers are the Komadougou Yobe and its tributaries Hadejia, Jama'are and Komadougou Gena. The West Coast Basin has an area of 101,802 km^2, which is 11 percent of the total area of the country. The rivers originate in the hilly areas to the south and west of the Niger River. The West Central Coast Basin with the major watercourses being the Cross and Imo Rivers, have an area of 58,493 km^2, which is 6 percent of the total area of the country, and receive much of their runoff from the plateau and mountain areas along the Cameroon border. Other rivers flowing into the Atlantic Ocean in the south include; Imo, Kwa Iboe, Ase, Orashi, Benin and numerous creeks in the Delta and Rivers States areas. Ogun and Oshun rives are fed by rivers originating from the Yoruba highlands. They flow slowly from north to south into the Lagos lagoons before discharging through creeks and swamps into the Atlantic Ocean.

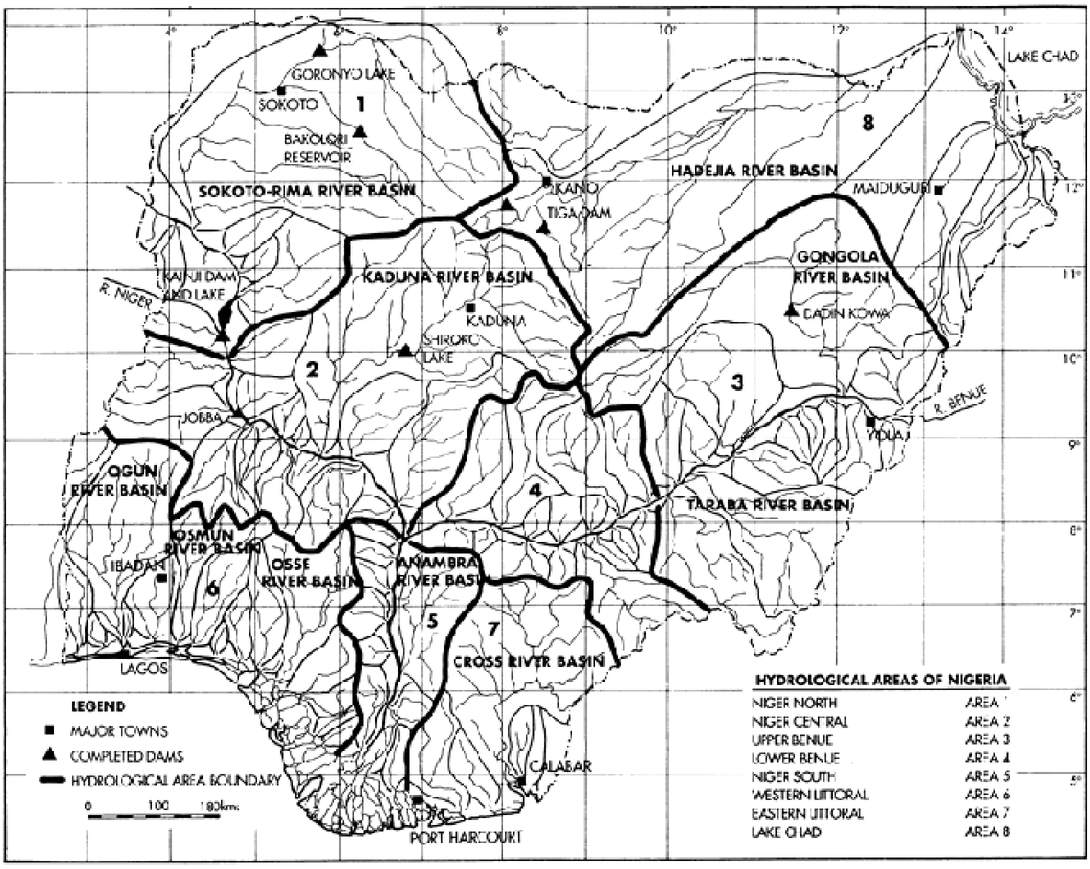


Fig. 4.6: Hydrological map of Nigeria showing major inland waters

4.4.1 Surface Water: Physiochemical and Microbial Characteristics

Surface water is water collecting on the ground or in a stream, river, lake, wetland, or ocean; it is related to water collecting as groundwater or atmospheric water. Surface water is naturally replenished precipitation and naturally lost through discharge to evaporation and sub-surface seepage into the ground.

Although water quality is complex, it is better described by the presence or absence of one or more of a large number of substances. These substances include physico-chemical and biological parameters present in the water. It is therefore important that water for drinking and other use categories be monitored to ascertain the level and nature of pollution. Water quality monitoring studies are centered mainly on physico-chemical, and biological analysis of water samples.

During dry season at the project site, Samples (3) were collected from a nearby lake (with distance of about 800m to the site boundary). During wet season, major sources of water for the host communities, *Amulo&Uzozo Streams*, situated close to the project site about 2km away, were sampled/taken for Surface water-quality sampling for (both in-situ and ex-situ) analysis of physio-chemical, heavy metals, and microbiological parameters of the Surface-Water Quality, and presented in Table 4.8.

Thus, a total of six (6) surface water (i.e. 3 per-season) was sampled of both upstream and downstream for water-quality sampling, as collected on-site during field-survey and in-situ analysis conducted at project site. The samples were stored/preserved in Lab-specified containers in an ice-packed cooler and transported to Richflood Laboratory for analysis, with Quality Assurance procedures *(as described in Study-Methodology above)*.

Table 4.8a **Physiochemical and Microbial analysis of the Surface Water (SW) Quality at project location, Wet Season**

S/N	PARAMETERS SAMPLED	UNIT	LAB RESULTS			FMEnv LIMIT
			SW_1 AMULO STREAM	SW_2 UZOZO STREAM	SW_3 CONTROL	
	PHYSICOCHEMICAL ANALYSIS					
1.	Colour	Hazen unit	Colourless	Colourless	Colourless	Colorless
2.	Odour	TN	Odourless	Odourless	Odourless	-
3.	Temperature	^0C	30.80	29.60	20.10	40
4.	pH	-	4.37	4.61	4.73	6.5-8.5
5.	Turbidity	mg/L	0.14	0.17	0.12	1.0
6.	Electrical Conductivity	µs	20.00	16.00	9.00	-
7.	Total Dissolved Solid	mg/L	10.00	7.00	1.30	500
8.	Total Suspended Solids	mg/L	4.00	13.00	1.00	>10
9.	Total Hardness	mg/L	25.50	32.50	8.00	200

10.	Dissolved Oxygen (DO)	mg/L	1.7	1.3	5.00	7.5
11.	Chemical Oxygen Demand	mg/L	40.00	33.00	18.00	-
12.	THC	-	ND	ND	ND	-
13.	Nitrate (NO^-_3)	mg/L	1.30	2.20	0.10	10.0
14.	Sulphate (SO_4^{2-})	mg/L	ND	ND	1.10	500
15.	Phosphate (PO_3^{2-})	mg/L	0.28	0.60	0.04	>5
16.	Ammonia (NH_3)	mg/L	0.23	0.11	11.20	<1.0
17.	Ammonium (NH_4^+)	mg/L	0.24	0.12	ND	-
18.	Lead (Pb)	mg/L	**0.13**	0.05	0.02	0.05
19.	Copper (Cu)	mg/L	**0.40**	**0.79**	**0.22**	0.1
20.	Iron (Fe)	mg/L	ND	ND	ND	1.0
21.	Magnesium (Mg)	mg/L	2.17	1.77	0.39	-
22.	Zinc (Zn)	mg/L	0.66	0.43	0.05	5.0
23.	Potassium (K)	mg/L	0.13	0.05	0.02	-
	MICROBIAL ANALYSIS					
24.	Total Coliforms	MPN/ml	$>2.3x10^1$	$1.4x10^1$	$1.8x10^1$	0
25.	Total Bacteria Count (TBC)	CFU/ml	TFC	$2.8x10^1$	$2.0x10^1$	0
26.	*Faecal Coliform*	CFU/100ml	NG	NG	NG	0
27.	*Salmonella spp.*	CFU/ml	NG	NG	NG	0
28.	*Shigella spp.*	CFU/ml	NG	NG	NG	0

SW= Surface Water, **MPN**= Most probable Number, **CFU**= Colony Forming Unit, **ND**= Not detected, **NG**=No growth, **TFC**= Too few to count
Lab Source: Richflood Laboratories; October, 2015; Sample Number: Rf/Lab/15/Pc/Mcb/Sw_1- Sw_3/008
Limit Source: Federal Ministry of Environment: National Guidelines and Standards for Water Quality in Nigeria.

Table 4.8b **Physiochemical and Microbial analysis of the Surface Water (SW) Quality at project location, Dry Season**

S/N	PARAMETER SAMPLED	UNIT	LAB RESULT				FMEnv Limit
			SW_1	SW_2	SW_3	SW_5 control	
PHYSICOCHEMICAL ANALYSIS							
1.	Colour		Colourless	Colourless	Colourless	Colourless	Colourless
2.	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless
3.	Temperature	^0C	33.60	30.40	27.80	30.10	40
4.	pH	-	6.55	6.67	4.22	4.73	6.5-8.5
5.	Total Dissolved Solid	mg/L	9.00	15.30	11.00	8.00	500
6.	Dissolved Oxygen	mg/L	1.30	1.20	1.40	1.30	7.5
7.	Turbidity	mg/L	0.16	0.14	0.17	0.12	1.0
8.	Electrical Conductivity	µS/cm	12.90	21.90	21.00	17.00	-
9.	Total Suspended Solids	mg/L	6.00	20.00	6.00	8.00	>10
10.	Total Hardness	mg/L	69.00	45.00	54.00	9.00	200
11.	Chemical Oxygen Demand	mg/L	32.00	30.00	30.00	22.00	-
12.	Biochemical Oxygen Demand	mg/L	0.40	0.10	0.70	0.20	0
13.	THC	-	ND	ND	ND	ND	-
14.	Nitrate (NO_3^-)	mg/L	1.40	1.00	4.00	2.10	10.0
15.	Nitrite (NO_2^-)	mg/L	0.02	0.01	0.01	0.02	1.0
16.	Phosphate (PO_4^{2-})	mg/L	0.26	0.27	0.93	22.17	>5
17.	Sulphate (SO_4^{2-})	mg/L	ND	ND	ND	ND	500
18.	Iron (Fe^{2+}/ Fe^{3+})	mg/L	0.05	0.06	0.04	0.03	1.0

19.	Lead (Pb^{2+})	mg/L	ND	ND	ND	ND	0.05
20.	Zinc (Zn^{2+})	mg/L	ND	ND	ND	ND	5.0
21.	Potassium (K^{+})	mg/L	ND	ND	ND	ND	-
22.	Copper (Cu^{2+})	mg/L	0.24	0.53	0.94	0.59	0.1
23.	Magnesium (Mg^{2+})	mg/L	ND	0.01	ND	0.06	-
MICROBIAL ANALYSIS							
24.	Total Coliforms Count	MPN/100ml	5.1	1.1	>$2.3x10^1$	$1.6x10^1$	0
25.	Total Bacteria Count	CFU/ml	$4.2x10^2$	TFC	TFC	$3.0x10^1$	0
26.	Faecal Coliform	MPN/100ml	NG	NG	NG	NG	0
27.	*Salmonella* spp.	CFU/ml	TFC	NG	NG	NG	0
28.	*Shigella* spp	CFU/ml	TFC	NG	NG	NG	0

SW= Surface Water, **MPN**= Most Probable Number, **CFU**=Colony forming unit, ***NG***: No Growth, **ND**: None Detected, **TFC**= Too few to count; **FMEnv:** Federal Ministry of Environment

LAB *Source:* Richflood Laboratories; March, 2016; **Sample Number:** Rf/Lab/16/Pc/Mcb/$Sw_{1, 2, 3\&}Sw_5$/028

Limit Source: Federal Ministry of Environment National Guidelines and Standards for Water Quality in Nigeria

Sample Sources: = Sw_1= Upstream (Lake), Sw_2 = Down Stream (Lake), Sw_3=Upstream (Stream)

Discussions and Result Analysis of Water Quality Parameters:

Temperature:

Water Temperature is a physical property expressing how hot or cold water is. Temperature is an important factor to consider when assessing water quality. In addition to its own effects, temperature influences several other parameters and can alter the physical and chemical properties of water. In this regard, water temperature should be accounted for when determining: Metabolic rates and photosynthesis production, compound Toxicity, Dissolved Oxygen and other dissolved gas concentrations, Conductivity and Salinity, Oxidation Reduction Potential (ORP), pH and Water Density.

Generally, the most common physical assessment of water quality is the Measurement of Temperature. Temperature impacts both the chemical and biological characteristics of surface water. It affects the dissolved oxygen level in the water, photosynthesis of aquatic plants, metabolic rates of aquatic organisms, and the sensitivity of these organisms to pollution, parasites and disease.

Water temperature plays a major role in the quality of aquatic life and habitats. Heat flow and the fluctuation of temperature determine what species will live and thrive in a body of water. Considered alone, water temperature can affect the metabolic rates and biological activity of aquatic organisms. As such, it influences the chosen habitats of a variety of aquatic life. Some organisms, particularly aquatic plants flourish in warmer temperatures, while some fishes such as trout or salmon prefer colder streams.

Also, high water temperatures can increase the solubility and thus toxicity of certain compounds. These elements include heavy metals such as cadmium, zinc and lead as well as compounds like ammonia.

The solubility of oxygen and other gases will decrease as temperature increases. This means that colder lakes and streams can hold more dissolved oxygen than warmer waters. If water is too warm, it will not hold enough oxygen for aquatic organisms to survive.

Water temperature can affect conductivity in two ways. As conductivity is measured by the electrical potential of ions in solution, it is affected by the concentration, charge and mobility of those ions. Ionic mobility is dependent on viscosity (liquid’s ability to resist flow) which is in turn dependent on temperature. Thus, water temperature affects viscosity, which in turn affects ionic activity and conductivity. The second way that temperature can affect conductivity is through ionic concentration. Many salts are more soluble at higher temperatures. As a salt dissolves, it breaks down into its respective ions. As warm water can dissolve several minerals and salts more easily than cold water, the ionic concentration is often higher. The increased mineral and ion content can be noticed in natural hot springs, which tout their "healing" abilities. These dissolved solutes are often referred to as Total Dissolved Solids, or TDS. These salts and minerals enter the water from rocks and sediment in contact with it. As they dissolve and the ionic concentration increases, so will the conductivity of water. With many salts are more soluble at higher temperatures, it means the rate at which conductivity increases is dependent on the salts present in solution.

Furthermore, as the water temperature increases or decreases, the ion concentrations will also shift, thus shifting the pH value.

Factors that Influence Water Temperature: Water temperature can be affected by many ambient conditions. These elements include exposure to sunlight/solar radiation, heat transfer from the atmosphere, air temperature, storm-water runoff, groundwater inflows, and stream confluence. Shallow and surface waters are more easily influenced by these factors than deep water. Increased Turbidity will also increase water temperature. Turbidity is the amount of suspended solids in water. These suspended particles absorb heat from solar radiation more efficiently than water. The heat is then transferred from the particles to water molecules, increasing the temperature of the surrounding water.

During ***Wet Season*** water-quality sampling at the project area, the level of Temperature in the sampled water ranges from 20.10 – 30.80 ^{0}C; while at the ***Dry Season***, the level of Temperature in the sampled water ranges from 27.80 – 33.60 ^{0}C. This is within Standard (*FMEnv*) limit.

Water pH:

pH stands for the "power of hydrogen". The numerical value of pH is determined by the molar concentration of hydrogen ions (H+). pH is a measure of a solution's acidity. In water, small numbers of water molecules (H2O) will break apart or disassociate into hydrogen ions (H+) and hydroxide ions (OH-). Other compounds entering the water may react with these, leaving an imbalance in the numbers of hydrogen and hydroxide ions. When more hydrogen ions react, more hydroxide ions are left in solution and the water is basic; when more hydroxide ions react, more hydrogen ions are left and the water is acidic. pH is a measure of the number of hydrogen ions and thus a measure of acidity. pH is measured on a logarithmic scale between 1 and 14 with 1 being extremely acid, 7 neutral, and 14 extremely basic. Because it is a logarithmic scale there is a ten fold increase in acidity for a change of one unit of pH, e.g. 5 is 100 times more acid than 7 on the pH scale. The optimum pH levels for fish are from 6.5 to 9.0. Outside of optimum ranges, organisms can become stressed or die.

pH can also affect the solubility and toxicity of chemicals and heavy metals in the water. Low pH levels can encourage the solubility of heavy metals. As the level of hydrogen ions increases, metal cations such as aluminum, lead, copper and cadmium are released into the water instead of being absorbed into the sediment. As the concentrations of heavy metals increase, their toxicity also increases.

Factors that Influence the pH of Water: There are many factors that can affect pH in water, both natural and man-made. Most natural changes occur due to interactions with surrounding rock (particularly carbonate forms) and other materials. pH can also fluctuate with precipitation (especially acid rain) and wastewater or mining discharges. In addition, CO_2 concentrations can influence pH levels.

pH levels can fluctuate daily due to photosynthesis and respiration in the water. The degree of change depends on the alkalinity of the water.

During ***Wet Season*** water-quality sampling at the project area, the level of pH in the sampled water ranges from 4.37 – 4.73; while at the ***Dry Season***, the level of pH in the sampled water ranges from 4.22 – 6.67. This is within Standard (*FMEnv*) limit.

Total Suspended Solids (TSS):

Total Suspended Solids (TSS) are particles that are larger than 2 microns found in the water column. Anything smaller than 2 microns (average filter size) is considered a dissolved solid. Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration.

These solids include anything drifting or floating in the water, from sediment, silt, and sand to plankton and algae. Organic particles from decomposing materials can also contribute to the TSS concentration. As algae, plants and animals decay, the decomposition process allows small organic particles to break away and enter the water column as suspended solids. Even chemical precipitates are considered a form of suspended solids. Total suspended solids are a significant factor in observing water clarity. The more solids present in the water, the less clear the water will be.

Thus, TSS highly affects water clarity. Some suspended solids can settle out into sediment at the bottom of a body of water over a period of time. Heavier particles, such as gravel and sand, often settle out when they enter an area of low or no water flow. Although this settling improves water clarity, the increased silt can smother benthic organisms and eggs. The remaining particles that do not settle out are called colloidal or non-settleable solids. These suspended solids are either too small or too light to settle to the bottom. Settle-able solids are also known as bedded sediments, or bedload. These sediments can vary from larger sand and gravel to fine silt and clay, depending on the flow rate of water.

In terms of water quality, high levels of total suspended solids will increase water temperatures and decrease dissolved oxygen (DO) levels. This is because suspended particles absorb more heat from solar radiation than water molecules will. This heat is then transferred to the surrounding water by conduction. Warmer water cannot hold as much dissolved oxygen as colder water, so DO levels will drop. In addition, the increased surface temperature can cause stratification, or layering, of a body of water. When water stratifies, the upper and lower layers do not mix. As decomposition and respiration often occur in the lower layers, they can become too hypoxic (low dissolved oxygen levels) for organisms to survive. When the suspended solids concentration is due to organic materials, particularly sewage effluent and decaying organic matter, the presence of bacteria, protozoa and viruses are more likely. These organic suspended solids are also more likely to decrease dissolved oxygen levels as they are decomposed.

What Contributes to Suspended Solids: Suspended solids in a body of water are often due to natural causes. These natural solids include organic materials such as algae, and inorganic materials such as silt and sediment (from runoff and erosion). Some algae, such as phytoplankton, are regular occurrences, especially in the ocean. Inorganic materials can easily become suspended due to runoff, erosion and resuspension from seasonal water flow. However, when suspended solids exceed expected concentrations, they can negatively impact a body of water. Excess over background amounts are often attributed to human influence, whether directly or indirectly. Pollution may contribute to either

organic or inorganic suspended solids, depending on the source. Algae, sediment and pollution will affect water quality in different ways depending on the quantity present.
Rain can also directly increase the level of total suspended solids through runoff. As water flows over a surface, it can pick up particles and deposit them in a body of water. Runoff can also wash away topsoil, and contribute to riverbank erosion. If the flow rate increases enough, it can resuspend bottom sediments, further raising TSS concentrations. In areas of dry, loose soil or earth-disturbed sites (e.g. mining or construction areas), wind can blow dust, sediment and other particles into the water. The addition of new particles will increase the suspended solids concentration. TSS has a direct reflection on water Turbidity and Clarity *(see discussion on Turbidity)*.

During ***Wet Season*** water-quality sampling at the project area, the concentration-level of TSS in the sampled water ranges from 1.00 – 13.00mg/l; while at the ***Dry Season***, the concentration-level of TSS in the sampled water ranges from 6.00 – 20.00 mg/l. This is within Standard (*FMEnv*) limit. Thus the *Colorless*-nature of the water. This is as a result of less solid particles present within the water body. This also means the more solids present in the water, the less clear the water will be. Total suspended solids are a significant factor in observing water clarity.

Turbidity and Water Clarity:

Turbidity is an optical determination of water clarity. Turbid water will appear cloudy, murky, or otherwise colored, affecting the physical look of the water. Suspended solids and dissolved colored material reduce water clarity by creating an opaque, hazy or muddy appearance. Turbidity measurements are often used as an indicator of water quality based on clarity and estimated total suspended solids in water. Thus, turbidity is the amount of particulate matter that is suspended in water.
The turbidity of water is based on the amount of light scattered by particles in the water column. The more particles that are present, the more light that will be scattered. As such, turbidity and total suspended solids are related. However, turbidity is not a direct measurement of the total suspended materials in water. Instead, as a measure of relative clarity, turbidity is often used to indicate changes in the total suspended solids concentration in water without providing an exact measurement of solids.

Turbidity can come from suspended sediment such as silt or clay, inorganic materials, or organic matter such as algae, plankton and decaying material. In addition to these suspended solids, turbidity can also include colored dissolved organic matter (CDOM), fluorescent dissolved organic matter (FDOM) and other dyes. CDOM is also known as humic stain. Humic stain refers to the tea color produced from decaying plants and leaves underwater due to the release of tannins and other molecules.

This discoloration is often found in bogs, wetlands or other water bodies with high amounts of decaying vegetation in the water. CDOM can cause water to appear red or brown, depending on the type of plants or leaves present. These dissolved substances may be too small to be counted in a suspended solids concentration, but they are still part of a turbidity measurement as they affect water clarity.

Thus, water clarity is directly related to turbidity, as turbidity is a measure of water clarity. The transparency of water is affected by the amount of sunlight available, suspended particles in the water column and dissolved solids such as colored dissolved organic material (CDOM) present in the water.

Salinity also affects water clarity. This is due to the effect of salt on the aggregation and settling velocity of suspended particles. In other words, salt ions collect suspended particles and bind them together, increasing their weights and thus their likelihood of settling to the bottom. Due to this mechanism, oceans and estuaries tend to have a higher clarity (and lower average turbidity) than lakes and rivers. These marine environments also have a higher rate of sedimentation as solids are pulled out of the water column to the seafloor.

Difference between Turbidity vs. Suspended Solids: Turbidity and total suspended solids refer to particles present in the water column. Turbidity and water clarity are both visual properties of water based on light scattering and attenuation. All three parameters are related to particles in the water column, whether directly or indirectly.

Turbidity is determined by the amount of light scattered off of these particles. While this measurement can then be used to estimate the total dissolved solids concentration, it will not be exact. Turbidity does not include any settled solids or bedload (sediment that "rolls" along the riverbed). In addition, turbidity measurements may be affected by colored dissolved organic matter. While this dissolved matter is not included in TSS measurements, it can cause artificially low turbidity readings as it absorbs light instead of scattering it.

Total suspended solids, on the other hand, are a total quantity measurement of solid material per volume of water. This means that TSS is a specific measurement of all suspended solids, organic and inorganic, by mass. TSS includes settleable solids, and is the direct measurement of the total solids present in a water body. As such, TSS can be used to calculate sedimentation rates, while turbidity cannot.

Water clarity is strictly relative to sunlight penetration. While this is usually determined by the amount of suspended solids in water, it can also be affected by CDOM and other dissolved solids. Water clarity is the most subjective measurement of these three parameters, as it is usually determined by human observation.

Importance of Turbidity and Total Suspended Solids Important: Turbidity and TSS are the most visible indicators of water quality. These suspended particles can come from soil erosion, runoff, discharges, stirred bottom sediments or algal blooms. While it is possible for some streams to have naturally high levels of suspended solids, clear water is usually considered an indicator of healthy water. A sudden increase in turbidity in a previously clear body of water is a cause for concern. Excessive suspended sediment can impair water quality for aquatic and human life, impede navigation and increase flooding risks.

Turbidity can also inhibit photosynthesis by blocking sunlight. Halted or reduced photosynthesis means a decrease in plant survival and decreased dissolved oxygen output. The higher the turbidity levels, the less light that can reach the lower levels of water. This reduces plant productivity at the bottom of an ocean, lake or river.

An increase in turbidity can also indicate increased erosion of stream banks, which may have a long-term effect on a body of water. Erosion reduces habitat quality for fish and other organisms. In terms of water clarity, reduced light penetration due to suspended sediment can obscure aquatic organisms’ vision, reducing their ability to find food. These suspended particles can also clog fish gills and affect growth rates.

Pollutants such as dissolved metals and pathogens can attach to suspended particles and enter the water. This is why an increase in turbidity can often indicate potential pollution, not just a decrease in water quality. Contaminants include bacteria, protozoa, nutrients (e.g. nitrates and phosphorus), pesticides, mercury, lead and other metals. Several of these pollutants, especially heavy metals, can be detrimental and often toxic to aquatic life. The addition of nutrients can encourage the development of harmful algal blooms. These microbes and heavy metals can impact not only aquatic organisms, but drinking water as well. Organic suspended solids, such as decomposing matter or sewage effluent often naturally include high levels of microorganisms such as protozoa, bacteria and viruses. Such pathogens contribute to waterborne diseases like cryptosporidiosis, cholera and giardiasis. Turbid water, whether due to organic or inorganic material, cannot be easily disinfected, as the suspended particles will "hide" these microorganisms.

Factors that Influence Turbidity: Turbidity is caused by presence of particles which include organic materials such as algae, and inorganic materials such as silt and sediment (as a result of runoff and erosion). However, there are specific factors that can affect turbidity levels in a body of water. These are water flow, point source pollution, land use and re-suspension.

Turbidity and water flow are causally related. High flow rates keep particles suspended instead of letting them settle to the bottom. Thus in rivers and other naturally-occurring high flow environments, turbidity can be a constant presence. Weather, particularly heavy rainfall, also affects water flow, which in turn affects turbidity. Rainfall can increase stream volume and thus stream flow, which can resuspend settled sediments and erode riverbanks. Tributaries can also alter turbidity. When a freshwater stream or river enters a saltwater estuary, the change in water flow can cause turbidity levels to increase.

Point-source pollution can increase turbidity through the addition of suspended solids and colored effluent (wastewater) to a body of water.

A major factor in increased turbidity and total suspended solids concentrations is due to land use. Construction, logging, mining and other disturbed sites have an increased level of exposed soil and decreased vegetation. Agricultural areas are also considered disturbed areas after they are tilled. Land development, whether it is agricultural or construction, disturbs and loosens soil, increasing the opportunities for runoff and erosion. The loosened soils caused by these sites can then be carried away by wind and rain to a nearby body of water. This leads to an increase in runoff rates, causing erosion and increased turbidity in local streams and lakes. Settleable solids in the runoff can be deposited on the bottom of a lake, river or ocean, damaging benthic habitats. Erosion due to land use is considered a non-point source of turbidity. The use of silt fences and sedimentation basins at construction sites can prevent soils from reaching nearby water sources. In addition to increasing turbidity levels through suspended sediment, agricultural runoff often includes nutrients as well. Due to the presence of these nutrients, this runoff can fuel the growth of algal blooms.

Also, on issue of resuspension, even carp and other bottom-feeding fish can contribute to increased turbidity levels. As they remove vegetation, sediment can become resuspended in the water. Sediment at the bottom of a body of water can be stirred up by shifting water flow, bottom-feeding fish, and anthropogenic causes such as dredging and mining activities.

In summary, Turbidity is a measure of how particles suspended in water affect water clarity. It is an important indicator of suspended sediment and erosion levels. Typically it will increase sharply during and after a rainfall, which causes sediment to be carried into the creek. Elevated turbidity will also raise water temperature, lower dissolved oxygen, prevent light from reaching aquatic plants which reduces their ability to photosynthesize, and harm fish gills and eggs.

During ***Wet Season*** water-quality sampling at the project area, the concentration-level of Turbidity in the sampled water ranges from 0.12 – 0.17mg/l; while at the ***Dry Season***, the concentration-level of Turbidity in the sampled water ranges from 0.12 – 0.17mg/l. This is within Standard (*FMEnv*) limit. Thus the *Colorless*-nature of the water; (*see related discussion Total Suspended Solids above)*

Dissolved Oxygen (DO):

Dissolved oxygen refers to the level of free, non-compound oxygen present in water or other liquids. It is an important parameter in assessing water quality because of its influence on the organisms living within a body of water. In limnology (the study of lakes), dissolved oxygen is an essential factor second only to water itself. A dissolved oxygen level that is too high or too low can harm aquatic life and affect water quality. Non-compound oxygen, or free oxygen (O_2), is oxygen that is not bonded to any other element. Dissolved oxygen is the presence of these free O_2 molecules within water. The bonded oxygen molecule in water (H_2O) is in a compound and does not count toward dissolved oxygen levels. One can imagine that free oxygen molecules dissolve in water much the way salt or sugar does when it is stirred.

Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants. These organisms use oxygen in respiration, similar to organisms on land. Fish and crustaceans obtain oxygen for respiration through their gills, while plant life and phytoplankton require dissolved oxygen for respiration when there is no light for photosynthesis. Microbes such as bacteria and fungi also require dissolved oxygen. These organisms use DO to decompose organic material at the bottom of a body of water. Microbial decomposition is an important contributor to nutrient recycling. However, if there is an excess of decaying organic material (from dying algae and other organisms), in a body of water with infrequent or no turnover (also known as stratification), the oxygen at lower water levels will get used up quicker.

Dissolved oxygen enters water through the air or as a plant by-product. From the air, oxygen can slowly diffuse across the water's surface from the surrounding atmosphere, or be mixed in quickly through aeration, whether natural or man-made. The aeration of water can be caused by wind (creating waves), rapids, waterfalls, ground water discharge or other forms of running water. Man-made causes of aeration vary from an aquarium air pump to a hand-turned waterwheel to a large dam. Dissolved oxygen is also produced as a waste product of photosynthesis from phytoplankton, algae, seaweed and other aquatic plants

The basic reaction of aquatic photosynthesis remains:

$CO_2 + H_2O \rightarrow (CH_2O) + O_2$

As aquatic photosynthesis is light-dependent, the dissolved oxygen produced will peak during daylight hours and decline at night.

What Affects Oxygen Solubility: The actual amount of dissolved oxygen (in mg/L) in water will vary depending on temperature, pressure and salinity. First, the solubility of oxygen decreases as temperature increases. Second, dissolved oxygen decreases exponentially as salt levels increase. Third, dissolved oxygen will increase as pressure increases. This is true of both atmospheric and hydrostatic pressures. Water at lower altitudes can hold more dissolved oxygen than water at higher altitudes. Thus, DO concentrations decrease as altitude increases (pressure decreases).

Dissolved oxygen concentrations are constantly affected by diffusion and aeration, photosynthesis, respiration and decomposition. While water equilibrates toward 100% air saturation, dissolved oxygen levels will also fluctuate with temperature, salinity and pressure changes. As such, dissolved oxygen levels can range from less than 1 mg/L to more than 20 mg/L depending on how all of these factors interact. In freshwater systems such as lakes, rivers and streams, dissolved oxygen concentrations will vary by season, location and water depth.

Human factors that affect dissolved oxygen in streams include addition of oxygen consuming organic wastes such as sewage, addition of nutrients, changing the flow of water, raising the water temperature, and the addition of chemicals.

During ***Wet Season*** water-quality sampling at the project area, the concentration-level of DO in the sampled water ranges from 1.3– 5.00mg/l; while at the ***Dry Season***, the concentration-level of DO in the sampled water ranges from 1.20 – 1.40mg/l. This is within Standard (*FMEnv*) limit.

Total Dissolved Solid (TDS):

Total Dissolved Solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and some small amounts of organic matter that are dissolved in water. In general, the total dissolved solids concentration is the sum of the cations (positively charged) and anions (negatively charged) ions in the water.

Total dissolved solids (TDS) combine the sum of all ion particles that are smaller than 2 microns (0.0002 cm). This includes all of the disassociated electrolytes that make up salinity concentrations, as well as other compounds such as dissolved organic matter. In “clean” water, TDS is approximately equal to salinity. In wastewater or polluted areas, TDS can include organic solutes (such as hydrocarbons and urea) in addition to the salt ions.

TDS in drinking-water originate from natural sources, sewage, urban run-off, industrial wastewater, and chemicals used in the water treatment process, and the nature of the piping or hardware used to convey the water, i.e., the plumbing.

While TDS measurements are derived from conductivity, some states, regions and agencies often set a TDS maximum instead of a conductivity limit for water quality. At most, freshwater can have 2000 mg/L of total dissolved solids, and most sources should have much less than that. Depending on the ionic properties, excessive total dissolved solids can produce toxic effects on fish and fish eggs. E.g. Salmonids exposed to higher than average levels of $CaSO_4$ at various life stages experienced reduced survival and reproduction rates.

Dissolved solids are also important to aquatic life by keeping cell density balanced. In distilled or deionized water, water will flow into an organism's cells, causing them to swell. In water with a very high TDS concentration, cells will shrink. These changes can affect an organism's ability to move in a water column, causing it to float or sink beyond its normal range.

TDS can also affect water taste, and often indicates a high alkalinity or hardness.

Elevated Total Dissolved Solids can result in your water having a bitter or salty taste; result in incrustations, films, or precipitates on fixtures; corrosion of fixtures, and reduced efficiency of water filter and equipment.

During ***Wet Season*** water-quality sampling at the project area, the concentration-level of TDS in the sampled water ranges from 1.30 – 10.00mg/l; while at the ***Dry Season***, the concentration-level of TDS in the sampled water ranges from 8.00 – 15.30mg/l. This is within Standard (*FMEnv*) limit.

Conductivity and Salinity:

Conductivity is a measure of water's capability to pass electrical flow. This is an indicator of the concentration of dissolved electrolyte ions in the water. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds. Compounds that dissolve into ions are also known as electrolytes. The more ions that are present, the higher the conductivity of water. Likewise, the fewer ions that are in the water, the less conductive it is. Distilled or deionized water can act as an insulator due to its very low (if not negligible) conductivity value. Sea water, on the other hand, has a very high conductivity.

Ions conduct electricity due to their positive and negative charges. When electrolytes dissolve in water, they split into positively charged (cation) and negatively charged (anion) particles. As the dissolved substances split in water, the concentrations of each positive and negative charge remain equal. This means that even though the conductivity of water increases with added ions, it remains electrically neutral.

Thus, salts dissolve in water to produce an anion and a cation, and these ions make up the basis of conductivity in water.

Then again, as a basic definition, ***Salinity*** is the total concentration of all dissolved salts in water. These electrolytes form ionic particles as they dissolve, each with a positive and negative charge. As such, salinity is a strong contributor to conductivity. While salinity can be measured by a complete chemical analysis, this method is difficult and time consuming. Seawater cannot simply be evaporated to a dry salt mass measurement as chlorides are lost during the process.

More often, salinity is not measured directly, but is instead derived from the conductivity measurement. This is known as practical salinity. There are many different dissolved salts that contribute to the salinity of water. The major ions in seawater *(with a practical salinity of 35)* are: chloride, sodium, magnesium, sulfate, calcium, potassium, bicarbonate and bromine. Many of these ions are also present in freshwater sources, but in much smaller amounts. The ionic compositions of inland water sources are dependent on the surrounding environment. Most lakes and rivers have alkali and alkaline earth metal salts, with calcium, magnesium, sodium, carbonates and chlorides making up a high percentage of the ionic composition. Freshwater usually has a higher bicarbonate ratio while seawater has greater sodium and chloride concentrations. The historical definition of salinity was based on chloride concentration (which could be determined by titration); however determining total salinity based on chloride concentrations is only accurate in water sources with a known chloride-salinity ratio, such as seawater.

Relationship and Importance of Conductivity and Salinity in Water Quality:

Conductivity and Salinity have a strong correlation. As conductivity is easier to measure, it is used in algorithms estimating salinity and TDS, both of which affect water quality and aquatic life.

Salinity is important in particular as it affects dissolved oxygen solubility. The higher the salinity level, the lower the dissolved oxygen concentration. Oxygen is about 20% less soluble in seawater than in freshwater at the same temperature. This means that, on average, seawater has a lower dissolved oxygen concentration than freshwater sources.

The effect of salinity on the solubility of dissolved gases is due to Henry's Law; the constant used will change based on salt ion concentrations.

Secondly, most aquatic organisms can only tolerate a specific salinity range. The physiological adaption of each species is determined by the salinity of its surrounding environment. Some aquatic organisms can even be sensitive to the ionic composition of the water. An influx of a specific salt can negatively affect a species, regardless of whether the salinity levels remain within an acceptable range. Salinity tolerances depend on the osmotic processes within an organism. Fish and other aquatic life that live in fresh water (low-conductivity) are hyperosmotic. Hyperosmotic defines a cell's ability to eliminate water and retain ions. Thus these organisms maintain higher internal ionic concentrations than the surrounding water. On the other side of the spectrum, saltwater (high-conductivity) organisms are hypoosmotic and maintain a lower internal ionic concentration than seawater. Euryhaline organisms are able to adapt their bodies to the changing salt levels. Each group of organisms has adapted to the ionic concentrations of their respective environments, and will absorb or excrete salts as needed.

Thirdly, A sudden increase or decrease in conductivity in a body of water can indicate pollution. Agricultural runoff or a sewage leak (polluting discharges) will increase conductivity due to the additional chloride, phosphate and nitrate ions. An oil spill or addition of other organic compounds would decrease conductivity as these elements do not break down into ions. In both cases, the additional dissolved solids will have a negative impact on water quality.

Fourthly, Salinity affects water density. The higher the dissolved salt concentration, the higher the density of water. The increase in density with salt levels is one of the driving forces behind *ocean convention.*

Conductivity and Salinity vary greatly between different bodies of water.

Factors affecting Conductivity in water: Every stream will have a baseline conductivity depending on the local geology and soils. Most freshwater streams and lakes have low salinity and conductivity values. In streams and rivers (unlike in oceans), normal conductivity levels come from the surrounding geology. Clay soils will contribute to conductivity, while granite bedrock will not. The minerals in clay will ionize as they dissolve, while granite remains inert. Likewise, groundwater inflows will contribute to the conductivity of the stream or river depending on the geology that the groundwater flows through. Groundwater that is heavily ionized from dissolved minerals will increase the conductivity of the water into which it flows.

On the other hand, the oceans have a high conductivity and salinity due to the high number of the dissolved salts present. Most of the salt in the ocean comes from runoff, sediment and tectonic activity. Rain contains carbonic acid, which can contribute to rock erosion. As rain flows over rocks and soil, the minerals and salts are broken down into ions and are carried along, eventually reaching the ocean.

Water flow, whether it is from a spring, groundwater, rain, confluence or other sources can affect the salinity and conductivity of water. Likewise, reductions in flow from dams or river diversions can also alter conductivity levels. Water flow and water level changes can also contribute to conductivity through their impact on salinity. The effect of water flow on conductivity and salinity values is fairly basic. If the inflow is a freshwater source, it will decrease salinity and conductivity values. Freshwater sources include springs, clear, clean streams and fresh groundwater. On the other side of the spectrum, highly mineralized groundwater inflows will increase conductivity and salinity. Agricultural runoff, in addition to being high in nutrients, often has a higher concentration of dissolved solids that can influence conductivity. For both freshwater and mineralized water, the higher the flow volume, the more it will affect salinity and conductivity.

Water level changes, such as tidal stages and evaporation will cause salinity and conductivity levels to fluctuate as well. The conductivity of water due to water level fluctuations is often directly connected to water flow. Conductivity and salinity fluctuations due to water level changes are most noticeable in estuaries. As tides rise, saltwater from the ocean is pushed into an estuary, raising salinity and conductivity values. When the tide falls, the saltwater is pulled back toward the ocean, lowering conductivity and salinity. Evaporation can cause salinity concentrations to rise. As the water level lowers, the ions present become concentrated, contributing to higher conductivity levels. This is why conductivity and salinity values often increase in summer due to lower flow volume and evaporation. On the other side of the scale, rain can increase water volume and level, lowering conductivity.

Conductivity is dependent on water temperature and salinity/TDS. Water temperature can cause conductivity levels to fluctuate daily. When water temperature increases, so will conductivity. For every 1°C increase, conductivity values can increase 2-4%. Temperature affects conductivity by increasing ionic mobility as well as the solubility of many salts and minerals. This can be seen in diurnal variations as a body of water warms up due to sunlight, (and conductivity increases) and then cools down at night (decreasing conductivity).

In addition to its direct effect on conductivity, temperature also influences water density, which leads to stratification. Stratified water can have different conductivity values at different depths. Temperature and salinity levels alter water density, and thus contribute to water column stratification. Just as a decrease in temperature increases water density, an increase in salinity will produce the same result. Discharges such as pollution can also contribute to salinity and TDS, as wastewater effluent increases salt ions and an oil spill increases total dissolved solids.

Unusual conductivity and salinity levels are usually indicative of pollution. In some cases, such as excessive rainfall or drought, they can be connected to extreme natural causes. Regardless of whether the result was caused by manmade or natural sources, changes in conductivity, salinity and TDS can have an impact on aquatic life and water quality. Most aquatic species have adapted to specific salinity levels. Salinity values outside of a normal range can result in fish kills due to changes in dissolved oxygen concentrations, osmosis regulation and TDS toxicity. When conductivity and salinity values extend too far from their usual range, it can be detrimental to the aquatic life residing in a body of water. This is why fewer, but perhaps hardier, species have adapted to life in estuaries, where salinity is constantly in flux. Estuarine life can tolerate rapidly changing salinity levels better than both their freshwater and marine counterparts. But even these brackish-water species can suffer if the salinity changes become too extreme.

During ***Wet Season*** water-quality sampling at the project area, the concentration-level of Electrical Conductivity in the sampled water ranges from 9.00 – 20.00 µS/cm; while at the ***Dry Season***, the concentration-level of Electrical Conductivity in the sampled water ranges from 12.90 – 21.90 µS/cm.

Water Nutrients *(and Phytoplankton)*:

Phytoplankton are microorganisms that drift about in water. They are single-celled, but at times they can grow in colonies large enough to be seen by the human eye. Phytoplankton are photosynthetic, meaning they have the ability to use sunlight to convert carbon dioxide and water into energy. While they are plant-like in this ability, phytoplankton are not plants. The term “single-celled plants” is a misnomer, and should not be used. Instead, phytoplankton can be divided into two classes, algae and cyanobacteria. Microscopic phytoplankton play some of the biggest roles in climate control, oxygen supply and food production. These single-celled organisms are responsible for more than 40% of Earth’s photosynthetic production. That process uses up carbon dioxide, which helps regulate CO_2 levels in the atmosphere, and produces oxygen for other organisms to live.

The largest influence on phytoplankton levels is **nutrient scarcity**. While sunlight levels affect productivity, nutrient levels affect phytoplankton growth and populations. While phytoplankton rely on photosynthesis to produce sugar for energy, they still need other nutrients to grow and reproduce. These nutrients are typically phosphorus, nitrogen and iron, though some species also require silicon, calcium and other trace metals. The more nutrients (particularly phosphorus) that are present in a body of water, the more algae and phytoplankton that will grow. An increase in the nutrient concentration of a body of water is called eutrophication. Eutrophication is often an indicator of agricultural runoff, which can raise phosphorus and nitrogen concentrations to very high levels. If there are too many nutrients, the algae will form a bloom, which can be very detrimental to water quality and aquatic health. The lack of iron in the open ocean limits phytoplankton growth. Nitrogen and phosphorus are also scarce away from coastlines, and can be limiting factors as well. However, ocean circulation can cause an upwelling, which moves deep, nutrient-rich water up into the photic (sunlight zone), replacing the nutrient-depleted surface water. Upwelling, seasonal ice melts and agricultural runoff can all increase nutrient levels, leading to an increase in phytoplankton populations.

Phytoplankton are an important aspect of a healthy body of water. Algae and cyanobacteria help to provide oxygen and food for aquatic organisms. As a key component, an imbalance of phytoplankton levels can cause major problems. If too many nutrients are available, it can trigger an algal bloom. Algal blooms and overproduction of phytoplankton can cause toxic red tides and fish kills. On the other hand, phytoplanktonic productivity can be limited by a lack of required reactants such as sunlight. This decrease in productivity can also lead to fish kills.

There are several causes that can contribute to an algal bloom. These blooms can occur seasonally, after an upwelling of nutrient-rich water, or due to pollution such as agricultural runoff. In both cases, the water becomes saturated with nutrients, creating an ideal environment for phytoplankton productivity. Even natural causes can trigger an algal bloom, such as a rainstorm followed by warm, sunny weather. Rain can contribute runoff, or encourage the mixing of nutrient-depleted and nutrient-rich layers of water. When nutrient levels rise, phytoplankton growth is no longer nutrient-limited and a bloom may occur.

Some sources of nutrients are surface water runoff from land, resuspended material from the river bed, and bank erosion. Discharges from dairy sheds and sewage treatment plants can also contribute to **elevated nutrient levels** if not properly managed. The process of nutrient enrichment is called **eutrophication**. Excess nutrient enrichment can lead to **algal blooms**. Factors contributing to the establishment of a bloom can be the transportation of large quantities of nutrients and a prolonged period of calm dry weather. Once a bloom is established it can persist for long periods even during winter.

Turbidity can sometimes be correlated with nutrients, however, to get a true relationship between turbidity and phosphate there needs to be a sizeable amount of data. Increases in total phosphate and total nitrogen can sometimes be correlated with an increase in turbidity and total suspended solids measured, particularly during flood events. This is because nutrients such as phosphates often adhere to clay particles, and it is during flood events when much of the material suspended is made up of sediment, soil and detritus. This can be from surface run off from the land, from the river bed, or eroded river banks.

Microorganisms and water Nutrients (Phosphate, Nitrate, Sulphate):

Phosphate (PO_4^{-3}): Phosphorus in small quantities is essential for plant growth and metabolic reactions in animals and plants. It is the nutrient in shortest supply in most fresh waters, with even small amounts causing significant plant growth and having a large effect on the aquatic ecosystem. Phosphate-induced algal blooms may initially increase dissolved oxygen via photosynthesis, but after these blooms die more oxygen is consumed by bacteria aiding their decomposition. Sources of phosphate (PO_4^{-3}) include animal wastes, sewage, detergent, fertilizer, disturbed land, etc.

Phosphate will stimulate the growth of plankton and other aquatic plants, which provide food for fish. However, an excess of phosphate in a water body could cause algae and aquatic plants to grow wildly, thereby using large amounts of oxygen. This condition is known as eutrophication or over fertilisation of receiving waters. Phosphorous is also an essential part of nucleoproteins in the cell nuclei, which control cell division and growth, and of deoxyribonucleic acid (DNA) molecules, which carry the inheritance characteristics of living organisms.

Nitrate (NO^{3-}): Blue-green algae have the ability to convert N_2 gas into Nitrate (NO^{3-}), which can be used by plants. Plants use nitrate to build protein, and animals that eat plants also use organic nitrogen to build protein. When plants and animals die or excrete waste, this nitrogen is released into the environment as NH^{4+} (ammonium). This ammonium is eventually oxidized by bacteria into nitrite (NO^{2-}) and then into nitrate. In this form it is relatively common in freshwater aquatic ecosystems. Nitrate thus enters streams from natural sources like decomposing plants and animal waste as well as human sources like sewage or fertilizer.

The major impact of nitrates on fresh water bodies is that of enrichment or fertilisation which may lead to eutrophication. Excess of nitrogen can cause over production of plankton and as they die and decompose they use up the oxygen, which causes other oxygen dependent organism to die.

Sulphates (SO_4^{2-}): Sulphates are utilized by many aquatic and microscopic organisms for their growth. These minerals are essential in maintaining the intricate food chain necessary for supporting all forms of life. Reduced concentrations (<0.5mg/l) of sulphur in water may have a detrimental effect on algal growth.

*Generally***,** Nitrates, Nitrites, Sulphates and Phosphates are important plant nutrients in water. The ionic forms (NO_3^-, NO_2^-, $SO_4^{2-}$and PO_4^{2}-) are the utilisable forms of nitrogen, sulphur and phosphorous which are key elements in plant growth.

Moreover, higher conductivity will result from the presence of various ions including nitrate, phosphate, and sodium.

During ***Wet Season*** water-quality sampling at the project area, the concentrations (from lab analysis) for Nitrate, Phosphate and Sulphate in the water sample of the project area ranges from 0.10-2.20mg/l, 0.04-0.60mg/l, and ND-1.10mg/l respectively; while at the ***Dry Season***, their concentrations (during water quality sampling/analysis) for Nitrate, Phosphate and Sulphate in the water sample of the project area ranges from 1.00-

4.00mg/l, 0.26-22.17mg/l and ND (Not-detected) respectively. These are within standard limits.

Water Hardness:

Water described as "hard" is high in dissolved minerals, specifically calcium and magnesium. The amount of dissolved Calcium (*Ca*) and Magnesium (*Mg*) in water determines its "*Hardness*." Hard water is not a health risk, but a nuisance because of mineral buildup on fixtures and poor soap and/or detergent performance, as they can engage in reactions that leave insoluble mineral deposits.

The degree of hardness becomes greater as the calcium and magnesium content increases and is related to the concentration of multivalent cations dissolved in the water.

Indications of Hard Water: Hard water interferes with almost every cleaning task from laundering and dishwashing to bathing and personal grooming. Clothes laundered in hard water may look dingy and feel harsh and scratchy. Dishes and glasses may be spotted when dry. Hard water may cause a film on glass shower doors, shower walls, bathtubs, sinks, faucets, etc. Hair washed in hard water may feel sticky and look dull. Water flow may be reduced by deposits in pipes. Dealing with hard water problems in the home can be a nuisance. The amount of hardness minerals in water affects the amount of soap and detergent necessary for cleaning. Soap used in hard water combines with the minerals to form a sticky soap curd. Some synthetic detergents are less effective in hard water because the active ingredient is partially inactivated by hardness, even though it stays dissolved. Bathing with soap in hard water leaves a film of sticky soap curd on the skin.

The film may prevent removal of soil and bacteria. Soap curd interferes with the return of skin to its normal, slightly acid condition, and may lead to irritation. Soap curd on hair may make it dull, lifeless and difficult to manage. When doing laundry in hard water, soap curds lodge in fabric during washing to make fabric stiff and rough. Incomplete soil removal from laundry causes graying of white fabric and the loss of brightness in colors. A sour odor can develop in clothes. Continuous laundering in hard water can shorten the life of clothes. In addition, soap curds can deposit on dishes, bathtubs and showers, and all water fixtures. Hard water also contributes to inefficient and costly operation of water-using appliances. Heated hard water forms a scale of calcium and magnesium minerals that can contribute to the inefficient operation or failure of water-using appliances. Pipes can become clogged with scale that reduces water flow and ultimately requires pipe replacement.

Generally, Symptoms of hard water include:

- Stiff, dingy laundry
- Mineral deposits on dishes and glassware
- High soap usage & need for fabric softeners
- Dry, itchy skin and scalp
- Unmanageable hair
- Extra work to remove soap curd on bathtubs & shower stalls
- High energy costs, possibly due to scale build-up in pipes and on appliances
- Scale build up in sinks, tubs, faucets & appliances

In summary, hard water is a common quality of water which contains dissolved compounds of calcium and magnesium and, sometimes, other divalent and trivalent metallic elements. The hardness of water is made up of two parts: ***temporary*** (carbonate) and ***permanent*** (non carbonate) hardness. When water is boiled, calcium carbonate scale can form, which can deposit on things like kettle elements. The scale will not stick to kettles that have a plastic polypropylene lining but will float on the surface. The permanent hardness that comprises calcium and magnesium sulphate does not go on to form scale when heated or boiled.

During ***Wet Season*** water-quality sampling at the project area, the level of Total Hardness in the sampled water ranges from 8.00 – 32.50mg/l; while at the ***Dry Season***, the level of Total Hardness in the sampled water ranges from 9.00 – 69.00mg/l. This is within Standard (*FMEnv*) limit.

Magnessium content of the sampled-water during the wet season analysis ranges from 0.39 -2.17 mg/l, while the dry season analysis for Magnesium content in the water ranges from ND- 0.06mg/l. This is within Standard (*FMEnv*) limit.

Chemical Oxygen Demand (COD):

COD is a measurement of the oxygen required to oxidize soluble and particulate organic matter in water. Chemical Oxygen Demand is an important water quality parameter because, similar to BOD, it provides an index to assess the effect discharged wastewater will have on the receiving environment. Higher COD levels mean a greater amount of oxidizable organic material in the sample, which will reduce dissolved oxygen (DO) levels. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms. The COD test is often used as an alternate to BOD due to shorter length of testing time.

Chemical oxygen demand (COD) is often used to measure organic matter in wastewater, treated effluent, and receiving waters. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers) or wastewater, making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L), which indicates the mass of oxygen consumed per liter of solution. Although COD measures more than organic constituents, the organic fraction usually predominates and is the constituent of interest. Sources of COD in stormwater are varied. However, soluble organic compounds are most likely to contribute to escalated COD concentrations. Residual food waste from bottles and cans, antifreeze, emulsified oils are all high in COD and are common sources of COD for industrial stormwater.

High COD levels decrease the amount of dissolved oxygen available for aquatic organisms. Low (generally under 3 mg/L) dissolved oxygen, or “hypoxia,” causes reduced cell functioning, disrupts circulatory fluid balance in aquatic species and can result in death of individual organisms as well as large “dead zones”. Hypoxic water can also release pollutants stored in sediment. High levels of COD in water often correlate with threats to human health including toxic algae blooms bacteria from organic wastes and seafood contamination.

COD analysis is a measurement of the oxygen-depletion capacity of a water sample contaminated with organic waste matter. The COD value indicates the amount of oxygen which is needed for the oxidation of all organic substances in water. Specifically, it measures the equivalent amount of oxygen required to chemically oxidize organic compounds in water.

The COD Test is commonly used to indirectly measure the amount of organic compounds in water. Most of the waste in effluent/waste-water comes from organic compounds, primarily lost product. As these substances oxidise or stabilise, they combine with some of the oxygen dissolved in the water. Atmospheric oxygen can replenish the dissolved oxygen supply, but only at a slow rate. If there is not enough dissolved oxygen in the water, the aquatic life can die. Under extreme conditions, the water may turn black and produce a foul odour. The amount of oxygen used is therefore a good indicator of the amount of organic waste present. It is expressed in mg / litre, which indicates the amount of oxygen consumed per litre of solution.

COD testing assesses all chemically oxidizable substances and can be directly related to the true oxygen demand imposed by the effluent if released into the environment. Because each organic compound differs in the amount of oxygen necessary for complete oxidization, the COD test reflects the effect of an effluent on the receiving stream more directly than measurement of carbon content. For more perspective on a waste stream's true organic load, Total Organic Carbon testing can be performed as a complementary analysis method to COD.

Chemical oxygen demand (COD) is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. COD measurements are commonly made on samples of waste waters or of natural waters contaminated by domestic or industrial wastes. Chemical oxygen demand is measured as a standardized laboratory assay in which a closed water sample is incubated with a strong chemical oxidant under specific conditions of temperature and for a particular period of time. A commonly used oxidant in COD assays is potassium dichromate ($K_2Cr_2O_7$) which is used in combination with boiling sulfuric acid (H_2SO_4). Because this chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, both of these sources of oxygen demand are measured in a COD assay.

Chemical oxygen demand is related to biochemical oxygen demand (BOD), another standard test for assaying the oxygen-demanding strength of waste waters. However, biochemical oxygen demand only measures the amount of oxygen consumed by microbial oxidation and is most relevant to waters rich in organic matter. It is important to understand that COD and BOD do not necessarily measure the same types of oxygen consumption. For example, COD does not measure the oxygen-consuming potential associated with certain dissolved organic compounds such as acetate. However, acetate can be metabolized by microorganisms and would therefore be detected in an assay of BOD. In contrast, the oxygen-consuming potential of cellulose is not measured during a short-term BOD assay, but it is measured during a COD test.

Chemical oxygen demand (COD) is used to measure the total quantity of oxygen-consuming substances in the complete chemical breakdown of organic substances in water. It is an important parameter in measuring quality and determining what organic load is present in the water. All aquatic plants and animals contribute to chemical oxygen demand through their metabolism and excretion of waste products. Dissolution of dead organisms also contributes to the organic carbon, as well as surrounding humus and peat. Anthropogenic dispersal includes all organic substances released into the environment. A high COD load in water may signify oxygen deficiency, and fish and other aquatic species are consequently repelled. The ratio between chemical oxygen demand and biochemical oxygen demand can be used in some contexts as a measure of whether the water contains toxic substances.

During ***Wet Season*** water-quality sampling at the project area, the level of COD in the sampled water ranges from 18.00 – 40.00mg/l; while at the ***Dry Season***, the level of COD in the sampled water ranges from 22.00 – 32.00mg/l.

Biological Oxygen Demand (BOD)

Oxygen demand is an important parameter for determining the amount of organic pollution in water. Testing oxygen demand has its widest application in measuring waste loadings of treatment plants and in evaluating treatment efficiency. At such, Biochemical Oxygen Demand (BOD) is a definitive indicator of required treatment in wastewater, and estimating BOD is an important part of wastewater treatment process control. High influent BOD requires extensive treatment to provide the oxygen necessary to break down the water's organic contents. Left untreated or partially treated, discharged water contains effluent organics that compete with downstream organisms for oxygen. This oxygen demand can kill or inhibit life downstream of the discharge area.

Thus, measuring BOD in treated water is an important part of the monitoring process. In addition, plants that treat wastewater from commercial operations measure the oxygen demand of waste as it comes to the facility to determine how much the commercial customer must pay in fees to have its waste treated. By monitoring wastewater entering the treatment facility, technicians are able to respond to changes in oxygen demand and adjust the treatment process accordingly. The challenge of this process lies in the fact that the BOD of incoming wastewater can vary substantially over days or hours, and accurate BOD measurement takes five days to complete. BOD testing uses microorganisms that consume oxygen while feeding on organic compounds in a wastewater sample over a five-day period. While this test is a good model of the aerobic waste treatment process, in some cases the microorganisms can become poisoned by toxic substances in the untreated wastewater. The five-day test also does not provide the real-time information necessary to make process control decisions. For this reason, many wastewater treatment facilities use a faster Chemical Oxygen Demand (COD) test to estimate BOD levels.

Microorganisms such as bacteria are responsible for decomposing organic waste. When organic matter such as dead plants, leaves, grass clippings, manure, sewage, or even food waste is present in a water supply, the bacteria will begin the process of breaking down this waste. When this happens, much of the available **dissolved oxygen** is consumed by aerobic bacteria, robbing other aquatic organisms of the oxygen they need to live.
Biological Oxygen Demand (BOD) is a measure of the oxygen used by microorganisms to decompose this waste. If there is a large quantity of organic waste in the water supply, there will also be a lot of bacteria present working to decompose this waste. In this case, the demand for oxygen will be high (due to all the bacteria) so the BOD level will be high. As the waste is consumed or dispersed through the water, BOD levels will begin to decline.

Factors affecting BOD level in the water:

1. The main factor that contributes to a high BOD in a food processing plant waste water is **the presence of high level of organic matter or food in the waste water.** Other organic matters that contribute to high BOD in a body of water are dead plants, leaves, grass clippings, manure and sewage. As mentioned above, when organic matter level in the water supply is high, the bacteria will begin the process of breaking down this waste. When this happens, much of the available **dissolved oxygen** is consumed by aerobic bacteria, robbing other aquatic organisms of the oxygen they need to live.
2. **Nitrates and phosphates -** in a body of water can contribute to high BOD levels. Nitrates and phosphates are plant nutrients and can cause plant life and algae to grow quickly. When plants grow quickly, they also die quickly. This contributes to the organic

waste in the water, which is then decomposed by bacteria. This results in a high BOD level.

3. **The temperature of the water -** can also contribute to high BOD levels. For example, warmer water usually will have a higher BOD level than colder water. As water temperature increases, the rate of photosynthesis by algae and other plant life in the water also increases. When this happens, plants grow faster and also die faster. When the plants die, they fall to the bottom where they are decomposed by bacteria. The bacteria require oxygen for this process so the BOD is high at this location. Therefore, increased water temperatures will speed up bacterial decomposition and result in higher BOD levels.

When BOD levels are high, **dissolved oxygen (DO)** levels decrease because the oxygen that is available in the water is being consumed by the bacteria. Since less *dissolved oxygen* is available in the water**, fish and other aquatic organisms may not survive.**

Table 4.9: BOD General Analysis: What to Expect

BOD Level *(in ppm)*	**Water Quality Analysis**
1 – 2	**Very Good** There will not be much organic waste present in the water supply.
3 – 5	**Fair: Moderately Clean**
6 – 9	**Poor: Somewhat Polluted** Usually indicates organic matter is present and bacteria are decomposing this waste.
100 or greater	**Very Poor: Very Polluted** Contains organic waste.

Source: Parameter-Analysis of Water Quality, WHO

NOTE: Generally, when BOD levels are high, there is a decline in DO levels. This is because the demand for oxygen by the bacteria is high and they are taking that oxygen from the oxygen dissolved in the water. If there is no organic waste present in the water, there won't be as many bacteria present to decompose it and thus the BOD will tend to be lower and the DO level will tend to be higher.

At high BOD levels, organisms such as macroinvertebrates that are more tolerant of lower dissolved oxygen (i.e. leeches and sludge worms) may appear and become numerous. Organisms that need higher oxygen levels (i.e. caddisfly larvae and mayfly nymphs) will NOT survive.

In summary:

- Biochemical oxygen demand is a measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter.
- Natural sources of organic matter include plant decay and leaf fall. However, plant growth and decay may be unnaturally accelerated when nutrients and sunlight are overly abundant due to human influence.
- Urban runoff carries pet wastes from streets and sidewalks; nutrients from lawn fertilizers; leaves, grass clippings, and paper from residential areas, which increase oxygen demand.
- Oxygen consumed in the decomposition process robs other aquatic organisms of the oxygen they need to live. Organisms that are more tolerant of lower dissolved oxygen levels may replace a diversity of more sensitive organisms.
- Biochemical oxygen demand is a measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter.
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- Oxygen consumed in the decomposition process robs other aquatic organisms of the oxygen they need to live. Organisms that are more tolerant of lower dissolved oxygen levels may replace a diversity of more sensitive organisms.
- Biological Oxygen Demand (BOD) is one of the most common measures of pollutant organic material in water. BOD indicates the amount of putrescible organic matter present in water. Therefore, a low BOD is an indicator of good quality water, while a high BOD indicates polluted water.

- Dissolved oxygen (DO) is consumed by bacteria when large amounts of organic matter from sewage or other discharges are present in the water. DO is the actual amount of oxygen available in dissolved form in the water. When the DO drops below a certain level, the life forms in that water are unable to continue at a normal rate. The decrease in the oxygen supply in the water has a negative effect on the fish and other aquatic life. Fish kills and an invasion and growth of certain types of weeds can cause dramatic changes in a stream or other body of water. Energy is derived from the oxidation process.
- BOD specifies the strength of sewage. In sewage treatment, to say that the BOD has been reduced from 500 to 50 indicates that there has been a 90 percent reduction.
- The BOD test serves an important function in stream pollution-control activities. It is a bioassay procedure that measures the amount of oxygen consumed by living organisms while they are utilizing the organic matter present in waste, under conditions similar in nature. The other traditional tests or indicators for water quality are chemical oxygen demand (COD) and pH.

Biochemical oxygen demand is a measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter. Natural sources of organic matter include plant decay and leaf fall. However, plant growth and decay may be unnaturally accelerated when nutrients and sunlight are overly abundant due to human influence. Urban runoff carries pet wastes from streets and sidewalks; nutrients from lawn fertilizers; leaves, grass clippings, and paper from residential areas, which increase oxygen demand. Oxygen consumed in the decomposition process robs other aquatic organisms of the oxygen they need to live. Organisms that are more tolerant of lower dissolved oxygen levels may replace a diversity of natural water systems contain bacteria, which need oxygen (aerobic) to survive. Most of them feed on dead algae and other dead organisms and are part of the decomposition cycle. Algae and other producers in the water take up inorganic nutrients and use them in the process of building up their organic issues. Consumers like fish and other aquatic animals eat some of the producers, and the nutrients move up the food chain. When these organisms die, bacteria decompose the organic compounds and release into the water inorganic nutrients such as nitrate, phosphate, calcium, and others. Some of these nutrients end up down stream or in sediments, but most of them recycle again and again. Most of the bacteria in the aquatic water column are aerobic. That means that they use oxygen to perform their metabolic activities of decomposition. Remember that we learned in other related exercises that under normal conditions, dissolved oxygen exists in very low concentrations. Natural levels of oxygen in aquatic systems are always somewhat depleted by normal levels of aerobic bacterial activity. In most cases, if dissolved oxygen concentrations drop below 5 parts per million (ppm), fish will be unable to live for very long. All clean water species such as trout or salmon will die well above this level and even low oxygen fish such as catfish and carp will be at risk below 5 ppm.

When abnormally high levels of aerobic bacterial activity takes place, however, the level of dissolved oxygen can drop dramatically. Under what circumstances does this happen? Generally, this occurs when there is some sort of abnormal "pollution" introduced into the system. This can occur in the form of organic pollution for sources such as domestic sewage, septic tank leakage, and fertilizer runoff, or could be in the form of inorganics from domestic or industrial sources. Natural sources of organic compounds can also come into aquatic systems by means of floods, landslides, and erosion.

One of the most important nutrients, which affected BOD in aquatic systems in the recent past is phosphate pollution from American households. It was discovered decades ago that the addition of phosphorous to soaps and detergents made them clean better. By the 1960's, millions of households and businesses were dumping tons and tons of phosphate down the drain. Eventually, much of this important nutrient made its way to the watercourses of America. Because phosphorous is one of the most important limiting factors (necessary nutrients) in aquatic systems, there began numerous and widespread algal blooms. Algal blooms are dramatic population outbursts of growth in which often one or two species of algae suddenly find the conditions right for rapid growth.

Because most unicellular algae reproduce asexually by rapid cell division, it doesn't take long for a species of algae to suddenly and literally turn the water green with billions and billions of new cells. Because the conditions necessary to these algal blooms are sometimes temporary or because the algae exceed the threshold level of some other limiting factor, the blooms are only temporary. They often last only a few days. What happens when the bloom is over? The algal cells don't have enough nutrients and most of them die. At this point, the aerobic bacteria become important and start to decompose the algae. Because there is so much food for them, they also experience a sort of bloom, and they literally suck the oxygen out of the water. When the oxygen is gone, the bacteria and most other aerobic creatures in the aquatic system start to die.

During water-quality sampling at the project area, (***Dry Season)***, the concentration-level of BOD in the sampled water ranges from 0.20 – 0.70mg/l. This is within *('very-good')* Standard-range of WHO limit (*see Table 4.9 above)*.

Heavy Metals

The term **heavy metal** refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Examples of heavy metals include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl),and lead (Pb). Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g. copper, selenium, zinc) are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning. Heavy metal poisoning could result, for instance, from drinking-water contamination (e.g. lead pipes), high ambient air concentrations near emission sources, or intake via the food chain. Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted. Heavy metals can enter a water supply by industrial and consumer waste, or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers, and groundwater. The main threats to human health from heavy metals are associated with exposure to lead, cadmium, mercury and arsenic.

Heavy metals are elements having atomic weights between 63.546 and 200.590 (Kennish, 1992), and a specific gravity greater than 4.0 (Connell et al., 1984). Living organisms require trace amounts of some heavy metals, including cobalt, copper, iron, manganese, molybdenum, vanadium, strontium, and zinc. Excessive levels of essential metals, however, can be detrimental to the organism. Non-essential heavy metals of particular concern to surface water systems are cadmium, chromium, mercury, lead, arsenic, and antimony (Kennish, 1992). All heavy metals exist in surface waters in colloidal, particulate, and dissolved phases, although dissolved concentrations are generally low (Kennish, 1992). The colloidal and particulate metal may be found in *1)* hydroxides, oxides, silicates, or sulfides; or *2)* adsorbed to clay, silica, or organic matter. The soluble forms are generally ions or unionized organometallic chelates or complexes. The solubility of trace metals in surface waters is predominately controlled by the water pH, the type and concentration of ligands on which the metal could adsorb, and the oxidation state of the mineral components and the redox environment of the system (Connell et al., 1984). The behavior of metals in natural waters is a function of the substrate sediment composition, the suspended sediment composition, and the water chemistry. Sediment composed of fine sand and silt will generally have higher levels of adsorbed metal than will quartz, feldspar, and detrital carbonate-rich sediment. Metals also have a high affinity for humic acids, organo-clays, and oxides coated with organic matter (Connell et al., 1984). The water chemistry of the system controls the rate of adsorption and desorbtion of metals to and from sediment. Adsorption removes the metal from the water column and stores the metal in the substrate. Desorption returns the metal to the water column, where recirculation and bioassimilation may take place. Metals may be desorbed from the sediment if the water experiences increases in salinity, decreases in redox potential, or decreases in pH.

1. *Salinity increase:* Elevated salt concentrations create increased competition between cations and metals for binding sites. Often, metals will be driven off into the overlying water. (Estuaries are prone to this phenomenon because of fluctuating river flow inputs.)
2. *Redox Potential decrease:* A decreased redox potential, as is often seen under oxygen deficient conditions, will change the composition of metal complexes and release the metal ions into the overlying water.

3. *pH decrease:* A lower pH increases the competition between metal and hydrogen ions for binding sites. A decrease in pH may also dissolve metal-carbonate complexes, releasing free metal ions into the water column (Connell et al., 1984).

Heavy metals in surface water systems can be from natural or anthropogenic sources. Currently, anthropogenic inputs of metals exceed natural inputs. Excess metal levels in surface water may pose a health risk to humans and to the environment.

The availability of trace metals in water are controlled by physical and chemical interactions. These interactions are affected by factors like pH, redox potential, temperature, CO_2 level, the type and concentration of available ligands and chelating agents, as well as type and concentrations of the metal ions. Trace or heavy metals in environmental perspective have potential of bio-accumulation and bio-concentration in aquatic organisms. Severe effects of heavy metal contamination include reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death. Exposure to some metals, such as mercury and lead, may also cause development of autoimmunity, in which a person's immune system attacks its own cells. Heavy metals analysed for in the ground water samples from the area were Iron (Fe), Lead (pb), Copper (Cu), and Zinc (Zn).

During ***Wet Season*** water-quality sampling at the project area, the concentration-level of Lead (pb), Iron (Fe), Copper (Cu) and Zinc (Zn) in the sampled water ranges from 0.02-0.13mg/l, ND, 0.22-0.79mg/l and 0.05-0.66mg/l respectively; while at the ***Dry Season***, the level of Lead (pb), Iron (Fe), Copper (Cu) and Zinc (Zn) in the sampled water ranges from ND, 0.03-0.06mg/l, 0.24-0.95mg/l and ND (Not-detected) respectively.

Thus, Zn and Fe contents in the sampled water are within Standard (FMEnv) limit; while observed result-values for Lead (pb) is above the 0.05mg/l limit and observed result-values for Copper (cu) is also above the 0.1mg/l limit. The effect of these heavy metal present in the water have been outlined above *(see heavy-metal discussions)*.

Microbiological Characteristics of the Sampled Surface Water

Generally, microbiology is the scientific study of living organisms which the naked eye cannot see, but are however around us. Microorganisms are essential components of the aquatic ecosystem and are involved in the synthesis of many organic and inorganic compounds during primary production as well as the decomposition of the organic matter. The groups of microorganisms studied are bacteria species, which are the most important organic matter decomposers in the study-area environment.

Bacteria are unicellular microorganisms that are ubiquitous in nature, which means that they are virtually found everywhere. They are classified into autotrophic and heterotrophic bacteria. Most bacteria are heterotrophic (THB) and thus depend on organic matter for nutrient. They include the nitrogen-fixing and non-nitrogen-fixing groups. The non-nitrogen-fixing group are the most prevalent bacteria and account for much of the decomposition of organic materials. The bacteria genera Klebsiella, is reported to be associated in nitrogen fixation with numerous grasses. Some bacteria have the special ability to degrade hydrocarbons and they are referred to as hydrocarbon utilising bacteria (HUB).

During water-quality sampling at the project area, the microbial characteristics of the sampled water quality of the surface water (river source) in the area shows that the (**No Growth**) concentration of E.Coli, Salmonella and Shigella constitute ‘no microbial problems’ to the water quality; with Total Coliforms and THB within limit. *See Table above.*

4.4.2 Ground Water Quality: *Physico-Chemical and Microbial Characteristics*

Groundwater is water located beneath the ground surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps, and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is **hydrogeology**, also called groundwater hydrology. Water infiltrates into the soil through pores, cracks, and other spaces until it reaches the zone of saturation where all of the spaces are filled with water (rather than air). The zone of saturation occurs because water infiltrating the soil reaches an impermeable layer of rocks so that it is not able to penetrate any further into the earth. Two main forces drive the movement of groundwater. First water moves from higher elevations to lower elevation due to the effect of gravity. Second, water moves from areas of higher pressure to areas of lower pressure. Together these two forces make up the driving force behind moving groundwater which is known as the hydraulic head.

Ground and surface water are by no means disjoint, as knowing where surface water recharges groundwater and where groundwater flows supply surface water is an important aspect of the hydrologic cycle. Hydrogeology is especially well suited to GIS. Groundwater moves much more slowly than surface water, on the order of less than a meter per day up to perhaps a hundred meters per day, and is 3-dimensional in flow. In contrast, surface water flows much faster and is more two-dimensional. Groundwater flow is a function of geology and “head,” the total potential energy at a location. Groundwater flows from higher head to lower head at a travel rate and flow path dictated by geology. Head values, geology, groundwater flow direction, even water table height and location of aquifers are among the quantities which can be presented spatially in GIS and used for analysis, management of water availability and water quality, and land use practices.

Moreover, the chemistry of groundwater varies from place to place depending on the nature of the subsoil and rocks that it passes through. Daly (1994) observed that in areas where limestone bedrock and limestone-dominated subsoil are common, groundwater is often ‘hard’, containing high concentrations of calcium, magnesium, and bicarbonate. However, in areas where volcanic rocks of sandstones are present, softer water is normal. Therefore, in considering the impact of human activities, it is necessary to first consider the natural (or baseline) water quality.

Groundwater is usually considered pure and safe to drink as it undergoes a filtering and cleansing process through a subsoil cover and rock medium that surface water does not have. However, this does not guarantee groundwater purity. Problems can arise either due to the natural conditions in the ground or pollution by human activities.

At the project site, Groundwater Samples *(3 per season)* were collected from the borehole source of the host community for *(both in-situ and ex-situ)* analysis of Ground-Water Quality.

Ground water and control was sampled at three (3) different locations within the project site, Ahala Ukwu, and Umuacheke communities. In situ field analysis measurements of pH, conductivity, Total Dissolved Solids (TDS), Total Salinity, Dissolved Oxygen (DO) and temperature were taken using handheld in situ water sampling metres at the various sampling locations.

The samples were stored/preserved in Lab-specified containers in an ice-packed cooler and transported to Richflood Laboratory for analysis, with Quality Assurance procedures *(as described in Study Methodology)*.

Physico-chemical and biological characteristics of the water quality in the project area are presented in Table 4.10.

Table 4.10a **Physiochemical and Microbial analysis of the GroundWater (GW) Quality at project location, Wet Season**

S/N	PARAMETERS SAMPLED	UNIT	LAB RESULTS			FMEnv LIMIT
			GW_1	GW_2	GW_3 CONTROL	
PHYSICOCHEMICAL ANALYSIS						
1.	Colour	Hazen unit	15.0	15.0	15.0	15.0
2.	Odour	TN	Odourless	Odourless	Odourless	-
3.	Temperature	^0C	24.0	27.8	24.5	40
4.	pH	-	6.79	7.01	6.68	6.5-8.5
5.	Turbidity	mg/L	0.08	0.04	0.02	1.0
6.	Electrical Conductivity	µs/cm	15.3	18.3	18.2	-
7.	Total Dissolved Solid	mg/L	10.7	12.8	12.7	500
8.	Total Suspended Solids	mg/L	3.00	ND	ND	>10
9.	Total Hardness	mg/L	45	45	30	200
10.	Dissolved Oxygen (DO)	mg/L	5.80	6.60	6.00	7.5
11.	Chemical Oxygen Demand	mg/L	54	32	33	-
12.	THC	-	ND	ND	ND	-
13.	Nitrite (NO^-_2)	mg/L	0.006	0.004	0.003	1.0
14.	Nitrate (NO^-_3)	mg/L	0.5	0.8	0.4	10.0
15.	Sulphate (SO_4^{2-})	mg/L	ND	ND	ND	500
16.	Phosphate (PO_3^{2-})	mg/L	0.81	0.04	0.05	>5
17.	Ammonia (NH_3)	mg/L	0.01	ND	ND	<1.0
18.	Lead (Pb)	mg/L	0.04	0.04	0.04	0.05

19.	Copper (Cu)	mg/L	0.01	0.04	0.03	0.1
20.	Iron (Fe)	mg/L	ND	0.06	0.12	1.0
21.	Magnesium (Mg)	mg/L	0.14	ND	ND	-
22.	Zinc (Zn)	mg/L	0.03	0.11	0.02	5.0
23.	Potassium (K)	mg/L	ND	ND	ND	-
MICROBIAL ANALYSIS						
24.	Total Coliforms	MPN/ml	<1.1	<1.1	<1.1	0
25.	Total Bacteria Count (TBC)	CFU/ml	TFC	NG	NG	0
26.	*Faecal Coliform*	MPN/100ml	NG	NG	NG	0
27.	*Salmonella spp.*	CFU/ml	NG	NG	NG	0
28.	*Shigella spp.*	CFU/ml	NG	NG	NG	0

SW= Surface Water, **MPN**= Most probable Number, **CFU**= Colony Forming Unit, **ND**= Not detected, **NG**=No growth, TFC= Too few to count; **FMEnv:** Federal Ministry of Environment

Lab Source: Richflood Laboratories; October, 2015; ***Sample Number:*** Rf/Lab/15/Pc/Mcb/Gw_1- Gw_3/008

Limit Source: Federal Ministry of Environment National Guidelines and standards for water Quality in Nigeria.

Sample Sources: GW_1= Borehole on site; GW_2= Community Borehole; GW_3= Community Borehole

Table 4.10b **Physiochemical and Microbial analysis of the GroundWater (GW) Quality at project location, Dry Season**

S/N	PARAMETERS SAMPLED	UNIT	LAB RESULT			FMEnv Limit
			GW_1	GW_2	GW_3 *Control*	
PHYSICOCHEMICAL ANALYSIS						
1.	Colour	Hazen unit	Pale	Colourless	Colourless	Colourless
2.	Odour	-	Odourless	Odourless	Odourless	Odourless
3.	Temperature	^0C	34.60	29.40	29.40	40
4.	pH	-	5.58	5.41	6.41	6.50-8.50
5.	Turbidity	mg/l	0.10	0.10	0.08	1.0
6.	Total Dissolved Solids	mg/l	10.30	3.90	3.90	500
7.	Electrical Conductivity	µS/cm	14.80	14.30	13.30	-
8.	Dissolved Oxygen	mg/l	1.70	1.90	1.60	7.50
9.	Total Suspended Solids	mg/l	2.00	6.00	5.00	>10
10.	Total Hardness	mg/L	45.00	56.00	72.00	200
11.	Chemical Oxygen Demand	mg/L	25.00	34.00	39.00	-
12.	Biochemical Oxygen Demand	mg/L	0.50	0.50	ND	0
13.	THC	-	ND	ND	ND	-
14.	Nitrate (NO_3^-)	mg/L	2.20	2.10	1.40	10.0
15.	Nitrite (NO_2^-)	mg/L	0.03	0.02	0.01	1.0
16.	Phosphate (PO_4^{2-})	mg/L	0.29	0.24	0.10	>5
17.	Sulphate (SO_4^{2-})	mg/L	2.00	2.00	ND	0.05
18.	Iron (Fe^{2+}/Fe^{3+})	mg/L	ND	ND	0.01	1.0

19.	Lead (Pb^{2+})	mg/L	ND	ND	ND	0.05
20.	Zinc (Zn^{2+})	mg/L	ND	ND	ND	5.0
21.	Potassium (K^{+})	mg/L	ND	ND	ND	-
22.	Copper (Cu^{2+})	mg/L	0.51	0.65	0.78	0.1
23.	Magnesium (Mg^{2+})	mg/L	ND	ND	0.02	-
MICROBIAL ANALYSIS						
24.	Total Coliforms Count	MPN/100ml	9.2	9.6	3.6	0
25.	Total Bacteria Count	CFU/ml	$3.8x10^{1}$	$3.6x10^{1}$	$1.04x10^{2}$	0
26.	Faecal Coliform	MPN/100ml	TFC	TFC	TFC	0
27.	*Salmonella* spp.	CFU/ml	NG	NG	NG	0
28.	*Shigella* spp	CFU/ml	NG	NG	NG	0

GW= Ground water, **MPN**= Most Probable Number, **CFU**=Colony forming unit, ***NG***: No Growth, **ND**: None Detected, **TFC**= Too few to count; **FMEnv:** Federal Ministry of Environment

LAB *Source:* Richflood Laboratories; March, 2016; **Sample Number:** Rf/Lab/16/Pc/Mcb/$Gw_{1\&}Gw_{3}$/028.

Limit Source: Federal Ministry of Environment National Guidelines and Standards for Water Quality in Nigeria.

Sample Sources: = Gw_1= Borehole, Gw_2= Borehole, Gw_3= Borehole.

Result Analysis of GroundWater Quality Parameters:

Previously, on the discussion of Surface Water Lab-results, content-definitions and explanation of Water-Quality Parameters have been detailed/described above; thus only result values of the Sampled-Groundwater lab-analysis are presented as follows.

Temperature: During ***Wet Season*** water-quality sampling at the project area, the level of Temperature in the sampled water ranges from 24.0 – 24.8 ^{0}C; while at the ***Dry Season***, the level of Temperature in the sampled water ranges from 24.9 – 34.60 ^{0}C.

pH: During ***Wet Season*** water-quality sampling at the project area, the level of pH in the sampled water ranges from 6.68 – 7.01; while at the ***Dry Season***, the level of pH in the sampled water ranges from 5.41 – 6.41.

Turbidity: During ***Wet Season*** water-quality sampling at the project area, the level of Turbidity in the sampled water ranges from 6.02 – 0.08 mg/l; while at the ***Dry Season***, the level of Turbidity in the sampled water ranges from 0.08 – 0.10 mg/l.

DO: During ***Wet Season*** water-quality sampling at the project area, the level of DO in the sampled water ranges from 5.80 – 6.60 mg/l; while at the ***Dry Season***, the level of DO in the sampled water ranges from 1.60 – 1.90 mg/l.

TDS: During ***Wet Season*** water-quality sampling at the project area, the level of TDS in the sampled water ranges from 10.7 – 12.7 mg/l; while at the ***Dry Season***, the level of TDS in the sampled water ranges from 3.90 – 10.30 mg/l.

TSS: During ***Wet Season*** water-quality sampling at the project area, the level of TSS in the sampled water ranges from ND – 3.00 mg/l; while at the ***Dry Season***, the level of TSS in the sampled water ranges from 2.00 – 6.00 mg/l.

Electrical Conductivity (EC): During ***Wet Season*** water-quality sampling at the project area, the level of EC in the sampled water ranges from 15.3 – 18.0 mg/l; while at the ***Dry Season***, the level of EC in the sampled water ranges from 13.30 – 14.80 mg/l.

Nutrients: During ***Wet Season*** water-quality sampling at the project area, the concentrations of Nitrate, Phosphate and Sulphate in the water sample of the project area ranges at 0.4-0.8mg/l, 0.04-0.81mg/l, and ND respectively; while at the ***Dry Season***, the concentrations of Nitrate, Phosphate and Sulphate in the water sample of the project area ranges at 1.40-2.20mg/l, 0.10-0.29mg/l, and ND-2.0mg/l respectively.

Total Hardness (TH): During ***Wet Season*** water-quality sampling at the project area, the level of TH in the sampled water ranges from 30.00 – 45.00 mg/l; while at the ***Dry Season***, the level of TH in the sampled water ranges from 45.00 – 72.00 mg/l.

COD: During ***Wet Season*** water-quality sampling at the project area, the level of COD in the sampled water ranges from 32.00 – 54.00 mg/l; while at the ***Dry Season***, the level of COD in the sampled water ranges from 25.00 – 39.00 mg/l.

Heavy metal: During ***Wet Season*** water-quality sampling at the project area, the level of Lead (pb), Iron (Fe), Copper (Cu) and Zinc (Zn) in the sampled water ranges at 0.04mg/l, ND-0.12mg/l, 0.01-0.04mg/l and 0.02-0.11mg/l respectively; while at the ***Dry Season***, the level of Lead (pb), Iron (Fe), Copper (Cu) and Zinc (Zn) in the sampled water ranges at ND, ND-0.01, 0.51-0.78mg/l and ND respectively.

Microbial analysis: The microbial characteristics of the sampled water quality of the ground water-source in the area shows that the (No Growth) concentration of E.Coli, Salmonella and Shigella constitute no microbial problems to the water quality; with Total Coliforms and THB within limit.

On a general note, on the Sample-analysis of the Groundwater Lab results, the result-values of the dry-season sampled parameters as outlined above are all within Standard (FMEnv) limit; except for the above-limit level of Cu.

4.4.3 Summary (Comparative Analysis) of Lab-Results

A. Seasonal Comparative Analysis: Value-Ranges of both (Wet&Dry) Seasons

Table 4:11 Summary of SURFACE WATER Lab-Result Values (for Wet&Dry Seasons)

PARAMETERS	WET SEASON RANGE	DRY SEASON RANGE
Color/Odour	Colorless/Odorless	Colorless/Odorless
Temperature	20.10 – 30.80 ^{0}C	27.80 – 33.60 ^{0}C
pH	4.37 – 4.73	4.22 – 6.67
Turbidity	0.12 – 0.17 mg/l	0.12 – 0.17 mg/l
Electrical Conductivity	9.00 – 20.00 mg/l	12.90 – 21.90 mg/l
Total Dissolved Solids	1.30 – 10.00 mg/l	8.00 – 15.30 mg/l
Total Suspended Solids	1.00 – 13.00 mg/l	6.00 – 20.00 mg/l

Total Hardness	8.00 – 32.50 mg/l	9.00 – 69.00 mg/l
Dissolved Oxygen	1.3 – 5.00 mg/l	1.20 – 1.40 mg/l
Chemical Oxygen Demand	18.00 – 40.00 mg/l	22.00 – 32.00 mg/l
Nitrate	0.10 – 2.20 mg/l	1.00 – 4.00 mg/l
Sulphate	ND – 1.10 mg/l	ND (Not Detected)
Phosphate	0.04 – 0.60 mg/l	0.26 – 22.17 mg/l
Total Hydrocarbon Content	ND	ND
Lead (pb)	0.02 – 0.13 mg/l	ND
Copper (cu)	0.22 – 0.79 mg/l	0.24 – 0.95 mg/l
Iron (fe)	ND	0.03 – 0.06 mg/l
Zinc (zn)	0.05 – 0.66 mg/l	ND
Magnesium (mg)	0.39 – 2.17 mg/l	ND – 0.06 mg/l
Potassium (k)	0.02 – 0.13 mg/l	ND

Table 4:12 Summary of GROUNDWATER Lab-Result Values (for Wet&Dry Seasons)

PARAMETERS	WET SEASON RANGE	DRY SEASON RANGE
Color/Odour	Colorless/Odorless	Colorless/Odorless
Temperature	24.0 – 27.80 ^{0}C	29.40 – 34.60 ^{0}C
pH	6.68 – 7.01	5.41 – 6.41
Turbidity	0.02 – 0.08 mg/l	0.08 – 0.10 mg/l
Electrical Conductivity	15.3 – 18.3 mg/l	13.30 – 14.80 mg/l
Total Dissolved Solids	10.7 – 12.7 mg/l	3.90 – 10.30 mg/l
Total Suspended Solids	ND – 3.00 mg/l	2.00 – 6.00 mg/l
Total Hardness	30.00 – 45.00 mg/l	45.00 – 72.00 mg/l
Dissolved Oxygen	5.80 – 6.60 mg/l	1.60 – 1.90 mg/l
Chemical Oxygen Demand	32.00 – 54.00 mg/l	25.00 – 39.00 mg/l
Nitrate	0.4 – 0.8 mg/l	1.40 – 2.20 mg/l
Sulphate	ND (Not Detected)	ND – 2.00 mg/l
Phosphate	0.04 – 0.81 mg/l	0.10 – 0.29 mg/l
Total Hydrocarbon Content	ND	ND
Lead (pb)	0.04 mg/l	ND

Copper (cu)	0.01 – 0.04 mg/l	0.51 – 0.78 mg/l
Iron (fe)	ND – 0.12 mg/l	ND – 0.01 mg/l
Zinc (zn)	0.02 – 0.11 mg/l	ND
Magnesium (mg)	ND – 0.14 mg/l	ND – 0.02 mg/l
Potassium (k)	ND	ND

B. Average result-values comparism with FMEnv (standard) Limit

Table 4.13: Average Values of Lab analysis in compliance to FMEnv Limit values

PARAMETERS	**WET SEASON AVERAGE VALUE**		**DRY SEASON AVERAGE VALUE**		**FMEnv LIMIT**	**GENERAL REMARK**
	Surface Water	***Ground Water***	***Surface Water***	***Ground Water***		
Temperature	25.5	25.9	30.7	32.00	**40**	Within Limit
pH	4.6	6.85	5.5	5.91	**7.5**	Within Limit
Turbidity	0.15	0.5	0.15	0.9	**1.0**	Within Limit
Electrical Conductivity	14.5	16.8	12.9	14.5	**-**	-
Total Dissolved Solids (TDS)	5.65	11.7	11.65	7.10	**500**	Within Limit
Total Suspended Solids (TSS)	7.0	1.5	13.00	4.00	**>10**	Within Limit
Total Hardness	20.25	37.5	39	58.5	**200**	Within Limit
Dissolved Oxygen	3.15	6.20	1.30	1.25	**7.5**	Within Limit
Chemical Oxygen Demand (COD)	29	43	32	32.00	**-**	-
Nitrate	1.2	0.6	2.50	1.8	**10**	Within Limit
Phosphate	0.32	0.43	11.22	0.2	**>5**	Within Limit
Lead (pb)	7.5	0.04	0	0	**0.05**	*Above limit
Copper (cu)	**0.5**	0.03	**0.6**	**0.65**	**0.1**	*Above limit
Iron (fe)	0	0.6	0.045	0.005	**1.0**	Within Limit

Figure 4.7a: Graph showing value of Lab results (SW, GW) analysis against FMEnv/Standard Limit, Wet Season

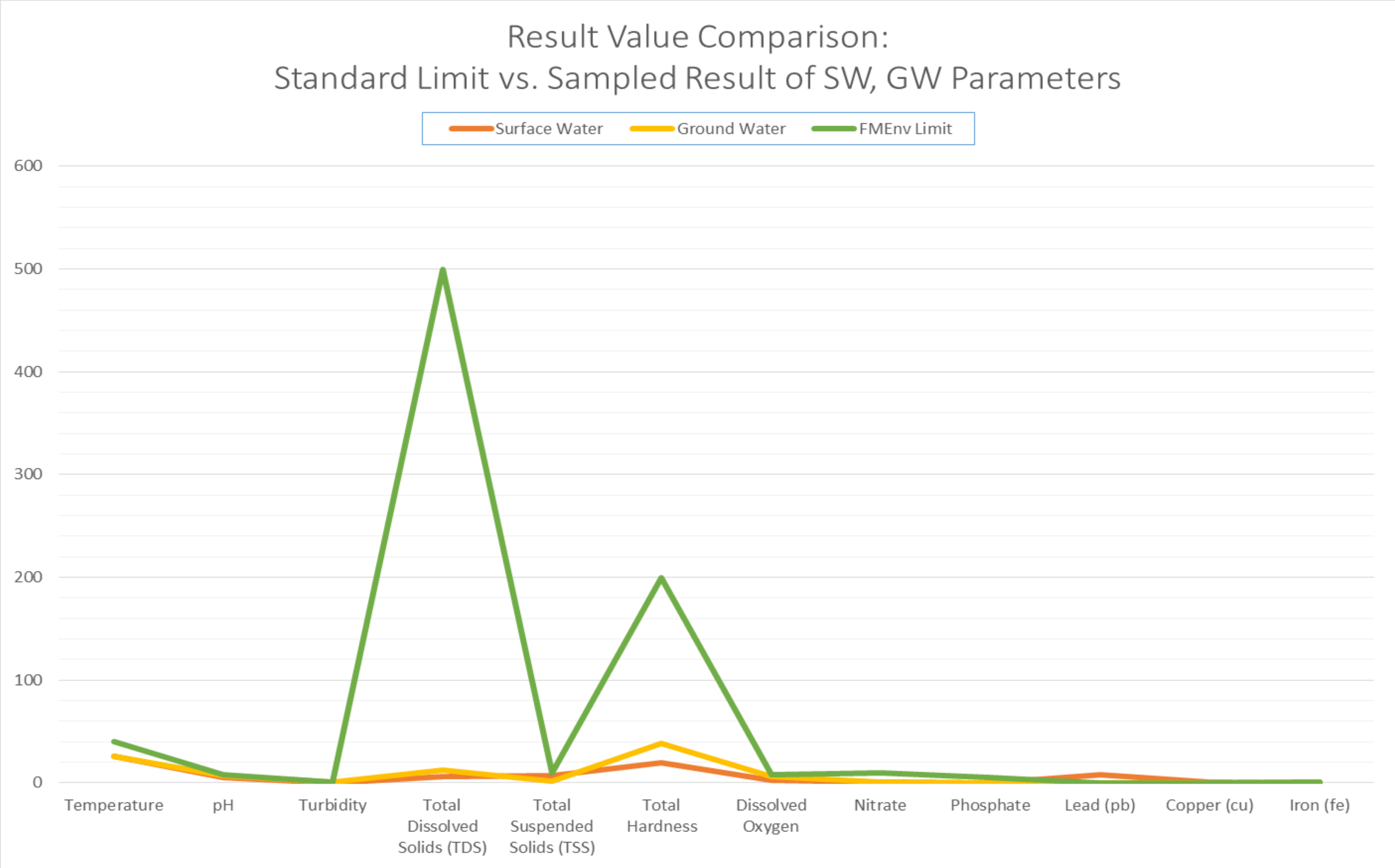
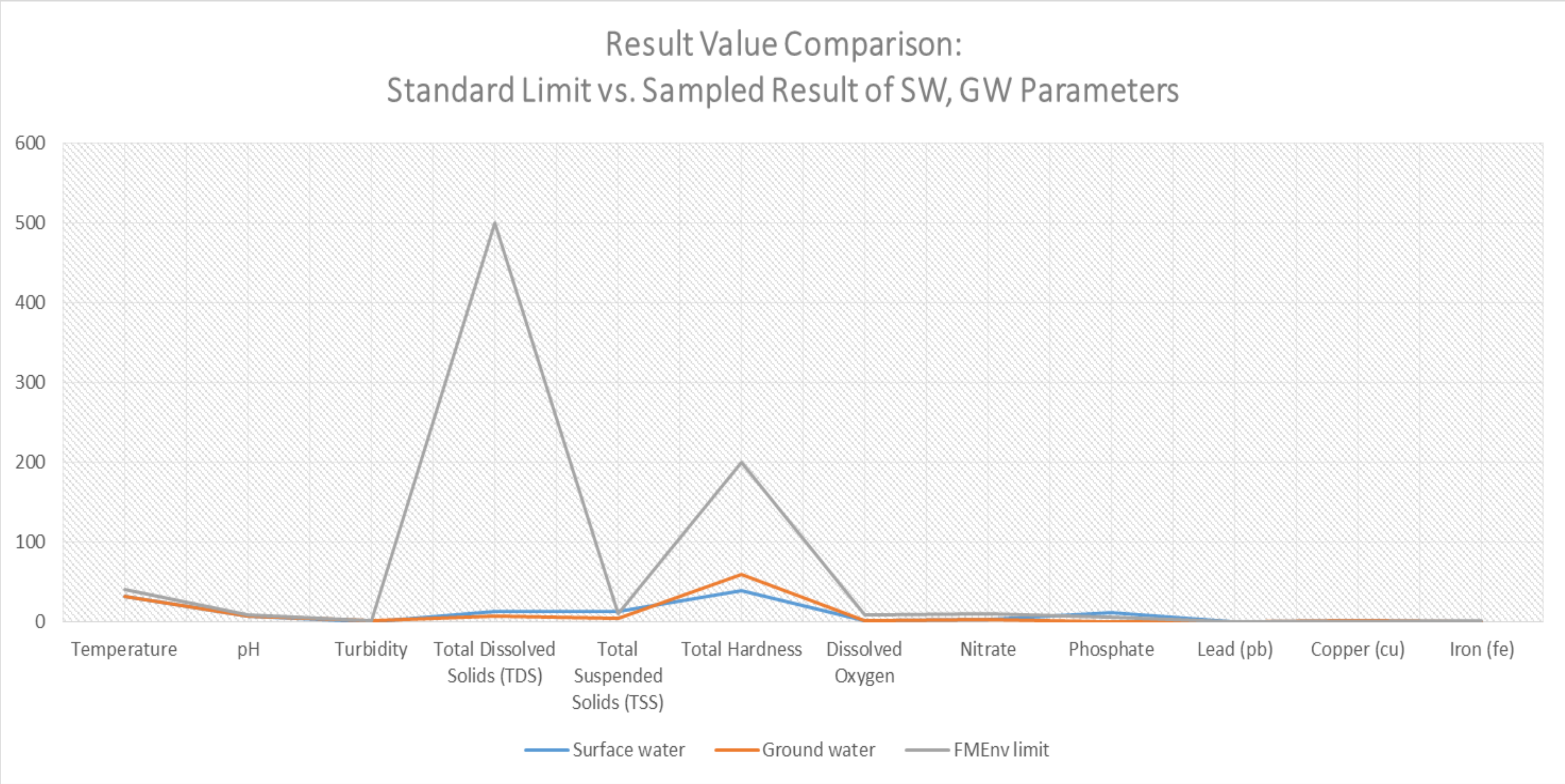


Figure 4.7b: Graph showing value of Lab results (SW, GW) analysis against FMEnv/Standard Limit, Dry Season



4.5 Soil Studies

The soils of Abia State fall within the broad group of ferrallitic soils of the coastal plain sand and escarpment. Other soil types include alluvial soils found along the low terrace of the Cross River and other rivers. The soils are not particularly fertile and are prone to much leaching because of heavy rainfall. The main ecological problems in the state are sheet and gully erosion.

Topographically, a study of the project area revealed that gully developments are more pronounced in areas with high terrain undulation. In this area, the slopes of the ground are steep and vary. This inevitably results in increase in the speed and volume of the overland flow and subsequently the rate of detachment and transportation of soil particles.

The table below shows the rate of soil loss in the south-east gully areas:

S/No.	STATE	SOIL LOSS (Tons/Ha/Yr)	
		Min (in low areas)	Max (in high areas)
1.*	**Abia**	**9.20**	**10.16**
2.	Anambra	9.11	10.03
3.	Ebonyi	8.71	9.60
4.	Enugu	9.46	10.54
4.	Imo	9.23	9.93

Table 4.14 Soil Loss in Gully Areas of the South-Eastern Nigeria

The nature of soil in the state is mostly loose and very porous. The soil particles are not consolidated and therefore detach easily when impacted by flood water. This is what facilitates the development of deep and wide gullies found in most areas.

Large portions of the vegetation cover are cleared annually for farming purposes, thereby exposing the top soil to erosion. With the soil exposed, it is no longer capable of resisting the erosive actions of the rainwater. The continuing action of the rain favors high rate of infiltration, enough to lubricate the underlying strata. Consequently this provokes heavy carrying away of the soil and leads to run off. This results in gulling as witnessed in of the area.

Soil is the collection of 'natural bodies' in the earth's surface, in places modified or even made by man of earthy materials, containing living matter and supporting or capable of supporting plants out-of-doors. Its upper limit is air or shallow water. At its margins it grades to deep water or to barren areas of rock or ice. Its lower limit to the not-soil beneath is perhaps the most difficult to define. Soil includes the horizons near the surface that differ from the underlying rock material as a result of interactions, through time, of climate, living organisms, parent materials, and relief. In the few places where it contains thin cemented horizons that are impermeable to roots, soil is as deep as the deepest horizon. More commonly soil grades at its lower margin to hard rock or to earthy materials virtually devoid of roots, animals, or marks of other biologic activity. The lower limit of soil, therefore, is normally the lower limit of biologic activity, which generally coincides with the common rooting depth of native perennial plants.

The "natural bodies" of this definition include all genetically related parts of the soil. A given part, such as a cemented layer, may not contain living matter or be capable of supporting plants. It is, however, still a part of the soil if it is genetically related to the other parts and if the body as a unit contains living matter and is capable of supporting plants.

The definition includes as soil all natural bodies that contain living matter and are capable of supporting plants even though they do not have genetically differentiated parts. A fresh deposit of alluvium or earthy constructed fill is soil if it can support plants. To be soil, a natural body must contain living matter. This excludes former soils now buried below the effects of organisms. This is not to say that buried soils may not be characterized by reference to taxonomic classes. It merely means that they are not now members of the collection of natural bodies called soil; they are buried paleosols.

Not everything "capable of supporting plants out-of-doors" is soil. Bodies of water that support floating plants, such as algae, are not soil, but the sediment below shallow water is soil if it can support bottom-rooting plants such as cattails or reeds. The above-ground parts of plants are also not soil, although they may support parasitic plants. Rock that mainly supports lichens on the surface or plants only in widely spaced cracks is also excluded.

The time transition from not-soil to soil can be illustrated by recent lava flows in warm regions under heavy and very frequent rainfall. Plants become established very quickly in such climates on the basaltic lava, even through there is very little earthy material. The plants are supported by the porous rock filled with water containing plant nutrients. Organic matter soon accumulates; but, before it does, the dominantly porous broken lava in which plant roots grow is soil.

More than 50 years ago, Marbut's definition of soil as "the outer layer" of the Earth's crust implied a concept of soil as a continuum (Marbut, 1935). The current definition refers to soil as a collection of natural bodies on the surface of the Earth, which divides Marbut's continuum into discrete, defined parts that can be treated as members of a population. The perspective of soil has changed from one in which the whole was emphasized and its parts were loosely defined to one in which the parts are sharply defined and the whole is an organized collection of these parts.

Soil is a naturally occurring, unconsolidated or loose material on the surface of the earth, capable of supporting life. To be soil, a natural body must contain living matter. Not everything "capable of supporting plants out-of-doors" is soil. Bodies of water that support floating plants, such as algae, are not soil, but the sediment below shallow water is soil if it can support bottom-rooting plants such as cattails or reeds. The above-ground parts of plants are also not soil, although they may support parasitic plants. Rock that mainly supports lichens on the surface or plants only in widely spaced cracks is also excluded. In simple terms, soil has three components: solid, liquid, and gas. The solid phase is a mixture of mineral and organic matter. Soil particles pack loosely, forming a soil structure filled with voids. The solid phase occupies about half of the soil volume. The remaining void space contains water (liquid) and air (gas).

Soil is one of our most fundamental and precious natural resources. Like clean air and water, life cannot survive without healthy soil. 95% of our food comes from the land one way or another. Soil is a miniature ecosystem consisting of both living and non-living matter. The non-living part of soil is made of weathered rocks and minerals plus the decayed remains of plants and animals (known as organic matter or humus) and air and water, while the living part of soil is made up of small animals (insects, worms), plants, fungus, bacteria and other microbes. Soil by volume on the average consists of 45% mineral, 25% water, 25% air and 5% organic matter (both living and dead organisms). It has been reported that a kilogramme of a good (healthy) forest soil can contain one 78 million bacteria, 3 million yeast cells and 1.4 million fungi.

Soil types in Nigeria are influenced by and follow very broadly, the climatic and vegetational zones of the country. This is expected because the degree of available moisture in the soil is an important factor in soil reactions and fertility and productivity. The soils of the humid tropical forests are quite different from those of the drier forests and the savanna zone, which in turn are different from the savanna zone (Oyenuga, 1967). The major soil types in Nigeria, according to FAO soil taxonomy legends are fluvisols, regosols, gleysols, acrisols, ferrasols, alisols, lixisols, cambisols, luvisols, nitosols, arenosols and vertisols (FAO, 1979). 48 % of the Nigerian soils fall into class 4 and 5, which are mainly vertisols, alisols, acrisols, ferrasols and arensol. These soils usually have low productivity due to inadequate moisture retention capacity and low organic matter. Except for the ferrasols, they are the most dominant types found in the northern dry parts of the country.

Nigerian soils can be classified into groups made up of four (climatic) zones that are soil associations (Fig. 4.8). The groups are: (i) Northern zone of sandy soils (ii) Interior zone of laterite soils; (iii) Southern belt of forest soils; and (iv) zone of alluvial soils (Oyenuga, 1967; Iloeje, 2001).

(i) Northern zone of sandy soils: This area lies in the very northern parts of the country. In some areas like the Sahel savanna belt, the soils are true to type, being formed under aridity and by the deposition of sand by the wind. These soils might have been formed from wind-sorted desert sands that accumulated over long periods of time when the Sahara desert encroached several kilometres south of its present limits. The soils of this zone produce much of the groundnut crop, some of the sorghum, cowpeas and large quantities of millet. For instance in Kano, Northern Kaduna, Zamfara and Sokoto states they have fine sandy loam, friable and relatively easy to cultivate soils. The soil is little leached and therefore ideal for groundnut cultivation. Whereas in southern Kuduna is found a mixture of soils that disintegrated from local granite, and loess soils that were brought down by winds from the north. The soil is in fact not sandy. These soils are the Zaria loam that produces the largest yield of cotton in Nigeria.

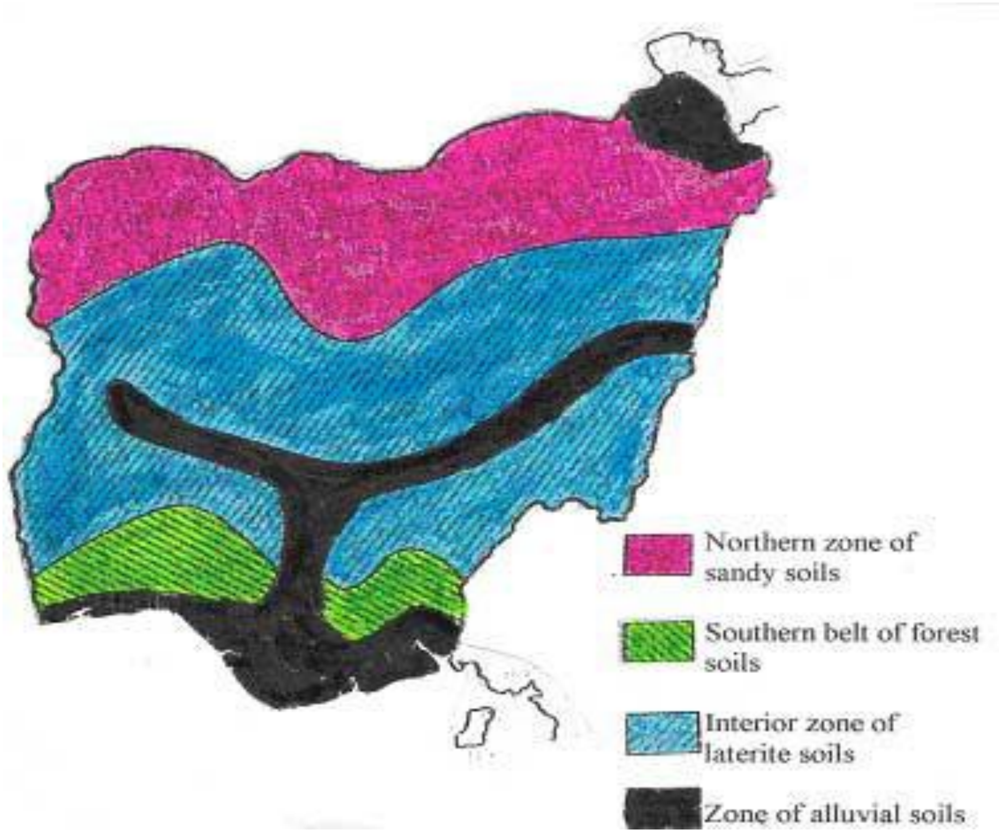


Fig. 4.8: Map showing soil zones and types in Nigeria

(ii) Interior zone of laterite soils: This zone is made up of sands and clays. They are grey to black clays poorly drained and seasonally flooded forming the "fadama". Soil in this zone is deeply corroded, generally sticky and impervious to water and has low fertility. When the virgin forest on them is cleared it reduces the fertility further, thus making available soil of little agricultural value. When the soil is exposed to the surface, it become as hard as brick and for this reason, the soil here is most suitable for road paving and wall construction than for farming. However, not only laterite soils are found in this zone. The Biu Plateau has rich soil that is productive and offers prospects for the expansion of the areas of cotton production.

(iii) Southern belt of forest soils: Soils in this zone broadly represent those of the humid, tropical forest climate zones of the south where the wet season is long, the harmattan season short and forest cover is dense. Local soil types depend largely on parent rock. Where the underlying rocks are granite or clay, the soils is a rich clayey loam. The forest soils yield cocoa, oil palm, rubber and they are of considerable importance in Nigerian agriculture.

(iv) Zone of alluvial soils: These soils are found on the flooded plains of rivers or on deltas, or along the coastal flats. This zone extends from the coastal inland and runs along the valleys of the Niger and the Benue rivers, thus cutting across the vegetational zones. The soils found in this zone do not depend highly on climate and vegetation for their formation. The underlying parent rock is the most important factor in their formation. Soils in this zone are characteristic of fresh-water soil of grey to white sand, grey clay and sandy clay with humic topsoil. Another group consists of brownish to black saline mangrove soils, with a mat of rootlets.

Factors that Control the Distribution of Soils

The properties of soil vary from place to place, but this variation is not random. Natural soil bodies are the result of climate and living organisms acting on parent material, with topography or local relief exerting a modifying influence and with time required for soil-forming processes to act. For the most part, soils are the same wherever all elements of the five factors are the same. Under similar environments in different places, soils are similar. This regularity permits prediction of the location of many different kinds of soil.

When soils are studied in small areas, the effects of topography or local relief, parent material, and time on soil becomes apparent. In the humid region, for example, wet soils and the properties associated with wetness are common in low-lying places; better drained soils form in most instances in higher lying areas. The correct conclusion is that *topography* or *relief* is important. In arid regions, the differences associated with relief may be salinity or sodicity, but the conclusion is the same. In a local environment, different soils are associated with contrasting parent materials, such as residuum from shale and from sandstone, and the correct conclusion is that *parent material* is important. Soils on a flood plain differ from soils on higher and older terraces where there is no longer deposition of parent material on the surface. The correct conclusion is that *time* is important. The influence of topography, parent material, and time on the formation of soil is observed repeatedly while studying the soils of an area.

With the notable exception of the contrasting patterns of vegetation in transition zones, local differences in vegetation are closely associated with differences in relief, parent material, or time. The effects of microclimate on vegetation may be reflected in the soil, but such effects are likely associated with differences in local relief.

Regional climate and vegetation influence the soil as well as topography or relief, parent material, and time. In spite of local differences, most of the soils in an area typically have some properties in common. The low-base status of many soils in humid or naturally acid rock or sediment regions stands in marked contrast to the typical, high-base status in arid or calcareous sandstone or limestone regions. To one who has studied soils only on old landscapes of humid regions, however, low base status is so commonplace that little significance is attached to it.

Regional patterns of climate, vegetation, and parent material can be used to predict the kinds of soil in large areas. The local patterns of topography or relief, parent material, and time, and their relationships to vegetation and microclimate, can be used to predict the kinds of soil in small areas. Soil surveyors learn to use local features, especially topography and associated vegetation, as marks of unique combinations of all five factors. These features are used to predict boundaries of different kinds of soil and to predict some of the properties of the soil within those boundaries.

Soil-Landscape Relationships: Geographic order suggests natural relationships. Running water, with weathering and gravitation, commonly sculptures landforms within a landscape. Over the ages, earthy material has been removed from some landforms and deposited on others. Landforms are interrelated. An entire area has unity through the interrelationships of its landforms.

Each distinguishable landform may have one kind of soil or several. Climate, including its change with time, commonly will have been about the same throughout the extent of a minor landform. The kinds of vegetation associated with climate also likely will have been fairly uniform. Relief varies within some limits that are characteristic of the landform. The time that the material has been subjected to soil formation has probably been about the same throughout the landform. The surface of the landform may extend through one kind of parent material and into another. Of course, position on the landform may have influenced soil-water relationships, microclimate, and vegetation.

Precisely, Soil is a natural body arranged in layers (soil horizons) consisting of mineral constituents. Soils vary in their morphological, physical, chemical and mineralogical characteristics. As the landscape is undulating, soil characteristics at different topographic positions differ. Soils differ in their characteristics primarily because of topography.

Thus, Soil is an unconsolidated mineral matter on the immediate surface of the earth that (1) serves as a natural medium for the growth of land plants; and (2) has been subjected to and influenced by genetic and environmental factors of parent material, climate (including moisture and temperature effects), macro- and microorganisms, and topography, all acting over a period of time and producing a product -soil- thatdiffers from the material from which it was derived in many physical, chemical, biological,and morphological properties and characteristics. Soil is a complex system, consisting of three phases: (1) soil gases; (2) soil water; (3) organic and inorganic solids. For a soil impacted by wastes, a fourth phase, non-aqueous phase liquids (NAPLs), may also be present.

Summary of results obtained for the physico-chemical characteristics of soil samples of the study area in top and bottom layers and Summary of the Soil Microbiological Characteristics in the Proposed Project Area are presented in ***Appendix C.***

4.6 Ecology

4.6.1 Vegetation Studies

Vegetation is an integral part of the terrestrial environment and performs several functions that are crucial to the sustenance of the environment. Some of these functions include:

- Protection of the fragile soils from the erosive impacts of rains and wind. In coastal and riverside areas, it also serves the added function of protecting the soils from the erosive actions of waves breaking along the seashore or river banks.
- Maintenance of soil fertility through continuous nutrient recycling.
- Conservation of water resources through shading and by extension, reducing rate of soil water loss through evaporation
- Preservation of water sheds.
- Regulation of air and soil temperatures
- Moisture balance
- Provision of habitat for countless terrestrial flora and fauna, such as birds, squirrels and some primates.
- Purification of the environment through the extraction of carbon dioxide during photosynthesis and the release of oxygen for human and animal respiration.

The intensive interactions of man with his environment in the state have created some ecological problems. These include the destruction of the rain forests through lumbering and the annual bush burning, both of which are responsible for the growth of deciduous forests and derived savanna which have replaced the original virgin vegetation.

Vegetation is affected by both human and natural factors such as soil characteristics, climatic conditions as well as urbanization agriculture, bush burning etc. more often than not, human changes are more drastic than natural changes. As such, any study of the environment, for the purpose of environmental impact identification must, necessarily, include vegetation and must focus on the general status of the vegetation within the project area, those vegetation attributes that are likely to be impacted, the extent of impact, as well as the mitigation measures to ameliorate these negative impacts.

In ecological terms, Nigeria is a land of extremes. In the south, lush forests (mangrove forest, fresh water swamp forest and rainforest) dominate the "natural" vegetation. This gives way to Guinea savanna in the middle belt, while savanna woodland and thorny vegetation dominate the semi-arid and arid regions of the north.

Tropical rainforests presently give a place to call home for 50% - 90% of all organisms, 90% of our relatives, the primates, and 50 million creatures that can live no place but the rich rainforests. The human race also benefits from what the trees give. For example, 25% of medicines come from the forests. Forests also perform important ecological functions. As aggregates of plant matter, forests do a great deal of oxygen production and help prevent excessive global warming. Additionally, forests tend to help replenish nutrients in land and thus prevent desertification. Trees improve the quality of the air that species breath by trapping carbon and other particles produced by pollution. Trees determine rainfall and replenish the atmosphere. As more water gets put back in the atmosphere, clouds form and provide another way to block out the sun’s heat. Trees are what cool and regulates the earth’s climate in conjunction with other such valuable services as preventing erosion, landslides, and making the most infertile soil rich with life. Mother earth has given much responsibility to trees. Lastly, and perhaps most obviously, we need to have forests since we rely on them as a source of timber. If we exhaust our supply of forests, we'll no longer be able to continue using them as the source of our building materials, heating fuel, and paper.

Vegetation, simply defined, is the plant cover of the earth consisting of assemblages of plants. Together with physiography, it constitutes the most observable element of the landscape. Vegetation expresses and reflects environmental conditions, particularly climate. Broadly speaking, the national vegetation over a geographical area is essentially a response to the climate in that area.

Nigeria's vegetation belts reflect this very close link between vegetation and climate. Nigeria has two broad belts of vegetation types, namely, the **forest and savannah types**. (Fig. 4.9). There is, however, also the mountain vegetation of the isolated high plateau regions in the central and far eastern parts of the country.

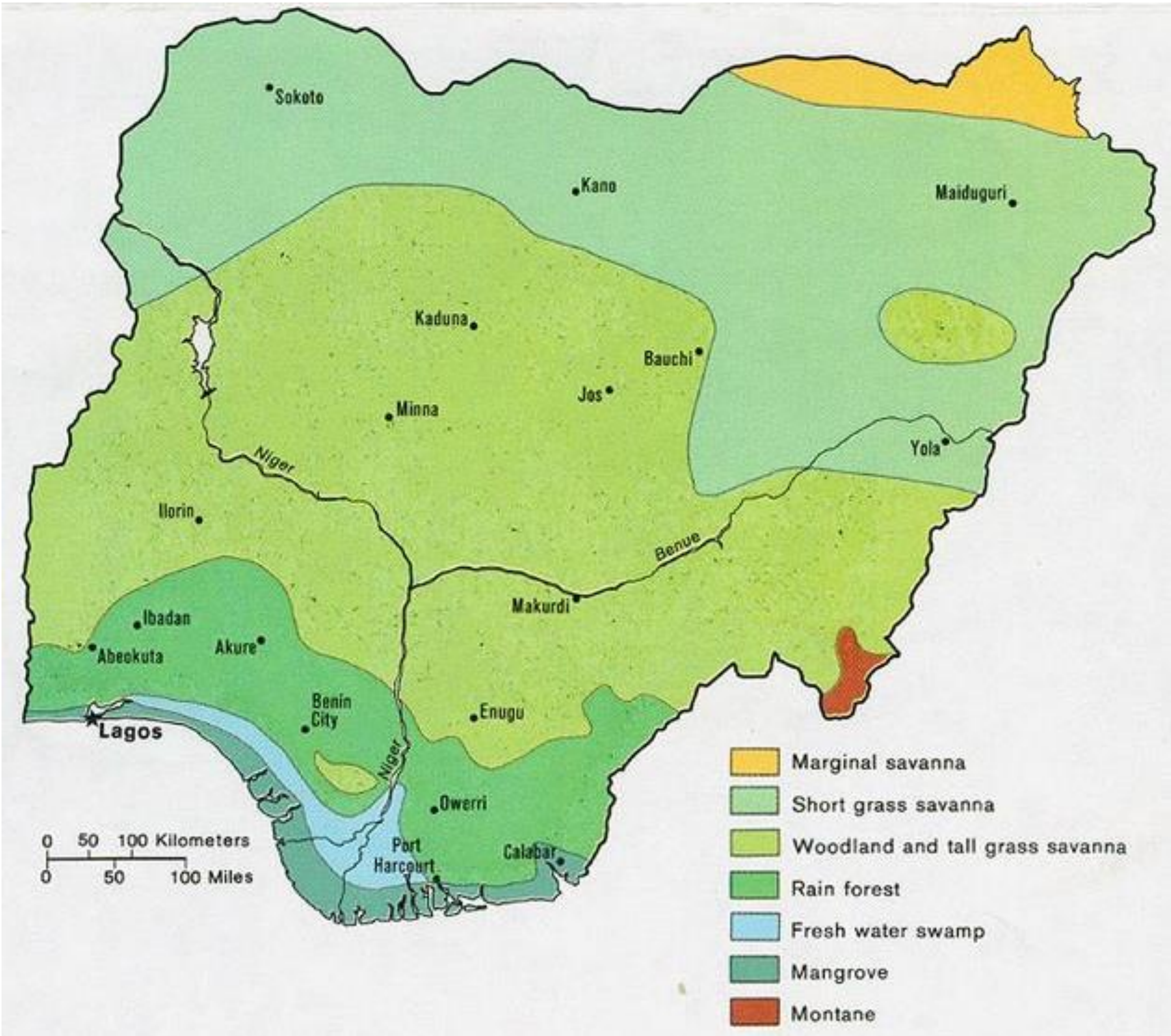


Fig.4.9: Vegetation Types in Nigeria

4.6.1.1 Forests

Nigeria has a heavily forested coastal south where humid tropical conditions favour tree growth. Three forest zones can be sub-divided, from the coast inland, viz:

1. Saline (mangrove) water swamp
2. Freshwater swamp
3. Tropical evergreen rainforest.

Mangrove (salt water) Swamp Forest: This vegetation type is restricted to the coastal strip, which varies in width from less than 1.5km in the Badagry and Lekki peninsula areas to over 50km in the Sapele area. It is pronounced where the fresh water from the rivers meets and mixes with the salt water from the sea, forming brackish swamps. The low-lying nature of the Nigerian coastal zone allows for the influx of saline water through tidal movements into the lagoons, creeks and extensive brackish wetlands. This has encouraged the growth of different species of mangrove vegetation, typical in the wetlands of the backshore areas.

The Nigerian mangrove ecosystem is the largest in Africa. The water in this ecosystem is typically brackish, especially at estuaries. The mangrove forests are increasingly coming under the threat of Nipa (*Nypa fructicans)*, an alien invasive, which establishes at disturbed sites and spreads into the mangrove vegetation. The spread of Nipa palm is affecting the fishery of the area.

In this belt, rainfall is very heavy with a mean annual rainfall of over 2500mm. The average monthly temperature is about 26^0C throughout the year. The land in the forest is low-lying and swampy and it is characterized by numerous rivers, creeks and creeklets. During the dry season, the flow of the rivers subsides and seawater is brought in by tides making the water in the creeks, and estuaries brackish. Saltwater also floods the alluvial deposits, making them salty. The mangrove swamp forest is characterized by the presence of the red mangrove plant (Rhizophora racemosa). Many of the mangrove trees have prop roots and breathing roots. These features enable them to grow well in the soft swampy areas.

Coconuts and reeds are common plants found on sandy beaches along the seashores. Animals found in the mangrove swamp forest vegetation include tilapia, species, angel-fish, bloody clam (Arca), oysters, barnacles, mangrove crab, lagoon crab, hermit crab, mudskipper fish, mosquitoes and birds (heron).

Freshwater Swamp Forest: This vegetation belt, on freshwater wetlands, occurs further inland beyond the reach of tidal waters. The rainfall in this biome is very heavy (between 2000-2500mm), relative humidity is high (between 70-75%) and evaporation from rivers is low. Rivers overflow their banks during the rainy season and flood the land, making the soil marshy and water logged.

The forest vegetation is irregular and broken. The canopy is open in some places. Shrubs and climbing plants form clumps of thick bush. In standing water, floating plant species include, water lettuce, Lemina and Salvina are found. Other species of plants found in the forest are raffia palm, sword grass, ferns and trees such as Alstonia and spondiathus.

Here, there is an enormous supply of freshwater from the inland rivers and run-off from abundant rainfall in the area. The major drainage systems, from west to east, are the Ogun, Benin, Imo, Niger Delta and Cross River, which deposit vast quantities of silt, mud and sandy materials into this area. It is a low-lying region, with hardly any part rising over 30m, thus, it facilitates the development of freshwater swamps along the Niger Delta, drowned estuaries, lagoons and creeks.

The Tropical Evergreen Rainforest: This is a belt of tall trees with dense undergrowth of shorter species dominated by climbing plants. The dominant species of the climbing plants is the lianas which are clustered and entangled in nature, making accessibility and exploitation of big trees very difficult. The prolonged rainy season, resulting in high annual rainfall above 2000mm in this area, ensures adequate supply of water and promotes perennial tree growth. This luxuriant vegetation belt stretches from the western border of Nigeria with Benin Republic, through a narrow stretch on the Niger-Benue river system into the extensive area in the south-east of the country. The narrow stretch on the Niger-Benue river system is due to the northward stretch and influence of the freshwater swamp forest north of the depositional environment of the Niger Delta.

The tropical evergreen rainforest accounts for a great number of plant species classified by their layering structure into three, namely: lower, middle and top layers (Fig. 4.10).

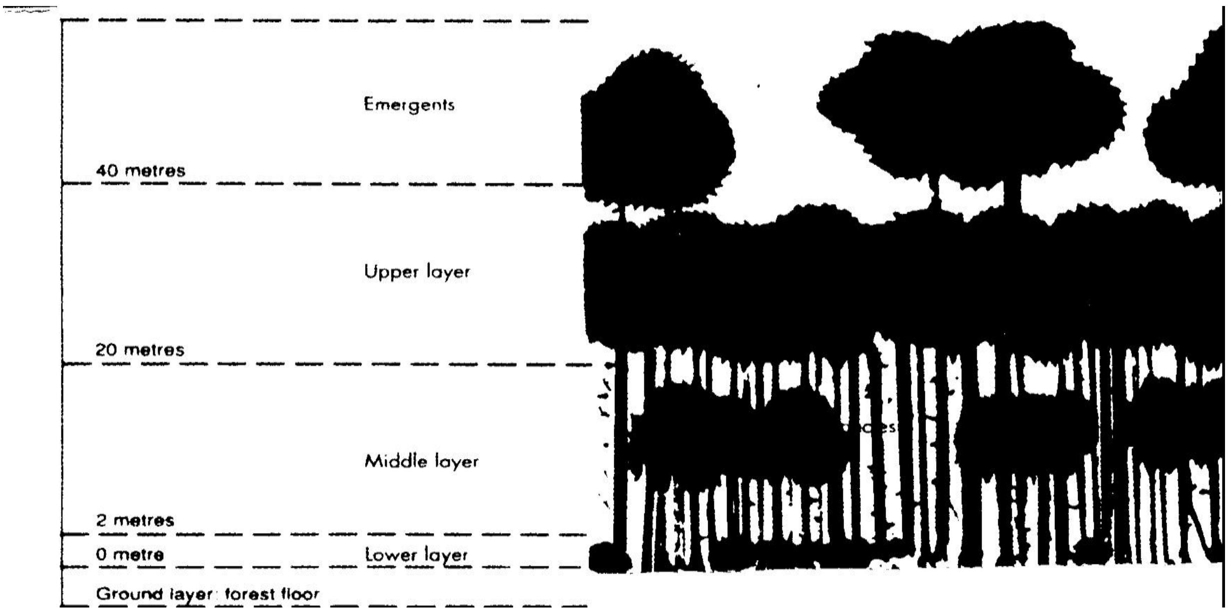


Fig. 4.10: Tropical rain forest showing tree layers

The Lower Layer: This forms the undergrowth where the vegetation is most dense, describing an abundance of herbs, shrubs and some grasses. They are hardly above 10m high as they are con- stantly subjected to destruction through clearing for cultivation. Apart from their climbing nature their development is also stifled by the taller and more luxuriant trees of the middle layer.

The Middle Layer: The tropical evergreen rain 5 forest derives its name from the nature of this layer. 3 The middle layer consists of heavily branched tall trees ranging between 15-30m with well-developed and deep green foliage. The layer's continued exposure to solar energy and prolonged humid conditions account for the hundreds of evergreen plant species. The luxuriant nature of this layer is typified by the interlocking of the tree branches to form an extensive canopy of evergreen foliage.

They have small crowns, which in a mature forest, touch and form a continuous upper canopy. The lower tree layer have plants that are straight, un-branched with thin stems. The shrub layer contains shrubs and also young plants of the tree layers. The ground vegetation consists of shade tolerant species such as ginger, ferns and mosses. There are also seedlings of the tree species. The forest floor is normally open, having only a few plants, because small amount of light reaches the forest floor. Another characteristic of the tropical rainforest is the presence of many climbing plants. Many of the animals found the forest are arboreal. These include; monkeys, squirrels, lizards, birds, frogs and insects.

The Top Layer: When viewed from the air, the extensive canopy of the middle layer is broken by very tall trees in a scattered manner, rather than the closely packed nature of the lower and middle layers. Trees of the top layer have tall straight stems of 50-60m with leaves growing on a few branches at the top of the trees. They thus possess very if striking stems developed over highly buttressed roots.

The top layer accounts for valuable economic trees such as the Mahogany, Iroko, Obeche, Sapele Wood and Walnut. They are very widely scattered making exploitation expensive. The prop roots are known to rise some four metres above n ground level in most cases, making felling difficult. The tropical evergreen rainforest belt of Nigeria is characterised by very high human population densities, with agriculture as the primary occupation of the people. The great demand for farmland has led to the destruction of extensive areas of the rainforest. The eastern zone of this belt has virtually been replaced by the oil palm plantation which produces oil, kernel and palm wine for economic purposes, as well as yam, cassava and vegetables, for subsistence. Some of the high rainforest are however still retained in pockets as reserves by the Federal and State governments, or as community bushes.

4.6.1.2 Savannah

Savannah vegetation in Nigeria, as in other parts of West Africa, consists of three major belts, from south to north, viz:

- Guinea Savannah
- Sudan Savannah; and
- Sahel Savannah.

One major characteristic of savannah vegetation is that trees vary in size and density from the Guinea, through the Sudan, to the Sahel Savannah.

Guinea Savannah: The guinea savannah covers roughly one-half of Nigeria and borders the tropical rainforest and it is found in parts of Edo, Benue, Anambra, Imo, Ebonyi, Enugu, Kogi, Kwara and Kaduna States. The mean annual rainfall is above 500mm and relative humidity is low (25-40%). The vegetation is an open savannah woodland type with scattered trees. The trees have short boles with broad leaves.

One major characteristics of the southern guinea savannah is the cyclic change of the vegetation, from the rainy to the dry season. In the rainy season, the vegetation is green and luxuriant. In the dry season, the trees shed the leaves and the vegetation turn dry and brown. Another characteristic of this savannah is the common occurrence of trees in the dry season that are adapted to fires by possessing thick, fire-resistant barks.

The guinea savannah tree species include, *Daniellia Oliveri*, butter tree, locust bean. The grasses species include Andropogon, Hyarrenia and Pennisetum. Common animals found in this Savannah include guinea fowl, deer, rats, grass cutters, snakes and termites (insects).

Sudan Savannah: This vegetation belt is found in the north-west stretching from the Sokoto plains in the west, through the northern sections of the central highland. It spans almost the entire northern states bordering the Niger Republic and covers over one quarter of Nigeria's total area. The low annual rainfall of usually less than 1000 mm and the prolonged dry season (6-9 months) sustain fewer trees and shorter grasses than the Guinea savannah. It is characterised by abundant short grasses of 1.5-2.0m and few stunted trees hardly above 15m.It is by far the most densely human populated zone of northern Nigeria. Thus, the vegetation has undergone severe destruction in the process of clearing land for the cultivation of important economic crops such as cotton, millet, maize and wheat. This is in addition to devastation due to animal husbandry, especially cattle rearing, which is greatly favoured in this belt because the area is relatively free from tse-tse fly. The trees of the Sudan savannah include the acacia, the shea-butter, baobab and the silk cotton.

Sahel Savannah: This is the last vegetational belt to the north of Nigeria with proximity to the fringes of the fast-encroaching Sahara desert. It is located in the extreme north-eastern part of the country, close to Lake Chad, where the dry season lasts for up to 9 months and the total annual rainfall is hardly up to 700mm. It is characterised by very short grasses of not more than one metre high located in-between sand dunes. The area is dominated by several varieties of the acacia and date- palms. The Lake Chad basin, with its seasonally flooded undulating plains, supports a few tall trees. At the same time, the drainage system of rivers and streams into the Lake Chad basin has favoured irrigation, without which cultivation would be virtually impossible. The increasing aridity in the area accounts for the progressive drying up of the Lake Chad. The mean annual rainfall is less than 500mm, but sometimes rainfall fails in the Sahel, resulting in drought. The zone is arid. The typical vegetation is an open thorn savannah, with trees up to 10m tall having small leaves and thorns. Common plant species include Acacia gum, Arabic Leptadenia and date palms. A common grass in this biome is *Aristida Stipioides.*

The Mountain Vegetation of Isolated Plateaus: The mountain vegetation of the isolated high mountains and plateaus of the central and eastern part of Nigeria is not well developed because of the great influence and interference by man and animals. For instance, the Jos plateau, which is one of the highest points in Nigeria, is in a grassland zone, but its vegetation depicts grassland at the top and base of the Plateau, while the slopes, favoured by moisture-laden wind, are covered by forests. These are also true of the Mandara and Adamawa mountains and the Obudu plateau.

The highland areas of the Obudu and Mambilla Plateaus hold patches of montane forests and grasslands at altitudes above 1,200 m. The presence of tree ferns (*Cyathea manniana),* and the profusion of epiphytes are characteristic of montane forests in this ecosystem. The Jos Plateau also has its own distinctive vegetation type. Here grasses are shorter and trees are fewer than area of lower altitudes.

The extent these principal Nigerian ecological resources are shown in Table 4.15.

Table 4.15: Scope of Principal Nigerian Ecosystems

ECOSYSTEMS	TOTAL AREA (HA)	% OF TOTAL AREA
Rain forest	8,874,225	9.61
Mangrove swamps and Other coastal wetlands	927,314	1.05
Freshwater and Inland wetlands	18,641,000	20.18
Savanna	44,883,510	48.53
Tree Crop Plantations	276,500	0.30
Fallow Vegetation (farmland)	18,779,251	20.33
Total	92,381,800	100.0
Coastal-land & Marine	41,090,000	

Source: Biological Diversity in Nigeria: A Country Study, 1991-92.FEPA, Abuja.

Nigeria is rich in biodiversity as the country is well endowed with a variety of plant and animal species. There are about 7,895 plant species identified in 338 families and 2,215 genera. There are 22,000 vertebrates and invertebrates species. These species include about 20,000 insects, about 1,000 birds, about 1,000 fishes, 247 mammals and 123 reptiles (FGN, 2010). Among these animals about 0.4% are threatened while 0.22% is endangered.

Precisely, the Niger Delta region especially the Mangrove Swamps is one of the most productive ecosystems with rich community of flora and fauna.

The vegetation **in Abia State** is ordinarily considered part of tropical rain forest which is the dominant natural vegetation in most parts of southern Nigeria. The northern part of the State has rich Savannah vegetation of which the bamboo (Dendrocalamusstrictus) is a typical grass species. The economic trees of the rainforest community are extremely numerous in species and varied in sizes, but the oil palm appears to be the most important.

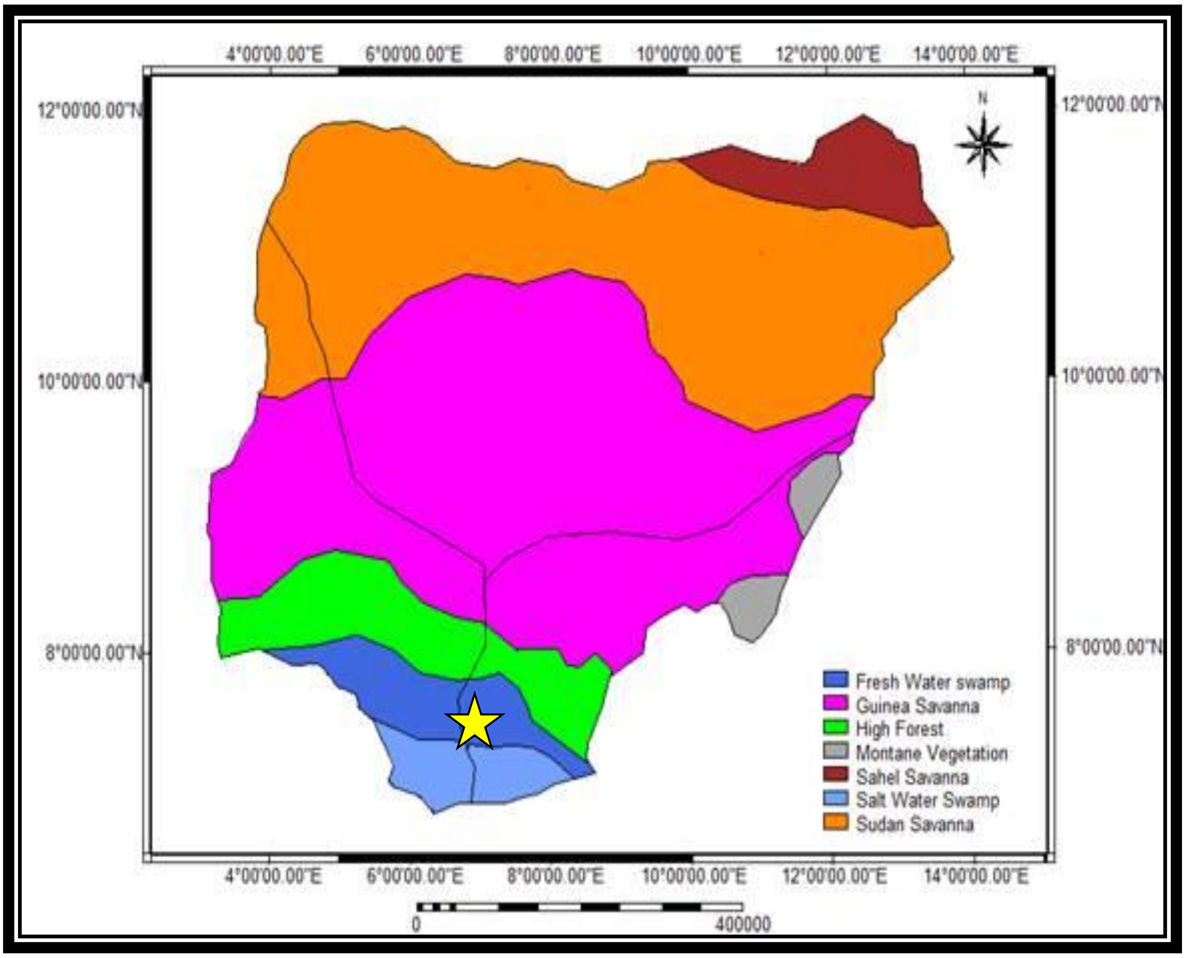


Figure 4.11: Vegetation Map of Nigeria

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

Table 4.16: Some Samples of Vegetation Cover for the Study Area

S/N	SCIENTIFIC NAME	FAMILY/SUB FAMILY	COMMON NAME	USE/ECONOMIC IMPORTANCE
1	*Theobroma Cacao*	Malvaceae	Cocoa	Food. Medicine, Cosmetics
2	*Elaeis guineensis*	Aracaceae	Oil Palm	Cooking/food
3	*Plantango Major*	Plantaginaceae	Plantain	Food, Medicine
4	*Cola nitida*	Malvaceae	Kolanut	Food, Stimulant
5	*Anacardium Occidentale*	Anarcardiaceae	Cashew	Food, Preservatives
6	*Manihot Esculenta*	Euphorbiaceae	Cassava	Food
7	*A. Comosus*	Bromeliaceae	Pineapple	Food (Beverage)
8	*Vernonia Amygdalina*	Asteraceae	Bitter leaf, Iron weed	Medicine
9	*Carica Papaya*	Caricaceae	Pawpaw	Food, Tradition medicine
10	*Cucurbita Pepo*	Cucurbitaceae	Pumpkin, Ugu (Igbo)	Food, Medicine
11	*Juglans Regia*	Juglandaceae	Walnut, Jipiter nut	Medicine
12	*Zea Mays*	Poaceae	Maize, Corn	Food
13	*Capsium*	Solanaceae	Chilli Pepper	Food
14	*Alstonia Scholaris*	Apocynaceae	Alstonia	Medicine
15	*Musanga Cecropioides*	Moraceae	African Corkwood	Insulation, Toys

Source: Fieldwork and Literature, 2014.

4.6.2 Fauna (Wildlife Studies)

Just like flora, fauna is a natural resource. Meat is an important part of many people's diets and a major source of protein in Nigeria. Meat and dairy farmers rely on this resource as a source of income. Animals also help with various aspects of labour. Work animals are common in many parts of the Northern Nigeria. Horses and mules provide extra power and stamina for farmers who lack mechanical equipment. Service animals provide eyes to the blind, and police dogs play an important role in crime fighting and the war on drugs. According to International Union of Conservation of Nature (IUCN) there are 248 species of mammals out of which 125 are found in the forest zone. There are 83 bird species in the country with no information on their distribution between forest and savanna. There are as many as 56 forest snakes out of which one, Mehelya egbensis, is reported to be endemic. Three crocodile species, including the Nile, the African dwarf and the slender snouted are present in various parts of the forest zone. There is a large number of amphibian species, 18 of these are rare, being found only in Nigeria and the Camerouns. One of the 18, Bufo perreft, is reported to be endemic to Nigeria.

The wildlife inventory for the study area was carried out by examining the animal footprints, droppings, interview with local hunters, etc. During the cause of the fieldwork campaign, birds and some other reptiles were observed and identified. Also, the local markets were visited to see and identify the predominant wildlife species.

A small variety of wild life flourishes in the project area. They consist of macro invertebrates such as insects and molluscs. Termites and the larvae of the scarabeid beetle are exploited for food. Terrestrial vertebrates including amphibians, reptiles, and birds' etc are present in the area.

The wildlife survey and interview with the local hunters in the study area revealed the presence of some mammalian, avian, amphibians, mollusks and reptile species. Significant among the species include: insects, Grass cutters, Antelopes, Sunbirds, Weaverbird (*Pleisisositaara spp*), kites, Cattle egrets (*Ardeola ibis*), Doves, Fruit pigeon, Parrot, etc.

Mammalia: Interviews with local hunters in conjunction with the frequency of evidence of animal presence indicate that the commonest mammals caught in the project area include; grass cutter, brush tailed porcupine, Maxwell's duiker, bush buck, red river hug and bush pig. Other mammals known in the area are antelope (*Neotragus batesi*), water chevrotain (*Hyemoschus aquaticus*) and black fronted duiker (*Cephalopus sylvicultor*) are reportedly threatened (NDES, 1997). The catches in the bush meat markets and in the hunters' bags were mainly grass cutters. A fairly good assemblage of primates and lesser primates namely: monkey, putty-nosed monkey, white throated guenon, red capped mangabey, red colobus, bush baby and bosman potto (all identified by experienced hunters through colour plates shown to them) occur in such areas. When caught they are sold at the local markets

Aves: The avifauna assemblage of the project area is dominated by predaceous and offal-eating birds namely the Falconidae (Kites, hawks, etc) and the piscivorous families namely the Ardeide (herons, egrets, etc). Also observed were a few individuals of the grey parrot (psittacidae). Generally, the avifauna appears to be diverse particularly in the dry season. During the rainy season, most species remain perched for a long time attending to their nest or taking shelter. The avian community observed in the area is however considered a conservative estimate as some birds especially the nocturnal species such as owls, seasonal migrants and those attending to their nests were not sighted at the time of the survey. In the area, bird hunting is not practiced, hence the avifauna, by this culture are protected. Among the rare species of the field, however, are the Eagle and woodpecker.

Reptilians: Data obtained showed that the project area harbours a good collection of the reptilian species. The area is the habitat of a wide variety of these reptiles such as snakes and the small harmless Agama lizard. Interviews of hunters confirmed the presence of a wide variety of snakes (spitting cobra, python and vipers etc) in the area. All but the chameleons have satisfactory conservation status and their abundance is likely to have been under estimated because of their secretive nature. The rainy season is the most probable period when chameleons might be caught basking in the sun or foraging on insects.

Amphibians: In the study area amphibians were found to have the lowest speciation. The Bufonids have the highest distribution and abundance followed by the Ranids. The black-clawed frogs of the family Pipidae are restricted to the brown swamp waters, while the Bull-frog Dicroglossus occipitalis occur in the deep ponds throughout the area. Among the rarest amphibians are the Racophorids (tree frogs). Interviews with the local hunters indicate that they are occasionally found under leaves, sometimes with their foam-like nests, during the rainy season.

Insect and Snail Fauna: The insect fauna within the study area is diverse and includes mainly dipterans like mosquitoes, houseflies, tse-tse flies and sand flies.

Through decades of exploitation and human induced habitat alteration, some species have become either threatened or endangered while others have been made to migrate. For species which were not encountered their droppings were used as basis for occurrence. For the reptiles such as snakes, skin shed (ecdysiast) was suggestive of the presence of the species. The inhabitants of the area had occasionally served as resource persons by providing information about the wide life being encountered. Questions relating to poaching activities and the type of games killed further provided a yardstick for confirming the presence or otherwise of some of the wild life.

For the domesticated animal species, the inhabitants provided information on aspects such as types kept/reared and purpose for keeping them. It is obvious that domestic livestock keeping is a significant activity in the area. The different kinds of livestock encountered include cattle, sheep, goats, chicken, guinea fowls and doves.

Information on fauna within the project area and its environs were gathered from interviews and field observations. The faunal composition of Abia State like most tropical high rain forest areas comprise of Mammals such as:

Table 4.17: Samples of faunal composition of the Study Area

S/ No	Animal Name	Class	Scientific Name
1	Elephant	Mammalia	*Elephas maximus*
2	Monkey	Mammalia	*Erythrocebus patas*
3	Bat	Mammalia	*Chiroptera*
4	Rat	Mammalia	*Rattus*
5	Squirrel	Mammalia	*Scuiridae*
6	Grass cutter	Mammalia	*Thryonomys Swinderianus*
7	Goat	Mammalia	*Capra aegagrus hircus*
8	Dog	Mammalia	*Canis lupus familiaris*
9	King Vulture	Bird/Aves	*Sarcoramphus papa*
10	Broad Winged Hawk	Bird/Aves	*Buteo platypterus*
11	Pigeon	Bird/Aves	*Columbidae colombiformes*
12	Dove	Bird/Aves	*Columbidae colombiformes*
13	Chicken	Bird/Aves	*Gallus gallus domesticus*
14	Bush Fowl	Bird/Aves	*Francolinus bicalcaratus*
15	Leaf Cutter Ant	Insects	*Atta spp*
16	Praying Mantis	Insects	*Stagmomantis sp*
17	Harleguin Bettle	Insects	*Acrocinus longimanus*
18	Blue Morpho Butterfly	Insects	*Morpho peleides*

19	Earth Worm	Amphibian	*Lumbricus terrestris*
20	Frog	Amphibian	*Anura ranidae*
21	Snake	Reptilia	*Heterodon nasicus*
22	Lizard	Reptilia	*Lacertilia*
23	Snail	Gastropoda	*Helix aspersa*
24	Millipede	Myriapoda	*Diplopoda*
25	Centipede	Chilopoda	*Scutigera coleoptrata*

Source: Fieldwork and Literature, 2014.

4.7 Land Use

The major land use in the area is farming and cattle rearing (Grazing) in some place not used for farming activities. The product of rock weathering in the area provided fertile soil and the drainage systems provided soil moisture. These two factors made the area agriculturally lively and very viable. Along the river bands, Fadama farming like tomatoes were planted and rice while in other places cereals are planted which are mostly maize and guinea-corn.

In practice, modern or mechanical clearing is profoundly classified as total, selective and wind rowing. Traditionally, agricultural land clearing is predominantly done during dry season. This approach depending on prevailing circumstances in terms of dryness of the vegetation and of course the interest of farmers may include setting the vegetation on fire to burn off all dry matters. The leaves of trees and shrubs withered and these are then manually removed either by cutting down or digging to uproot them depending on the size and type of tree. Generally, wild cash crop trees such as locust bean trees, shea butter, cashew, orange, mongo trees among others are spared so as to serve as complimentary source of income to the household of farmers especially during off- season period.

The choice of land clearing option is limited to the prevailing cultural practices associated to a given locality. The current practices lacked structured and critical appraisal of appropriate land clearing option related to prevailing nature of vegetation distribution, cost and specific energy requirements. Land Clearing is seldom considered in the strides to mechanizing tillage in Bauchi State and indeed Nigeria. Farming has being predominantly peasant in nature, up till recent when commercialization of agriculture is being encouraged, despite its huge financial and material requirement. Towards attainment of food sufficiency, adoption of appropriate tillage mechanization with its economic importance of enhancing transition of our farmers from peasant farming to commercial type. Appropriate land clearing is an important prerequisite to effective and efficient use of tillage machinery to enhance easy adoption of tillage mechanization. It leads to cutting off unnecessary costs accrued to tillage practices, eventual reduction in cost of farm produce, enhancement of better productivity and ultimately results in cheaper farm produce thus enlarging the bracket of those that can afford it which will result in hunger reduction.

Small Holder farming system is also said to be most sustainable when manure is applied. Studies of the sustainability levels of small holder farm management practices showed that fallow system is unsustainable because of the persistent grazing by domestic animals. Fallow is supposed to help accumulate soil nutrients and to restore fertility but this never happens when the grass and weed cover is removed by grazing animals. Similarly, the application of inorganic fertilizer is unsustainable; it only increases the level of nitrogen, phosphorus and potassium in the case of NPK fertilizer but does not add to the sustainability of the practice. However, organic manure is found to be necessary because it improves soil structure and add nutrients through mineralization.

The predominant land use of the area is farming both of plant and livestock. The traditional use of land in the area is mainly agricultural (crop cultivation). Generally, mechanized farming and use of fertilizers is common in the area. The common crops cultivated in the area include potatoes, grains- guinea corn, millet, onions, watermelon, sorghum, yam, maize and vegetables. There are also sites of cultural and religious significance in the community among which is burial sites. Land in the area is also used for the construction of markets, schools; health posts/centres mosques, and roads.

Generally, the land use characteristics of the study area include forestry, farming, grazing, , hunting and gathering. These activities form important part of the economy of the subject area.

4.8 Socio-Economic Study

The collection of information on socio-economy was based on an appropriate checklist of questions), which enhanced interview time without necessarily leaving out any vital information. A multi-Method approach was used in gathering socio-economic data and information, namely,

(1) Focus Group Discussion (FGD), In the FGD method, the groups comprise Community Elders, women leaders, youth leaders, and Religious leaders and other interest groups or individuals.

(2) In-Depth Interview (IDI), and

(3) Observation.

Beside coordinated interviews with key informants, which include paramount rulers/chiefs in council community elder/leaders of thought as well as the CDC and youth leadership in the communities' household questionnaires were also administered. Sampling of between (5) five to (10) ten households were randomly selected from the target population in the community. Secondary sources of data included published-documents, referenced.

The socio-economic studies involved:

* Description of demographic pattern of the local communities in the project area by size, land use, economic activities (with emphasis on low income groups highly dependent on primary activities), community structure, employment markets and labour supply income distribution and consumption, and migration pattern.
* Determining the views of the population through discussions with local communities. Study on cultural heritage/artifacts, and other historical/cultural patrimony of the communities.

Additionally, the socio-economic characteristics studied included amongst others:

- Settlement pattern and distribution
- Cultural treasures and artifacts
- Population structure and distribution
- Social infrastructure and amenities, Health and diseases
- Predominant economic activities and Income level
- Religion, Political structure and administration

Consultation as defined is the process of asking for information about the environmental implications of projects subject to Impact Assessment (IA) process, from designated bodies, organizations or persons with environmental responsibilities or interests. From the foregoing definition, it is clear that consultation must have a wide variety of scope in different countries. It is also clear that provisions and practices relating to consultation, and particularly to public participation, must be strongly influenced by the culture, the educational level and the political consciousness in the jurisdiction concerned.

Consultation is an important element of this socio-economic assessment and an integral component of any environmental study. This is because appropriate and adequate consultations will ensure smooth project operation and guarantee economic and commercial sustainability of any project. It involves information dissemination and interaction/dialogues with identified stakeholders (including communities within the project vicinity).

Interaction with people and eliciting feedback allows the affected populations to influence the decision-making process by raising issues that should be considered in project of sign; mitigation; monitoring and management plans; and the analysis of alternatives. The overall result would be the optimization of the potentials of the operation of the facility/project and maximization of its benefits.

The key objectives of consultation on the exercise are to:

- ensure that the community and all stakeholders are well informed on the operation of the project-site;
- provide a framework for improving the understanding of the potential impacts of the project-site operation on the ecological, social and health environment;
- identify alternative sites or designs, and mitigation measures, in order to improve environmental and social soundness;
- identify contentious issues in the operation of the company's operation;
- establish transparent procedures for carrying out the activities of the company's Steel-Manufacturing; and
- create accountability and a sense of local ownership of the company's facility thus minimizing community conflicts and project interruptions that may result.

Benefits of Consultation

Regardless of regulatory and other requirements for consultations, it may also offer a number of other benefits, which are enough reasons for undertaking it. These benefits are outlined below.

- Obtaining regulatory approval: statutory requirement for the continued operation of the project.
- By taking the advice and views of local community into account at the operation of the project.
- Consultation can help to avoid errors and interruptions and the need for mitigation and remedial measures which may be more costly or less effective when implemented at a later stage.
- Defining the scope of the EIA.
- Gaining the trust and co-operation of local community.
- Every consultation helps the owners of the any facility to understand needs, concerns and values and prevents misconceptions arising from poor communication.
- Consultation can also be a powerful means of improving the relationship in existing operations.
- Identifying opportunities and partnerships.
- Improving economic performance.
- Improve corporate reputation.
- Increased project success.
- Promoting sustainability of the project.
- Increasing accountability.

Levels of Consultation

In this study the following levels of consultation was carried out:

(i) Primary Stakeholders

The primary impact stakeholder in this project is the host communities which is directly affected by the existing facility, the local government area responsible for the welfare of the affected community, Youth Vanguards, and project owners.

(ii) Secondary Stakeholders

The secondary-impact stakeholders are those not directly affected by the project, but who may have an influence, interest or expertise to offer. These include non-governmental organizations (NGOs), regulatory authorities (FMEnv and ASMEnv).

Study Design

The socio-economic survey of the project was designed with the cardinal aim of extracting information from the community people within the project area. The study design includes literature research, identification of sample populations, administration of questionnaires and conducting interviews in the affected community. Households were randomly sampled for even and appropriate representation. Generally, the study was broken into three components involving field survey data collation and analysis, and reporting.

Target Population

The target population was essentially indigenes of the community aged above 15 years. The age was carefully chosen to capture the groups that would be most directly impacted upon and also most active, physically, socially, economically and health wise. Generally, the target groups are:

- Village/Community Head and members the council of chiefs.
- Youth associations
- Women associations
- Other community based organizations
- Economic subgroups like hunters, farmers, traders etc.
- The community development union or committee (CDC)
- Individuals/household

Data Sources

Information on the socio-economic and health profiles of the community was obtained from both primary and secondary sources. The primary sources of data included the following.

- Questionnaires administered on households
- Focused group interview (FGI).

- Interview with individuals during the field survey
- Observation made by EA team during field survey

Beside coordinated interviews with key informants, which include paramount rulers/chiefs in council community elder/leaders of thought as well as the CDC and youth leadership in the communities' household questionnaires were also administered. Sampling of between (5) five to (10) ten households were randomly selected from the target population in the community. Secondary sources of data included published-documents, such as publications of the National population commission, Federal Office of Statistics (FOS), Federal Ministry of Health, Academic publications. All appropriately referenced.

4.8.1 Socio-Economic Baseline-Data of Project Area

This section presents a brief of the socio-economic profiles of the Ahala Ukwu Village, Umuahala Community, Obuzor Ukwu Autonomous, and Umuacheke, Umuigwe/ Umuogogo Community, Isimiri Umuorie Autonomous in Ukwa-West Local Government Area of Abia State, which is potentially affected by the operation of the project-site.

Each host community is located to the project site with a distance of 5km.

The proposed project will have impact on the communities located in and around the area earmarked for the project operations, as well as on the regional and national socio-economic level. An understanding of this socio-economic context is important to identify and address social impacts at all levels.

The following sections describe the demographic structure, socio-cultural issues, infrastructural facilities, economic and health conditions within the community from where socio-economic services are obtained. This socio-economic survey begins with a consultation process with the host communities during the conduct of the EIA and highlights the expressed concerned, needs and expectations of the people of the community.

General Socio-Economic Profile of the Project area (Abia State)

Abia State is a state in the South-Eastern part of Nigeria. The capital is Umuahia and the major commercial city is Aba, formerly a British colonial government outpost. The state was created on 27 August, 1991 from part of Imo State and its citizens are predominantly Igbo people (95% of population). It is one of the nine constituent states of the Niger Delta region.

The name "Abia" is an abbreviation of four of the state's densely populated regions Aba, Bende, Isuikwuato, and Afikpo. It is one of the thirty-six (36) States that constitute the Federal Republic of Nigeria. Abia people are of the Igbo ethnic group who predominates much of the South-eastern part of Nigeria. Their traditional language is Igbo. English is widely spoken and serves as the official language in governance and business. The people Abia are mainly Christians.

Abia State is bounded on the north and northeast by the states of Anambra, Enugu, and Ebonyi. To the west of Abia is Imo State, to the east and southeast are Cross River State and Akwa Ibom State, and to the south is Rivers State. The southern part of the State lies within the riverine part of Nigeria. It is low-lying tropical rain forest with some oil-palm brush. The southern portion gets heavy rainfall of about 2,400 millimetres (94 in) per year especially intense between the months of April through October. The rest of the State is moderately high plain and wooded savanna. The most important rivers in Abia State are the Imo and Aba Rivers which flow into the Atlantic Ocean through the Niger Delta.

Figure 4:12 Abridged-Map of Nigeria showing Project-Location, Abia State

Figure 4.13: The City Tower (known to welcome people to), Abia State

The name "Abia" is an abbreviation of four of the state's densely populated regions Aba, Bende, Isuikwuato, and Afikpo. It is one of the thirty-six (36) States that constitute the Federal Republic of Nigeria. Abia people are of the Igbo ethnic group who predominates much of the South-eastern part of Nigeria. Their traditional language is Igbo. English is widely spoken and serves as the official language in governance and business. The people of Abia are mainly Christians.

The state covers an area of about 5,243.7 sq. km which is approximately 5.8 per cent of the total land area of Nigeria. The area is low-lying tropical rain forest with some oil-palm brush. The southern portion gets heavy rainfall of about 2,400 millimetres (94 in) per year especially intense between the months of April through October. The rest of the State is moderately high plain and wooded savanna. The most important rivers in Abia State are the Imo and Aba Rivers which flow into the Atlantic Ocean through the Niger Delta.

Abia State has 17 local government areas (LGAs). They are:

- Aba North
- Aba South
- Arochukwu
- Bende
- Ikwuano
- Isiala Ngwa North

- Isiala Ngwa South
- Isuikwuato
- Obi Ngwa
- Ohafia
- Osisioma Ngwa
- Ugwunagbo
- Ukwa East
- Ukwa West
- Umuahia North
- Umuahia South
- Umu Nneochi

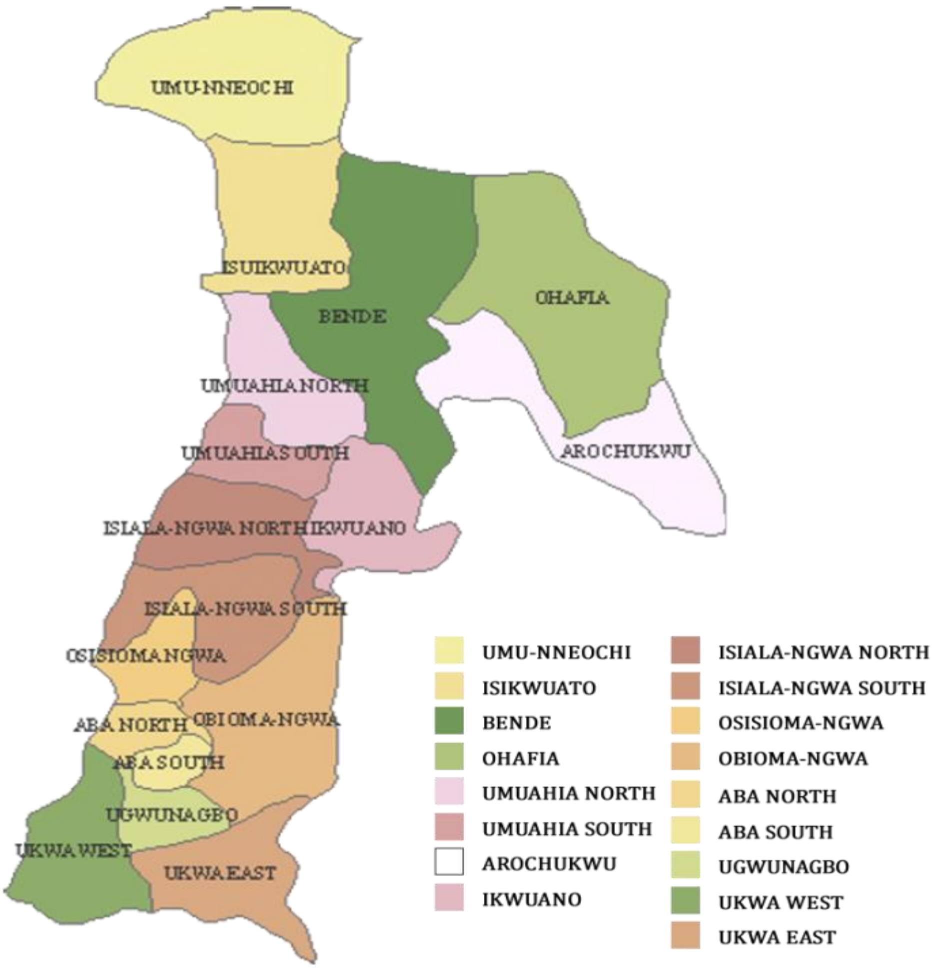


Figure 4.14: Map of Abia State showing the 17 L.G.As

The State has a general population of 2,833,999 people, as at 2006 population census as presented in the Table (4.18) below

Table 4.18: **Abia State Population Showing Local Government Areas and Sex Data**

S/No.	Local Government Areas	POPULATION	MALE	FEMALE
1.	Umu-Nneochi	163,928	79,295	84,633
2.	Isiukwuato	114,442	56,831	57,611
3.	Bende	192,111	97,789	94,322
4.	Ohafia	245,144	122,704	122,440
5.	Arochukwu	170,206	87,555	82,651
6.	Umuahia North	220,660	112,102	108,558
7.	Umuahia South	138,570	69,965	71,028
8.	Ikwuano	137,993	66,965	71,028
9.	Isiala-Ngwa North	153,734	76,684	77,050
10.	Isiala-Ngwa South	134,762	67,040	67,722
11.	Obio Ngwa	181,439	90,284	91,155
12.	Aba North	107,488	53,733	53,755
13.	Osisioma Ngwa	219,632	111,256	108,376
14.	Aba South	423,852	227,595	196,257
15.	Ugwunagbo	82,618	39,705	42,913
16.	Ukwa East	58,865	30,136	28,729
17. *	Ukwa West	88,555	25,284	43,271
TOTAL		**2,833,999**	**1,434,193**	**1,399,806**

Source: National Bureau of Statistics (2006 Population Census)

Agricultural Resources, Minerals and Industries

Agriculture is the major occupation of the people of Abia State. This is induced by the rich soil, which stretches from the northern to the southern parts of the state. Subsistence farming is prevalent and about 70 per cent of the population is engaged in it.

A few farmers also produce on a large scale. Farming in the state is determined by the seasonal distribution of rainfall. Some farmers now use irrigation methods. The main food crops grown are yam, cassava, rice, cocoyam and maize while the cash crops include oil-palm, rubber, cocoa, banana and various types of fruits.

Modern poultry has been introduced and is practised by a good number of people, hence there is adequate supply of eggs and other poultry prod- ucts in the state. The Golden Chicken project at Ogwe in Ukwa Local Government Area is a modern mechanised poultry farm.

There are three agricultural zones in Abia State: Aba, Umuahia and Bende. In the Aba and Umuahia agricultural zones, such cash crops as palm pro- duce, cocoa and rubber are produced, while food crops such as yam, cassava, rice, plantain, banana, maize and cocoyam are produced in large quantities.

The Bende agricultural zone is a major pro- ducer of rice and yam. Fishing is also carried out by people who live along the Imo River. Large areas of forest can be found in all the Local Government Areas. They provide raw materials for the pulp and paper industry.

Abia also has large crude oil deposits, as an oil producing state. Crude oil and gas production is a prominent activity, as it contributes to 39% of the GDP. Representing 27% of the GDP, agriculture, which employs 70% of the state workforce, is the second economic sector of Abia. With its adequate seasonal rainfall, Abia has much arable land that produces yams, maize, potatoes, rice, cashews, plantains, taro, and cassava. Oil palm is the most important cash crop. The manufacturing sector only accounts for 2% of the GDP. The industrial centre of the state is in Aba, with textile manufacturing, pharmaceuticals, soap, plastics, cement, footwear, and cosmetics.

Abia State is blessed with enormous mineral resources. The proper exploitation of these minerals has obvious economic and development implications.

The types, location and potential uses of these minerals are shown below;

Table 4.19: Mineral List in Abia State (The Project-Area)

S/N	Minerals	Sources of Raw Materials	Utilization (or Potential uses)
1	Crude Oil	Oilfields at Imo River ,Obuzo, OwazaNgboko, Nkali, Odogkwa, Obeakpu and Isimiri	Export, refined products petro-Chemicals
2	Natural Gas	Ohuru Gas Fields in Ukwa East LGA.	
3	Tar Sands/ Oilshales	Ugwueme-Lokpanta axis in Nneochi LGA	Asphalt, tar, Refined products
4	Lead,Zinc, Copper	Lokpaukwu (Nneochi LGA)	Metal extraction of lead, Zinc copper
5	Phospate (traces)	Amaeke in Umuahia and Ewe in Arochukwu LGA	Fertiliser Detergent and other chemical industries
6	Gypsum	Lokpaukwu (Nneochi)	Cement manufacturers ,pharmaceticals chalk plaster of paris
7	Limestone	Ewe- Arochukwu LGA southwestern part of Isuikwuato LGA	Cement , Glass, Water treatment, sugar Refining Iron and Steel ,Construction Agriculture fertiliser, etc
8	Iron Ore	Around the Northern part of Isuikwuato LGA	Iron and Steel
9	Kaolin	Umuahia, Ikwuano LGA and northwestern sector of Isuikwuato LGA	Paints, detergent, steel glass ceramics etc
10	Industrial sands	Ukwa, Aba , Umuahia	Glass , Foundry, Ceramics , abrasives
11	Igneous rocks	Uturu LokpantaLekwesi	Aggregate for road and building construction
12	Laterite	All LGAs	for surfacing roads

There are two major power plants in Abia, The Alaoji Power plant and the Geometric Power plant.

The nearest airport to Abia state is Sam Mbakwe Cargo Airport (Owerri Airport), an hour's drive to Aba; and Port Harcourt International Airport, 2 hours to Aba and about three hours to Umuahia. Uyo Airport Akwa Ibom State can also serve would be visitors. The Distance between Uyo (Akwa Ibom) and Umuahia (Abia) is: 73.28 kilometres (45.53 mi).

The rail transport is also another means of travel, very effective but currently on revitalization. Aba is connected to Port Harcourt by rail. The Coastal parts of the State are equally accessible with boats and canoes.

Administrative Structure

Each of the seventeen LGAs in the state is headed by the Local Government Chairman who is the Chief Executive Officer of the local government. He is usually assisted by a Secretary, Supervisory Councillors and Councillors. Most local government councils in the state have five departments viz: Administration, Agriculture, Health, Education and Works.

The administrative headquarters of the local government area is located in one of the urban or semi urban areas within the local government area. High courts are found in Aba and Ohafia local government areas as well as Umuahia, the state capital. Magistrate courts are located in Aba, Arochukwu, Ohafia, Bende, lsuikwuato and Ukwa LGAs. Customary courts are also found in Ukwa, lsuikwuato, Bende, Ohafia, and Arochukwu LGAs. Each autonomous community has a traditional head, the Eze, that has been identified, selected, appointed and installed by the people according to their own tradition and presented to the government for recognition.

Selection may be hereditary, elective or rotatory. For such an Eze to be recognised, the local government chairman has to endorse the documents presented to him by the Eze before for- warding the documents to the governor for recognition. The Eze also has to be presented by the autonomous community at an appointed date and time to the governor or his representative, for recognition.

The government also appoints one Eze from each autonomous community. An election is usually conducted amongst recognised Ndi Ezes for each local government to select members to serve at the council of Ndi Eze at the state level.

Figure 4.15: Traditional leaders symbol in the project-area

About half of the members of the council are selected while half are appointed. Every member of the council of Ndi Eze is required to serve for three years unless prevented from doing so by death or resignation. The council of Ndi Eze in Abia State is made up of 36 Ezes with one chairman and two deputy chairmen.

Ethnic Composition, Language and Culture:

Abia State is inhabited by the lgbo. The lgbo language is spoken throughout the State with no restriction to other languages. Abia State is richly endowed culturally. This is evident in the people’s mode of dressing, dancing, arts and crafts, as well as festivals and the widely known lgbo traditional hospitality.

The traditional apparel for the men is an over-flowing jumper or long-sleeve shirt worn over a “George” wrapper tied around the waist and flowing down to the ankles. This dress is complemented with a cap and a walking stick for support and defence. For the women, the traditional wear is a blouse over an “Abada” or “George”, around the waist. This outfit goes with a headgear, ba earrings and necklace.

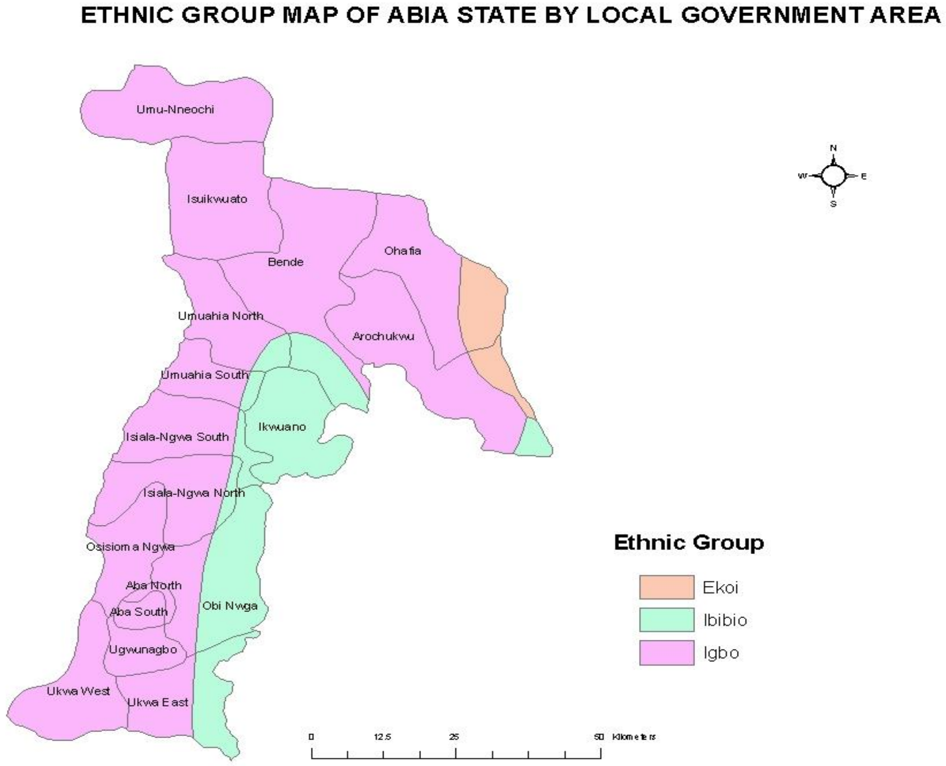


Figure 4.16: Ethnic groups by LGA in Abia State

Festivals, Arts And Crafts

Each community in Abia State has different festivals celebrated in honour of its gods and goddesses, or to mark important events. The beginning of the planting season as well as the harvest season are celebrated annually. The New Yam festival, celebrated as thanksgiving to God (Chukwu) by everyone, is pervasive in lgbo land.

Works of art produced in the state include carved doors, stools, walking sticks, traditional flutes, mortars, gongs and pestles. One work of art particularly worthy of note is the traditional "Akwete' cloth of Ukwa East.

An outline of the lgbo cultural heritage will be incomplete without a word or two of the lgbo tradi- tional hospitality to visitors. This is reflected in the presentation of kolanuts to visitors. The kolanut signifies that the visitors are heartily welcome. The rituals of the presentation of the kolanut are con- summated with the offering of prayers and thanks-giving or request to the supreme God and othei deities for the protection of the visitor and the host.

The State boasts of a large variety of traditional Festivals/dances in virtually all the autonomous communities in the State. These are celebrated at various seasons in the year. Officially, there is the State-owned Ugwuabia Festival. Ugwuabia (the pride of Abia) festival is a grassroot festival where all the LGAs in the State come to showcase the best of all their culture in a carnival.

The main centres of cultural attraction are the famous traditional “Akwete” cloth weaving in Ukwa East LGA the Azumini Blue River has natural swimming pools which attract visitors from within and outside the state.

- The Ohafia War Dancers
- AmaforIsingwu bi annual Iza aha ceremony
- The Akpe Festival in Umuahia etc.

Figure 4.17: festival celebration of culture: an attraction for tourist

Tourism in the State

Some of these tourism potentials in the State have been identified and documented while others are yet to be identified. Among those identified and documented are:

(a) The Long Juju of Arochukwu: This is a cave with a long dark tunnel that is associated with the slave trade. Prior to the slave trade era, it had served as a court of arbitration for the settlement of local, tribal and inter-tribal disputes / problems. During the slave trade, it was an important route through which slaves were sold and transported outside the country through the Cross River to the Ocean port in Port Harcourt.

Because of the significant role it played during this period, the long Juju has gained international recognition in historical perspectives. The state Government has therefore applied to the world body UNESCO for its recognition as a World heritage Site. The site is open for development to internationally acceptable standards through Private Public partnership (PPP).

(b) The Azumini Blue River: This is a good relaxation spot for both local and foreign tourists. As the name implies, the blueness and freshness of the river makes it a unique spot for tourism attraction. The river that takes its course from the Aba River (popularly called waterside) has room for the construction of a world-class tourism resort. When fully developed, the Azumini Blue River site would provide an all-year round site for tourists worldwide; as it is crystal clear and offers canoe rides to its visitors. What's more is you can enjoy a nice barbeque by the river seated on your comfortable beach chairs or perhaps have a cool drink of pineapple juice.

(c) The Amakama Wooden Cave at Amakama: This is a wonder tree with a hollow inside that is capable of accommodating up to twenty people at a time. The tree is claimed to be as old as the Amakama community and had acted as a safe haven to the community during the inter-tribal wars and the slave raids era. The beautiful serene environment of the site is good for the construction of a standard tourism village.

(d) The Caves: These are located in the northern axis of the State ranging from Umunneochi to Arochukwu. They include: (i) The Ngodo Cave at NgodoIsuochi which has both stalactite and stalagmite inside, (ii)The Uhuchukwu cave at AhabaImenyi in Isuikwuato LGA, (iii) The Ulochukwu Abiama Cave at AmankaluAlayi in Bende LGA, (iv) The EziOfia Cave at Amekpu Ohafia, (v) The OnuIbina Cave at Ihechiowa in Arochukwu LGA etc.

An outstanding feature of these Caves is that they are cut out in wonderful natural rocky landscapes and they are tourist's delights any day. It is believed that the Uhuchukwu Cave, the Ulochukwu Abiama cave and the Long Juju cave (IbiniUkpabi) were once residences of Chukwu Abiama/Obioma-the-kind hearted deity that once wielded great powers of arbitration.

(e) The National War Museum and Ojukwu Bunker in Umuahia: These are Federal Government Establishments that contain the relics of the Nigerian Civil War. These relics are constant reminders of the evils of war. The museum serves as a research centre.

(f) The Museum of Colonial History in Aba: This is a Federal Government Establishments which houses the history of the evolution of the Nigerian State from pre-colonial, colonial and present times. It also serves as a research centre.

The rich cultural heritage of Abia State also lends itself to the promotion of tourism.

4.8.2 Socio-Economic sampling/data

To make this socio economic sampling close to being representative, random sampling approach was adopted.

Respondent Demographics

The survey respondents were 50 in total. The survey respondents were made up of 75% males and 25% females. All of them were Christians. This is a representative of the general religion in the community.

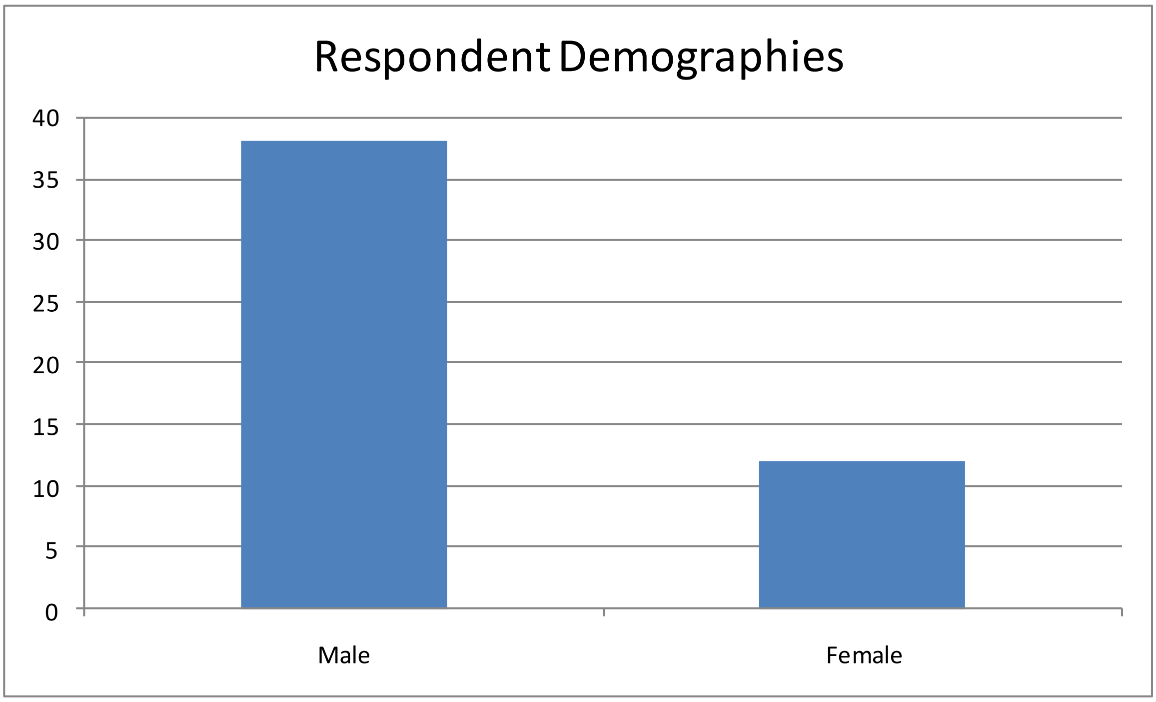


Figure 4.18: Graph showing respondent demography

Educational Level

From the socio economic survey carried out, it is seen that the literacy level within the host community is moderate with respect to the educational proportion.

There are three universities in the state: the federally owned Michael Okpara University of Agriculture at Umudike and the state-owned, Abia State University in Uturu and the Gregory University Uturu (Privately owned). The Abia State Polytechnic is also in the city of Aba.

Two secondary schools, government primary schools and private schools are seen within the community.

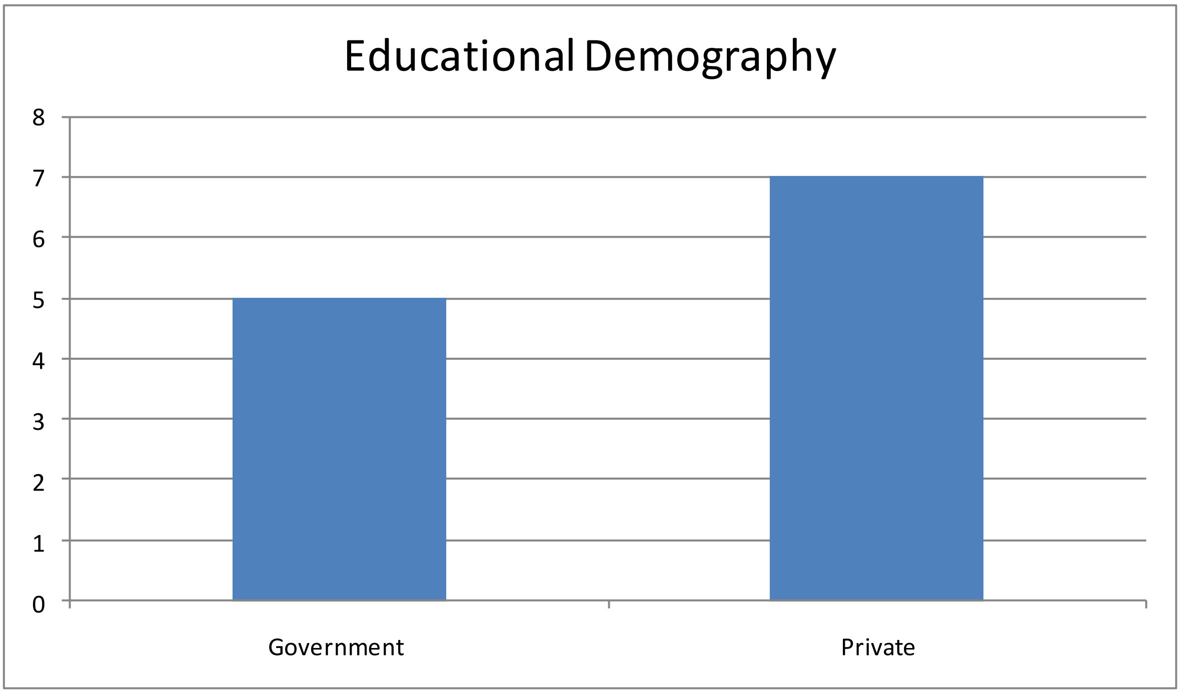


Figure 4.19: Graph showing Educational Demography

Health Facilities

The World Health Organization (WHO) recognized the role of good health care system and, therefore, opines that *health* is not only the absence of infirmity, but includes the overall wellbeing of the people. The measure or the availability of good healthcare system has helped to rekindle the hope of the people in terms of long life expectancy locally and internationally. There are two tertiary hospitals, the Federal Medical Center in Umuahia and the Abia State University Teaching Hospital in Aba, which serve as referral hospitals in the State.

Prevalence of Disease in the Project Area

Inferences from interaction with the persons sampled with questionnaire's aid shows that the prevalent health complaints are Malaria and Typhoid.

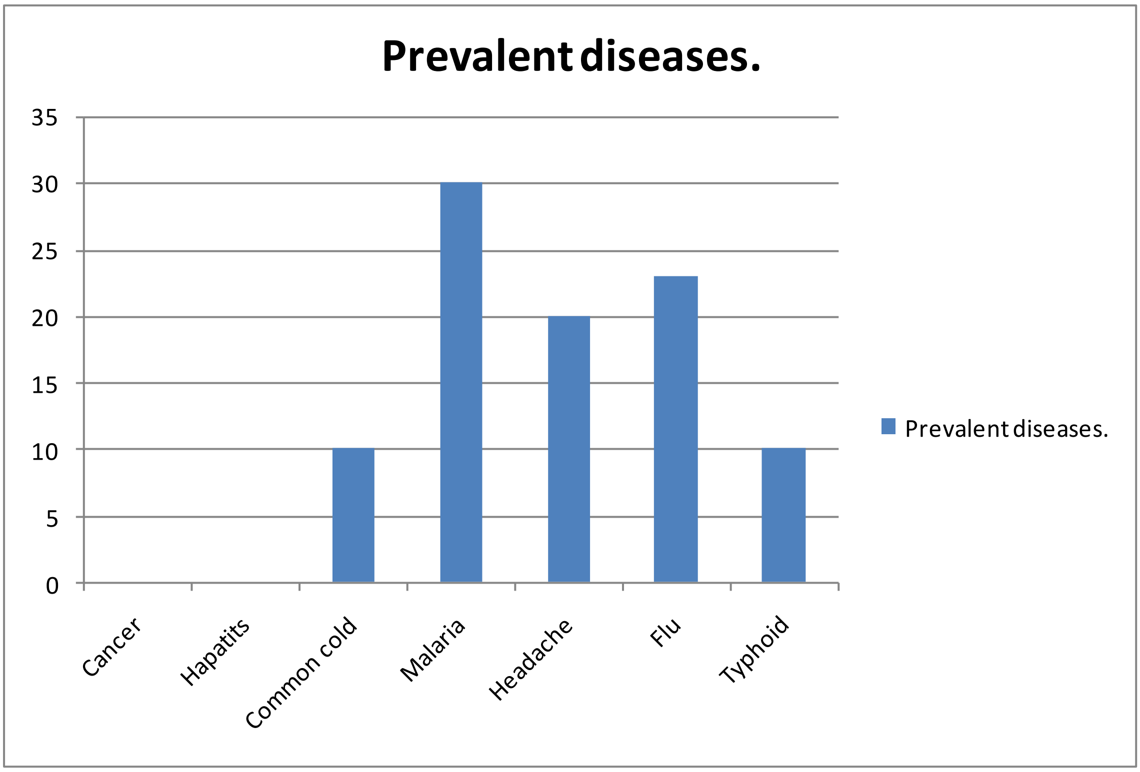


Figure 4.20: Graph showing prevalent diseases in the community

Social Amenities/Water Supply

The host communities *(Ahala Ukwu Village, Umuahala Community, Obuzor Ukwu Autonomous, and Umuacheke, Umuigwe/Umuogogo Community, Isimiri Umuorie Autonomous),* possess little social amenities like road and water. Farmers make use of river water to irrigate their farmlands. Government electricity is visible at the area, though still remains one of the community needs.

Government presence is evident in the community by the occurrence of NDDC *(Niger Delta Development Commission)* Project activities on road construction linking various communities.

Primary schools (2) are present in the communities.

No clinic present within both communities but make referrals to Obehie primary health care center about 4km away.

The major source of water in Umuahala and Umuogogo communities is Borehole water.

There are also commercial tankers that sell water within the community; though rain water is also a very dependable source of water, as the area is within the tropical rain forest vegetation/rainfall zone of Nigeria.

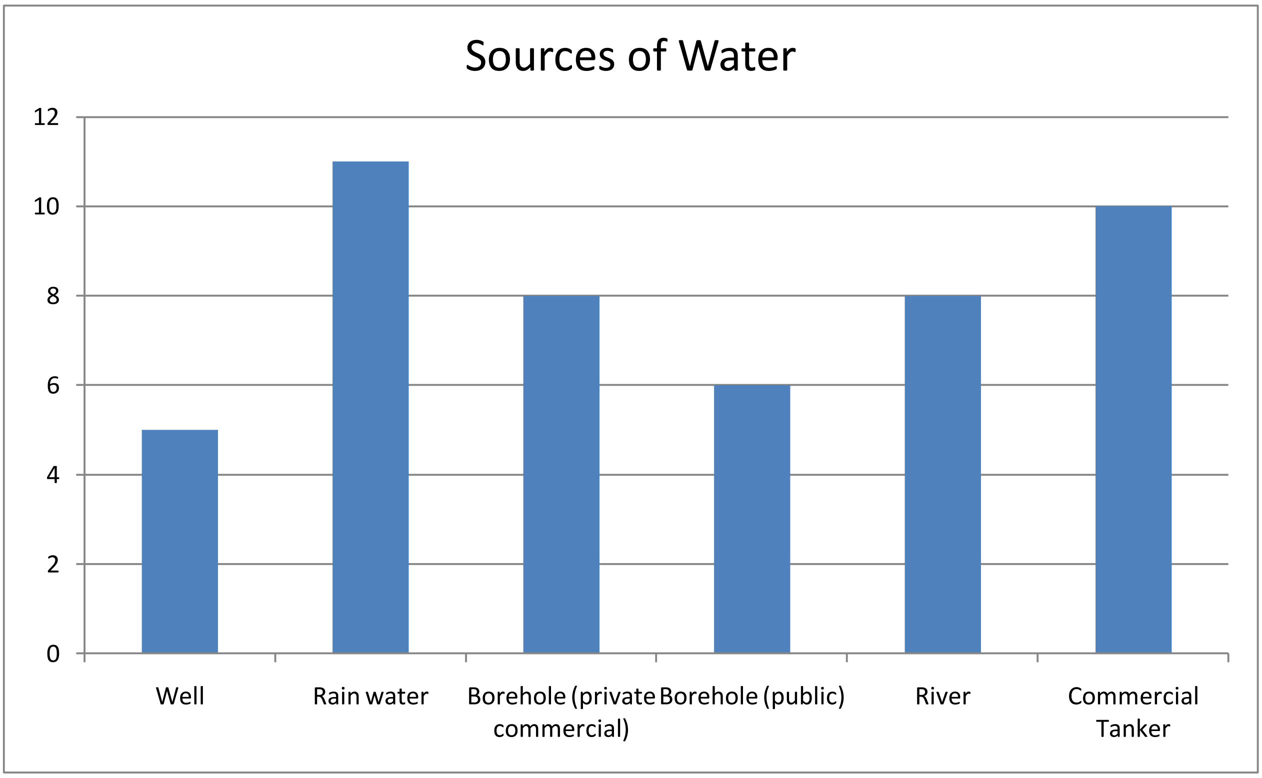


Figure 4.21: Graph showing Sources of Water

Waste disposal methods in the local community

The waste disposal methods found in the community includes private open dump, public open dump, organized collection (both LGA and Individual), burning, disposal in bush, burying. The most common method of waste disposal in the community is the bush, followed by public open dumps. The figure below illustrates this.

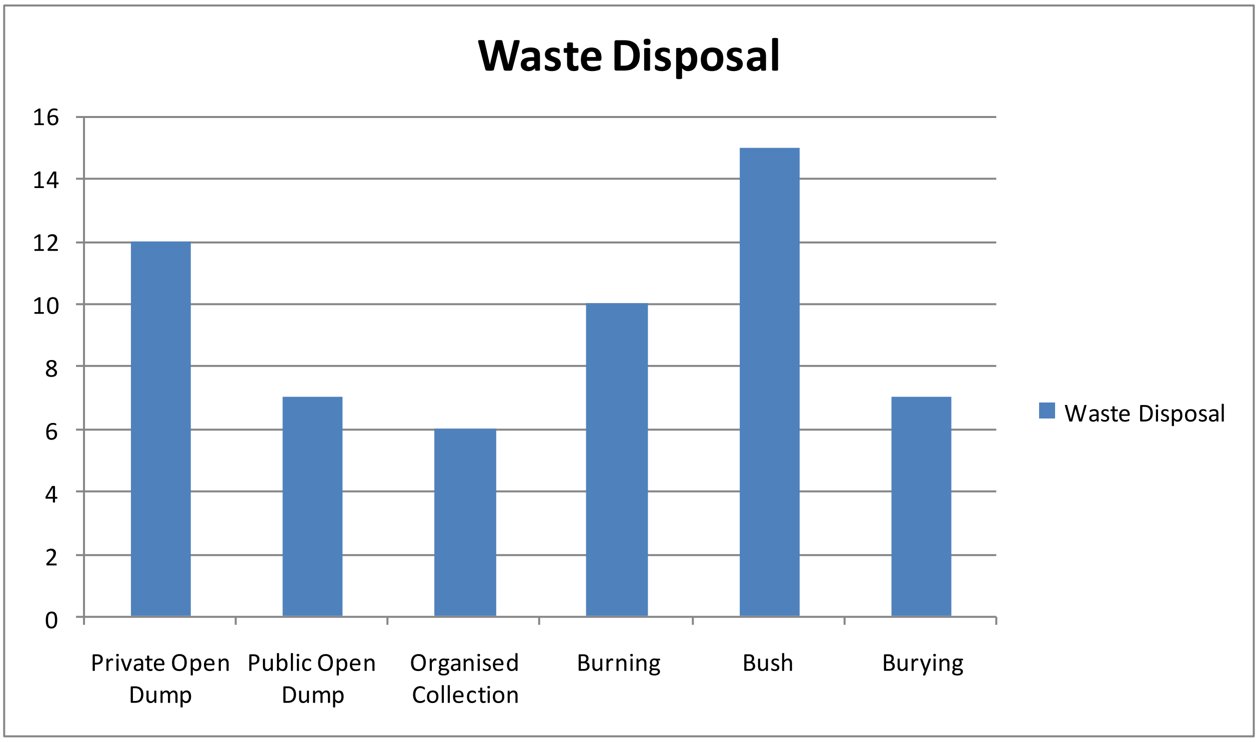


Figure 4.22: Graph showing waste disposal method in the local community.

Toilet Facilities

The toilet facilities found in the community were pit, bush and water closet. The figure below illustrates this. The most common toilet facilities used in the community is pit toilet, closely followed by bush.

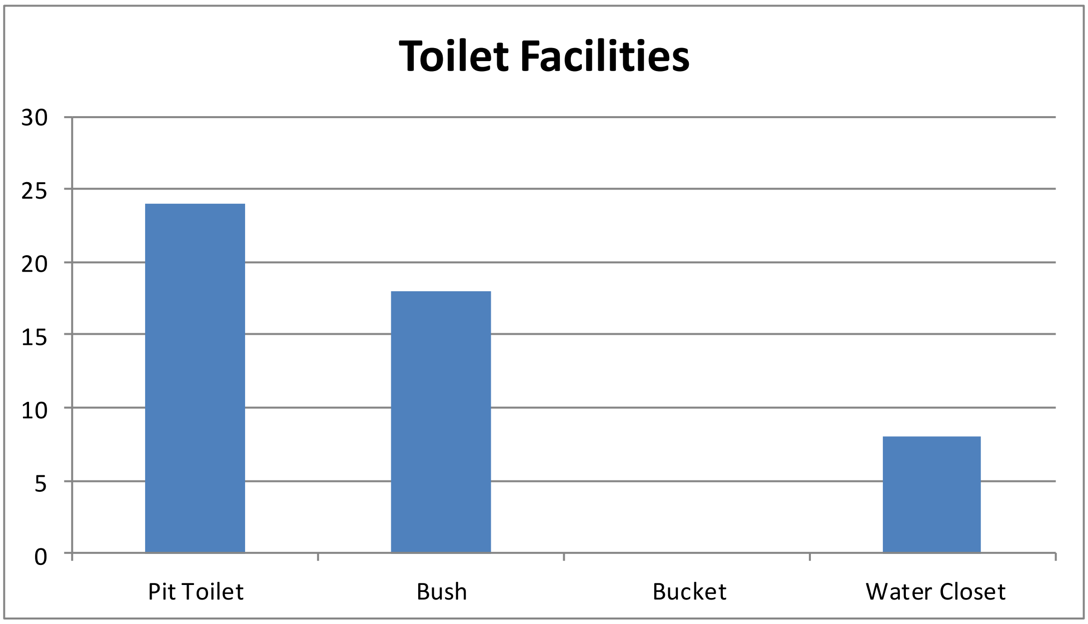


Figure 4.23: Graph showing Toilet Facilities.

Common Fuel used for Cooking

The common fuels used in the studied community are firewood, kerosene, gas, charcoal and sawdust. The most common fuel used is firewood, followed by kerosene. The figure below illustrates this.

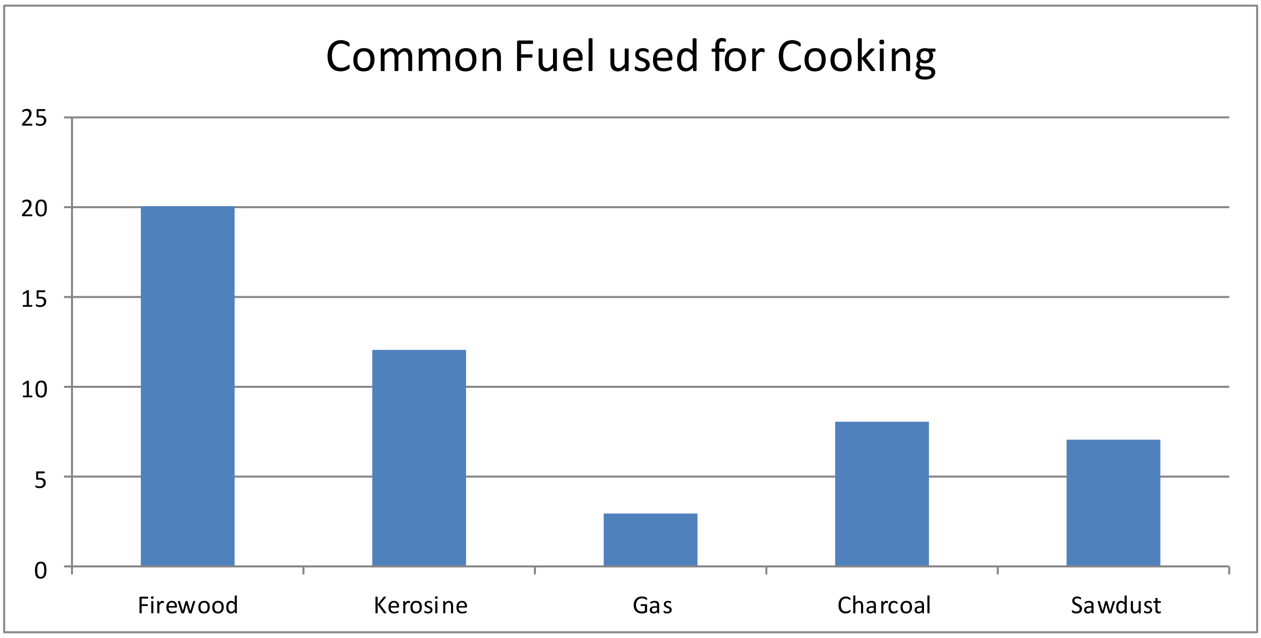


Figure 4.24: Graph showing Common Fuel used for cooking.

Marriage type:

The major marriage practice at the community is the monogamy type of marriage. 38 people representing about 75% of the respondents are married while 12 were unmarried none of the respondents practiced polygamous marriage.

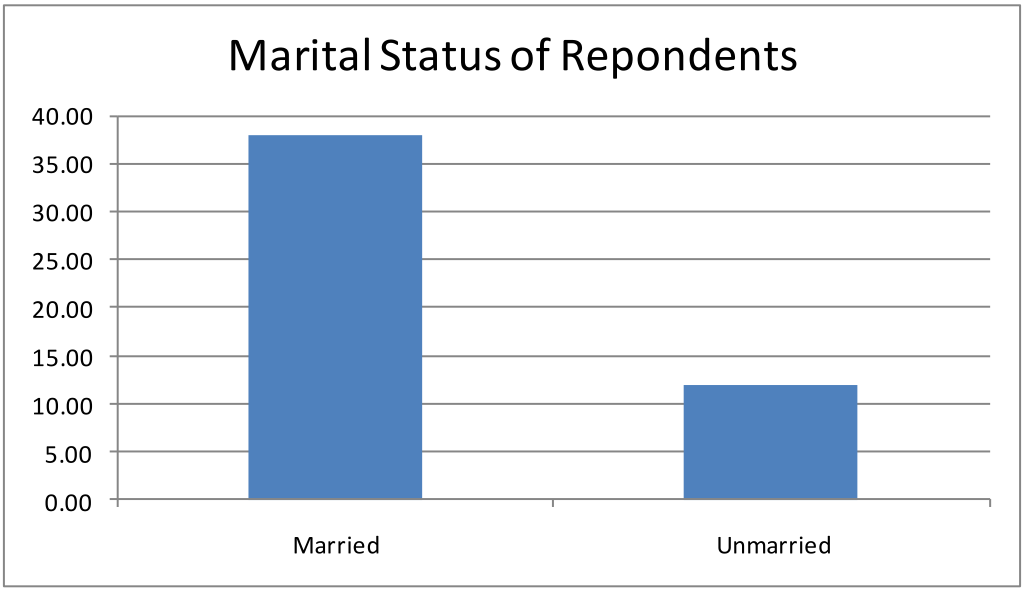


Figure 4.25: Graph showing marital status of respondents.

Housing pattern

Majority of the houses in Ukwa-West Local Government Area are built of mud, cement and brick blocks.

Household Occupational Categories

The most common primary occupation of the respondent's is farming, followed by mining and trading. Most of those farming practiced subsistent farming and make up to N500,000 annually and those that traded made an average of N400,000 annually.

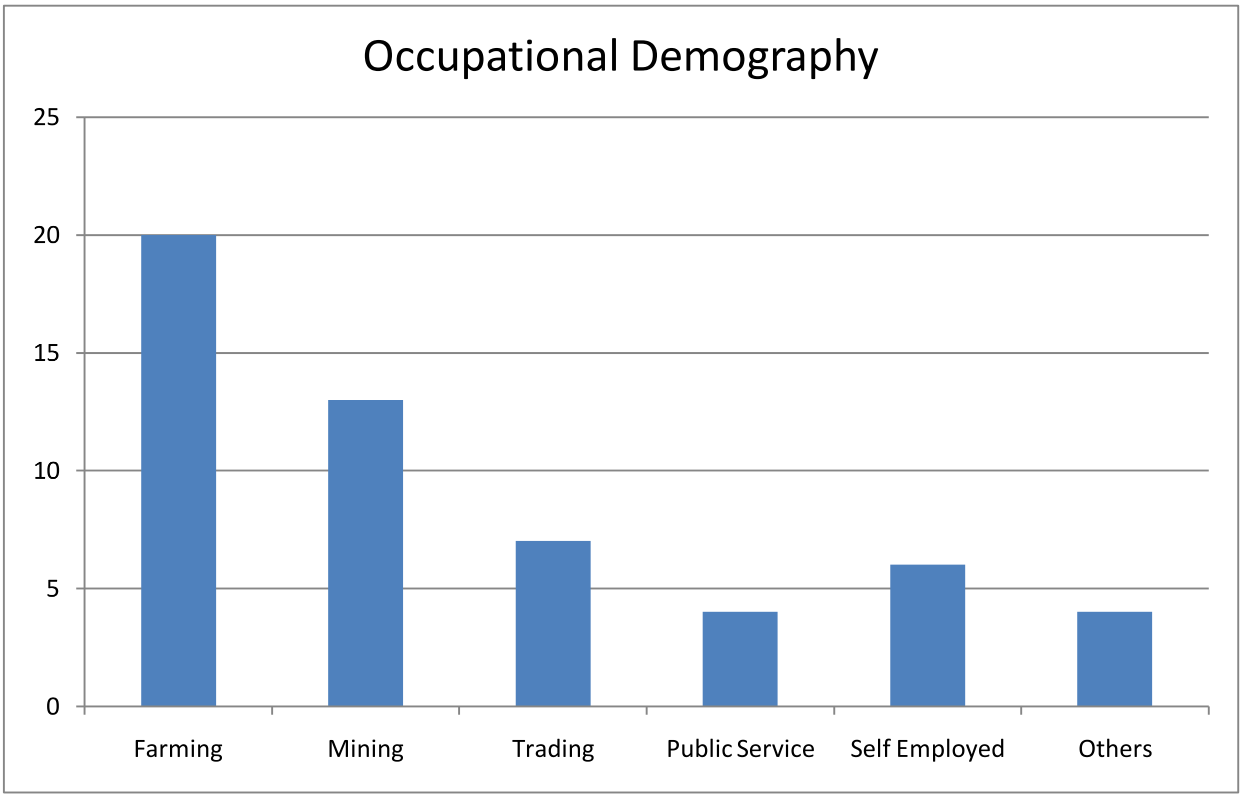


Figure 4.26: Graph showing Occupational Demography.

38% of the total respondents practiced farming as their major occupation, 28% mining, and 14% had trading as their predominant occupation, 8% of the respondents are employed in the public service. 12% of the respondents were self employed.

Household income categories

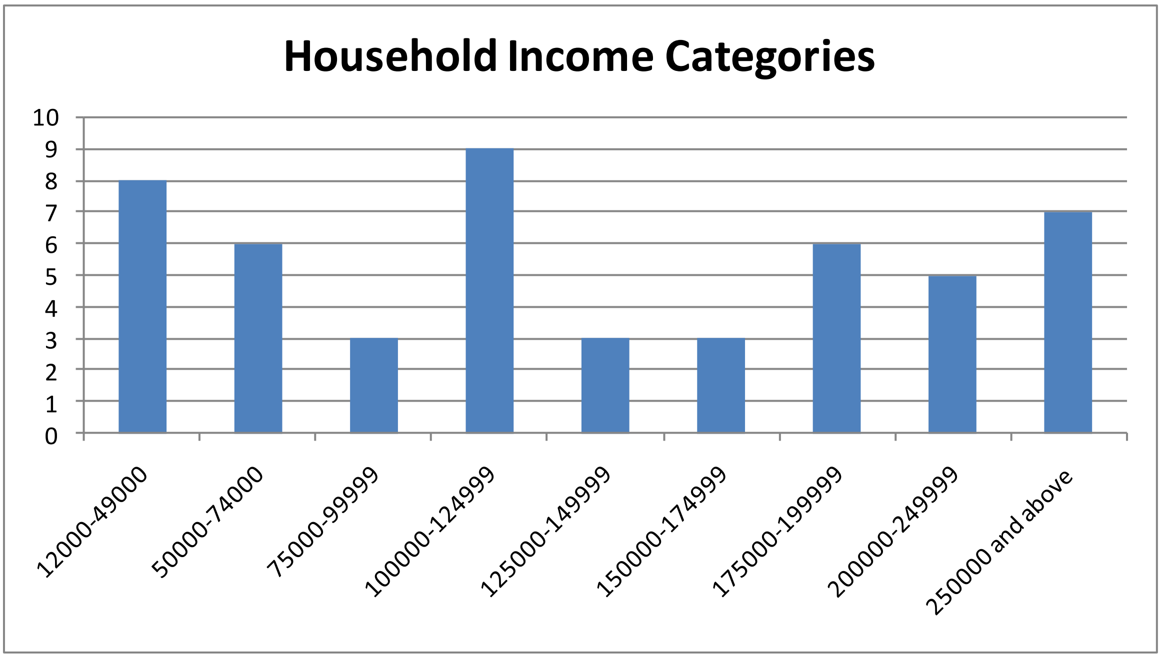


Figure 4.27: Graph showing Household Income Categories

The most common income category of the respondent's households is N100, 000- N124, 999 per month with 18%. The next common category is N12000-N49000 per month with 16%. The figure above illustrates this result.

Common means of transportation

The means of transportation available to the community are trekking, private bicycles, commercial motorcycles, private motorcycles, commercial buses and taxis, and private cars. The most common source of transportation is the use of commercial buses and taxis.

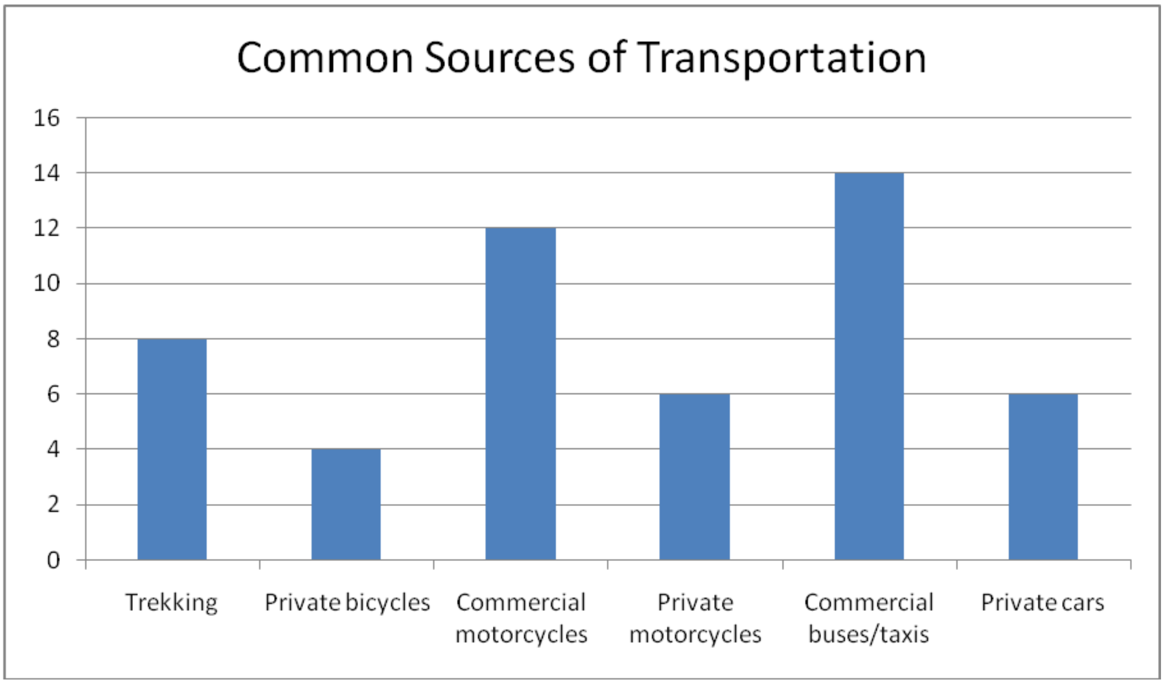


Figure 4.28: Graph showing Sources of Transportation.

Land Use Pattern/Farming occupation

Most of the land use is for Farming. The predominant farming method is subsistent manual farming, though few engage in commercial farming (trading of their economic crops) of farm produce.

The land use pattern is agricultural and the predominant occupation of the indigenes is farming and trading. The dominant crops grown are *Zea mays* (maize), *Manihot esculenta* (Cassava), *Musa paradisiaca* (plantain), *Ananas comosus* (pineapple), *Cucumis sativus* (cucumber), *Capsicum* (pepper), *Dioscorea Sp* (yam), *Oriza sativa* (rice), while most economic trees present are *Elaeis guineensis* (palm fruit), *Mangifera indica* (mango), *Malus domestica* (apple), orange, *Carica papaya* (pawpaw), *Pyrus* (pear), and guava.

Also, another major land use in the area is for Mining purposes. However, a quarter portion of the land use is for residential purposes, as most of the respondents live in their own houses.

4.8.3 Health Impact Assessment

General Indicators of Health Hazard:

General water quality indicators are parameters used to indicate the possible presence of harmful contaminants. Testing for indicators may eliminate costly tests for specific contaminants. Generally, if the indicator is excessive, the supply may contain other contaminants as well, and further testing is recommended. For example, coliform bacteria are present in the air, soil, vegetation, and all warm-blooded animals. A positive total coliform bacteria test result may be followed by a faecal coliform or E. coli bacteria test which, if present, would confirm that sewage or animal waste is contaminating the water. The pH value is also considered a general water quality indicator along with Total Dissolved Solids. Total Dissolved Solid should not change appreciably over time. The test for Nitrate provides a good routine (as often as once a year) analysis for most rural water supplies, unless there is a reason to suspect other contaminants.

4.8.4 Community Perception/ View about the project

The respondents expressed their level of pleasure and displeasure at the presence of Inner Galaxy Steel Co. Ltd. in their community. 50% of the respondents were very pleased, 20% were somewhat pleased, 18% were neither pleased nor displeased, 10% were somewhat displeased and 2% were very displeased. This shows that 70% of the respondent were pleased (on some level) with the presence of the company in the area. The table below illustrates the result.

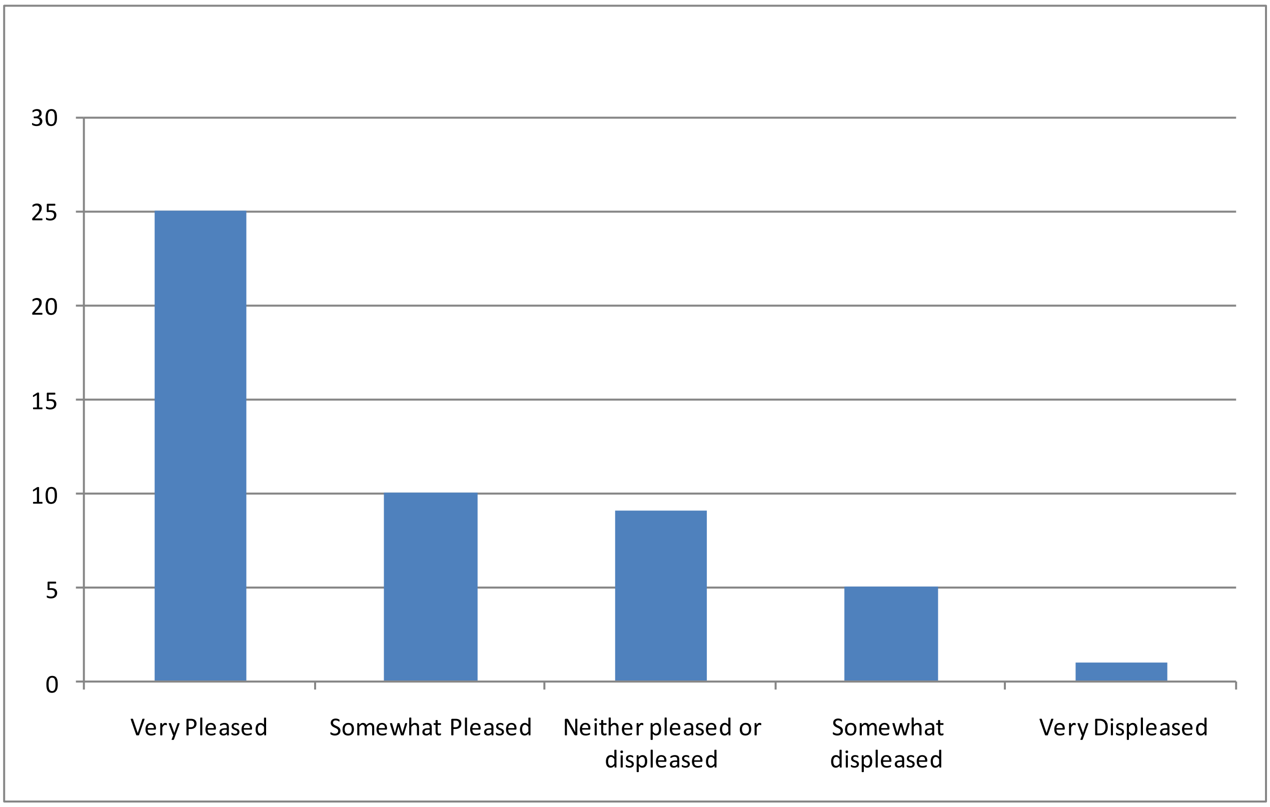


Figure 4.29: Graph showing Community Perception.

Those who were pleased said it was because Inner Galaxy Steel Co. Ltd. activities would bring about the much anticipated infrastructural development. Those who said they were somewhat pleased were of the opinion that there would be no significant infrastructural development like roads and also no significant increase in the economy of the area. However respondents who were either somewhat displeased or very displeased were of the opinion that the company's presence would bring disharmony in the community at large and its elites. They also believe that their land is being wasted and polluted by various companies doing business in the area (without commensurate compensation in terms of infrastructure and scholarship). Most of the respondents were of the opinion that the proposed project would not have any adversely effect, both on the environment and the socio-economy on the community. The figure below illustrates this.

Figure 4.30: Graph showing Community Perception of project's impact

Most of the respondents think that Inner Galaxy Steel Co. Ltd. project will not adversely affect amenities. However, amenities thought to be potentially affected are roads, water, health institutions, educational institutions, social welfare, social security, recreation and buildings.

The community generally has a collective high-percent support for the project. They relate peacefully with the company's activities; as CDA is being implemented, like the on-going (un-tarred) road construction.

An percentage-outlook of the project's impact response can be logically summarized using a pie-chart as seen below:

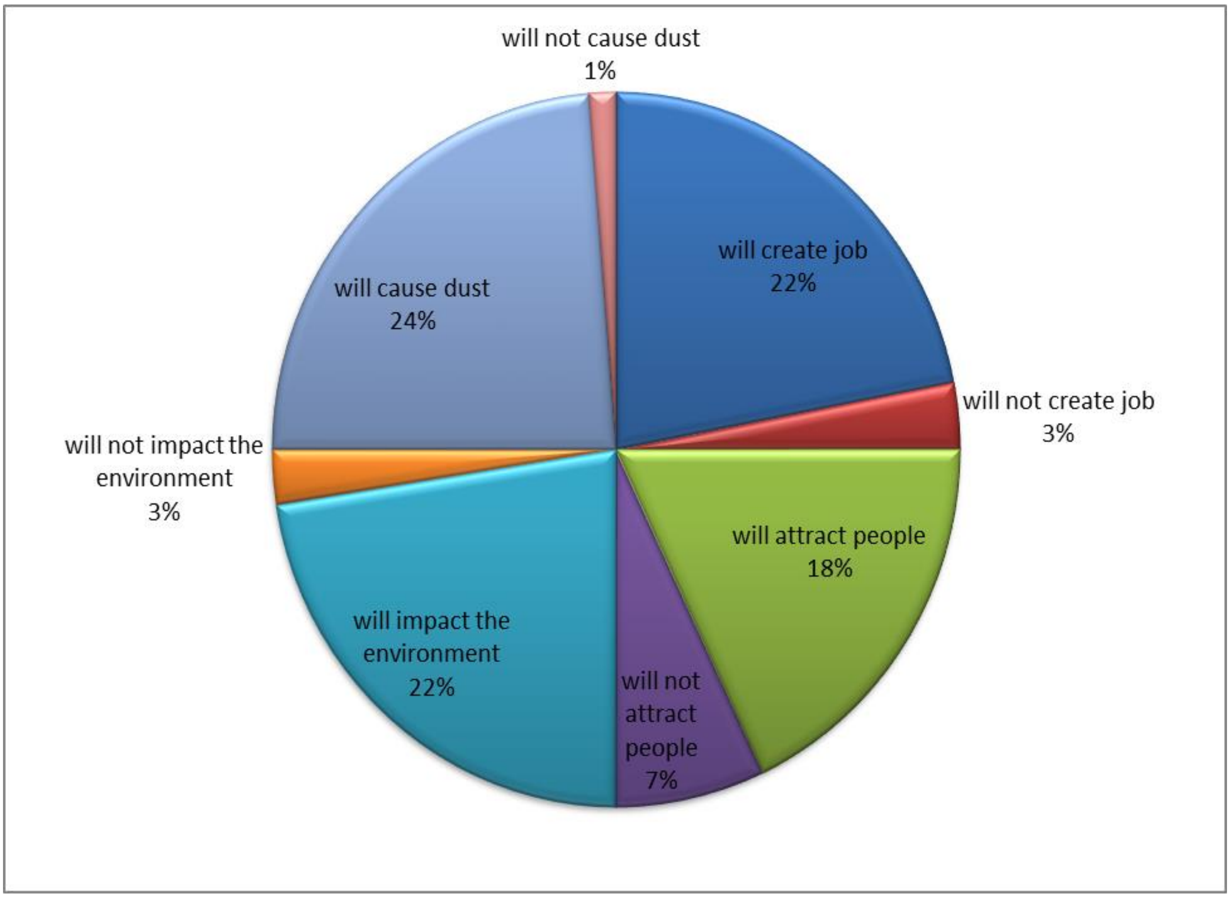


Figure 4.31: Pie Chart Showing Community's View of the Project

In summary of the communities' perspective on the project impact, they identified the following, as **needs** the project proponent (Inner Galaxy Steel Co. Ltd.) should address (in its Corporate Social Responsibility- **CSR**) to help the community appreciate the positive impact of the project:

Major Community (Socio-economic) Needs:

- More water project for the community
- Requested for more employment for community members.
- Hospitals
- Provision and extension of Electricity supply from the project location.
- Construction of more school building
- Building of town hall and community palace for the chief
- Empowerment and Scholarships
- Rehabilitation of access Road
- Requested for training on skill acquisition.

The above general perspectives of the residents of the project-site communities should be look into in totality to enable a good working relationship with the people/indigenes of the project area and the company.

As part of Community Socio Responsibility, Inner Galaxy went into several agreement with both host communities by employing certain percentage of the community member as part of it work force. Also, the Company intend to provide capacity and training development to host community members thereby given them permanent employment status for operations of various machineries.

4.8.5 Ecological Risk Assessment

This entails the evaluation of the likelihood that a project will harm the environment. Among Environmental Assessment methods, most attention has been paid to those used to identify and evaluate significant hazards and effects that portend ecological risk. These include:

- Harm to living resources
- Damage to human health
- Hindrance to other activities
- Impairment of quality for use
- Reduction of amenities
- Damage to cultural and heritage resources
- Damage to physical structures

Consequently, environmental hazards are substances or activities with the potential to cause these effects. All hazards and consequent effects should be identified whether they are likely to be:

- Beneficial or adverse
- Short or long term
- Temporary or permanent
- Direct or indirect
- Local or strategic

Consultation will assist in identifying likely interactions and will assist in identifying those environmental risks of particular concern. It is also essential that the assessment process quickly leads to a refinement in the number of hazards and effects being studied. This study takes into cognizance these factors as such a detailed environmental ecological risk assessment is also being undertaken. At the end of all the laboratory analysis, the results would be subjected to statistical risk analysis.

CHAPTER FIVE

POTENTIAL AND ASSOCIATED IMPACTS' ASSESSMENT

5.1 General

The key objective of an EIA is to predict changes (adverse or beneficial, whole or partial) in the ecological and socio-economic environment resulting from a proposed development project or activity as well as recommend mitigation measures to minimize, eliminate or offset those aspects that will adversely impact on the environment.

This chapter outlines the methodology for predicting impacts of the proposed construction of 1.3km 132kV Transmission Line and Steel-manufacturing project. It also identifies and discusses subsequent mitigation measures recommended for each impact identified.

The environmental, social and economic impacts of the project were assessed to confirm the preffered alternative ('go-ahead option') of the project, and to ensure that identified residual impacts are properly addressed by appropriate mitigation and monitoring measures. The process involved looking at the environmental baseline features, uniqueness, potential vulnerabilities and the nature, location, and duration of construction activities, and project design features in effect throughout operation.

Moreso, this assessment process involved the identification of the environmental aspects (i.e. elements/activities of the proposed project that will interact with the air, water, sediment, plankton, benthos and human population) as per project description (chapter three). These aspects were then superimposed / interacted with the environmental components (described in chapter four). The effects, nature, and extend of the impacts were then evaluated and ranked.

In pursuance of its policy on the environment and in compliance with relevant national and international laws, conventions and acceptable industry standards, Inner Galaxy Steel Company Ltd. has embarked on this impact assessment prior to the commencement of the project. The study is intended to predict, identify, interpret and communicate the impacts of the various phases of the project on the environment. This Chapter however evaluates the potential impacts of the various project activities of the proposed project on the environment. The assessment approach generally involves matching the various activities of the proposed project (as described in Chapter 3 of this report) with the components of the existing environment. Consequently, the interaction may lead to changes in or impacts on the environment, hence mitigation measures are proffered in order to reduce, offset or ameliorate such changes (See Chapter Six). The assessment of the potential and associated impacts of the proposed steel-manufacturing project in Ukwa-West LGA of Abia State is presented hereunder.

Internationally and locally proven acceptable methods of impact prediction and evaluation were used as basis for developing the assessment process for the proposed project associated and potential impacts.

5.2 Impact Assessment Methodology

The guidelines of ISO 14001 were used for impact prediction and evaluation. This allow for interactive and descriptive analysis of relationships between the proposed project activities and the various environmental components (biophysical, health and social). The pathway followed in the identification / assessment and evaluation of the potential and associated impacts of the proposed project is illustrated in the **Figure 5.1&2.**

The methodology adopted in the assessment of impacts entailed identification of aspects and impacts using source reference materials; defining impacts criteria and determination of mitigation measures followed by the formulation of impact management plan.

The impacts are analysed and discussed in detail in line with the EIA scope. All impacts were first assessed without the necessary mitigation and the results presented in a summarised impact table (Table below), which form the core of the impact assessment. Mitigation measures were thereafter recommended and discussed, with the aim of enhancing positive impacts and minimising negative impacts.

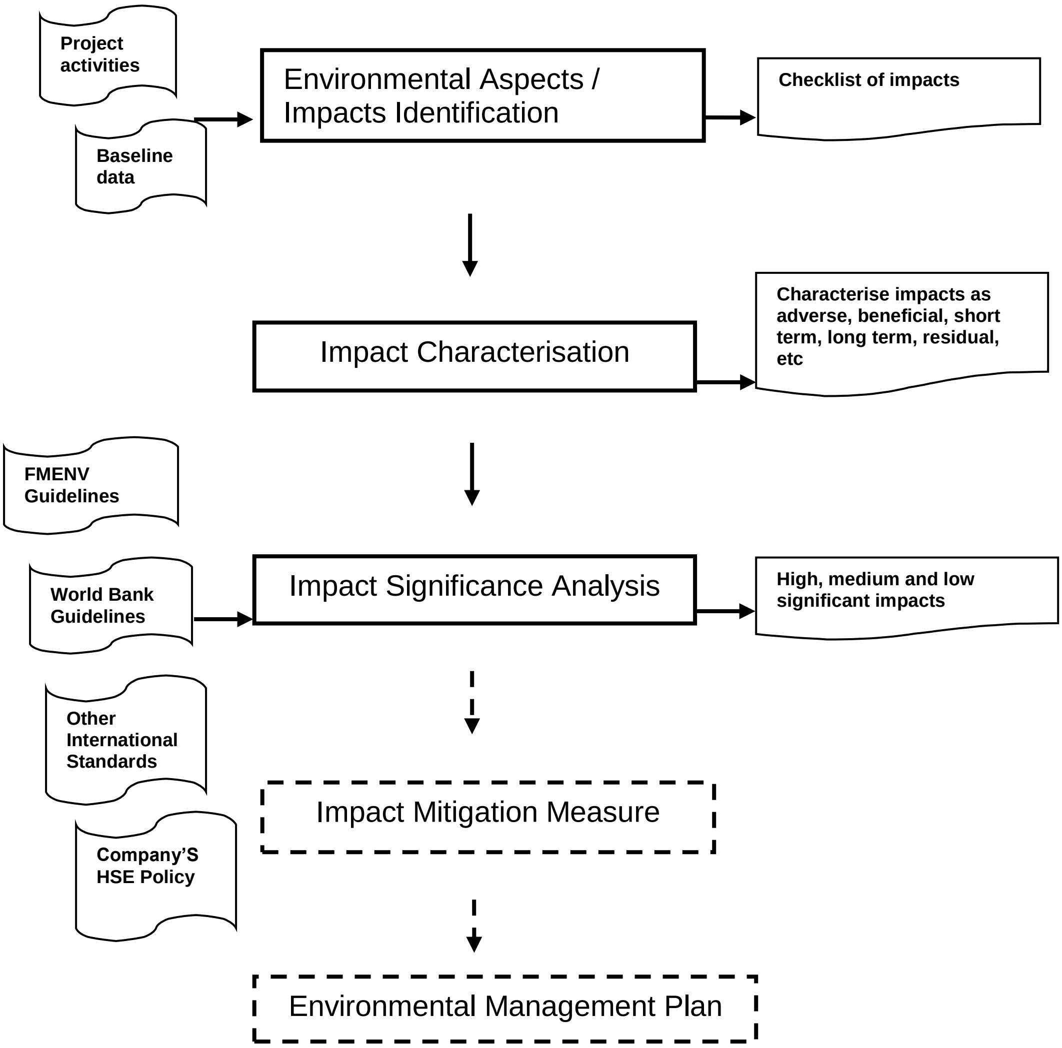
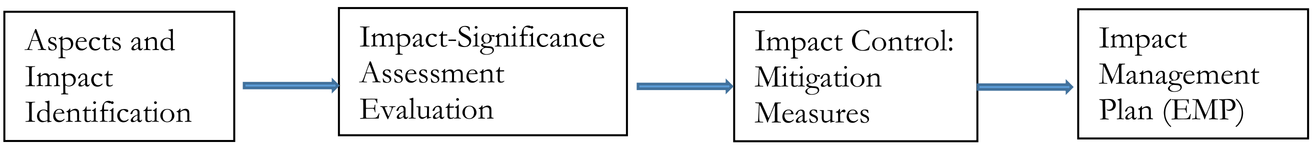


Fig. 5.1: Impact Assessment Pathway

Details of the process are discussed in **sections 5.2.1** – **5.3** while the results are presented thereafter in **Table 5.2**.

Figure 5.2: Summary of Impact Management Procedure:



5.2.1 Impact Identification

The environmental aspects of the proposed project were teased out from the planned project activities description *(Chapter 3)*. These aspects were then matched with the existing baseline description of the project environment *(Chapter 4)* and used to develop a checklist of potential and associated impacts of the proposed project. The development of the checklist was carried out using the FMEnv EIA Sectoral Guidelines for Power, Infrastructural Projects, the World Bank Environmental Assessment Source Book, Volume III (Guidelines for Environmental Assessment of Energy and Industrial Projects, 1991). Other source references include Inner Galaxy Steel Company Ltd Nig. Ltd. HSE Policy and other relevant international standard codes used for such developmental projects.

Environmental-Aspect (Project' Activities of Construction of 132kV Transmission Line)

The process adopted in the identification and assessment of the potential and associated impacts of the proposed 1.3km 132kV Transmission Line project considered various phases of the project, namely:

- Pre-construction:- this will include mobilisation of materials and personnel, community engagement, permit to work, site preparation activities etc.;
- Construction/Installation: - foundations, tower construction, transmission line erection and stringing and other associated earthen works;
- Commissioning and Operation/Maintenance: - project inspection, turnover, commissioning as well as operations and subsequent maintenance activities;
- Decommissioning: - disusing/abandoning of project facilities

The checklist (matrix interaction below; Table 5.1) shows the various project activities that generate impact. Impacs are identified based on the project aspects.

Key: **x** = 'impact is identified' in the the specified activity; *as shown in the table below.*

Table 5.1: Transmission Line Project Activities – Environmental Indicators *Interaction Matrix*

Project Activities	Pre-Construction			Construction & Installation									Operation/Maintenance									Decommissioning		
				Planned Activities						Unplanned			Planned Activities			Unplanned								
Environmental Indicators ↓	Mobilization of construction elements	Recruitment/community Engagement	Site preparation (access & camping)	Onsite fabrication (metal works)	Tower foundation (Piling, trenching, etc.)	Tower erection/stringing activates	Waste management	Fuel / hazardous materials handling	Painting and coating	Logistics (support, supply & servicing)	Fires / explosions	Incidents / Accidents	Commissioning / Testing	Power Transmission	ROW maintenance	Line element replacement	Waste management	Logistics (support, supply & servicing)	Tower falling incidents	Fires	Incidents and Accidents	Geo-hazards	Transmission Line Decommissioning	Abandonment / Restoration
Air Quality																								
Particulates	x		x	x	x					x	x				x			x		x		x	x	x
NOx, SOx, COx, etc.	x		x	x	x					x								x				x	x	x
Gaseous Hydrocarbons										x								x				x		
Water Quality																								
Turbidity			x		x										x		x						x	x
Water Physio-chemistry	x		x		x	x	x								x		x						x	
River-bed Physio-chemistry			x		x	x											x						x	
Aquatic Ecology																								
Plankton					x		x	x									x						x	
Fishes							x	x									x					x		
Macro-benthos					x		x	x									x					x		
Terrestrial Ecology																								
Fresh Water Swamps			x		x		x	x							x		x						x	
Mangrove Swamps			x		x		x	x							x		x					x		
Rainforests			x		x		x	x			x				x		x			x		x	x	
Avifauna	x		x		x	x				x	x			x	x			x					x	x
Rodents and Mammals	x		x		x	x	x	x		x	x			x	x		x	x				x	x	x

Project Activities	Pre-Construction			Construction & Installation									Operation/maintenance									Decommissioning		
				Planned Activities						Unplanned			Planned Activities			Unplanned								
Environmental Indicators ↓	Mobilization of construction elements	Recruitment/community Engagement	Site preparation (access & camping)	Onsite fabrication (metal works)	Tower foundation (Piling, trenching, etc.)	Tower erection/stringing activates	Waste management	Fuel / hazardous materials handling	Painting and coating	Logistics (support, supply & servicing)	Fires / explosions	Incidents / Accidents	Commissioning / Testing	Power Transmission	ROW maintenance	Line element replacement	Waste management	Logistics (support, supply & servicing)	Tower falling incidents	Fires	Incidents and Accidents	Geo-hazards	Transmission Line Decommissioning	Abandonment / Restoration
Soil Quality																								
Physic-chemistry			x		x	x	x	x	x							x	x						x	
Topography / Natural Drainage	x		x		x	x				x					x			x				x	x	x
Sensory Perceptions																								
Noise Disturbance	x		x	x	x	x				x	x			x	x			x					x	
Visual Intrusions			x		x	x							x						x				x	x
Socio-Economics / Human Health																								
Existing / Planned infrastructures	x		x		x	x	x			x	x	x		x	x		x	x	x	x			x	
Employment Opportunities		x	x	x	x	x	x		x	x					x		x	x					x	x
Worker Safety / Occupational Health	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Public Health			x				x							x	x		x		x			x		
Land-use			x		x			x			x		x										x	
Fishing			x				x	x																
Traffic on local roads	x		x		x	x				x								x					x	
Macro & Micro Economics	x	x	x	x	x	x	x						x	x	x	x		x					x	x

Table 5.1- ***Cont'd.*****: Transmission Line Project Activities – Environmental Indicators** ***Interaction Matrix***

5.2.2 Environmental Impact Indicators

The environmental impact indicators are easily observable parameters that will indicate change/deviation, which can be used to monitor the various environmental components, as presented in Table 5.2.

Table 5.2: Environmental Components and Potential Impact Indicators

S/N	ENVIRONMENTAL COMPONENTS	IMPACT INDICATORS
1	Air Quality	SPM, CO_2, NOx, SOx, CO, VOC, CH_4, NH_3, etc
2	Soil/Agriculture	Soil type and structure, physico-chemical and microbiological characteristics, etc
3	Surface Water Quality	Physico-chemical and microbiological parameters such as; dissolved and suspended solids, turbidity, toxicity, etc
4	Ground water quality	Physico-chemical and microbiological parameters such as; dissolved and suspended solids, turbidity, toxicity, etc
5	Socio-economics/Health	Needs and concern of host communities, perception on the proposed project/ Health risks, Waste streams, handling, treatment and disposal, etc.

5.2.3 Impact Characterization

The identified impacts of the proposed project were further characterized as explained below. The characterization was based on the nature, characteristics and duration of the various project activities on the ecological components of the environment as well as human health and safety as necessary.

An *adopted* 'checklist approach' have been developed and populated to identify the proposed project activities and components of the physical, biological and social environment that may be affected as a result of planned and unplanned project activities. This involved categorising the project into activities/phases and then the project environment into various components. The interaction between these two elements (the project and environment) may lead to changes in the environment.

i.e: **[Environment] + [Project] = {Changed Environment}**

This change may be direct or indirect, adverse or beneficial, cumulative or residual, long term or short term as described below.

Table 5.3 Impact Characterization

Impact Characterization	**Definition**
Beneficial Impacts	Impacts that would produce an overall positive effect on the well-being of the people as well as the environment.
Adverse Impacts	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	Impacts resulting directly (direct cause-effect consequence) from a project activity
Indirect Impacts	Impacts that are at least one step removed from a project activity. They do not follow directly from a project activity.

Normal Impacts	Impacts that will normally 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	Impacts that will last only within the period of a specific project activity.
Long-term Impacts	Impacts whose effects remain even after a specific project activity.
Reversible Impacts	Impacts whose effects can be addressed on application of adequate mitigation measures
Irreversible Impacts	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	Impacts resulting from interaction between ongoing project activities with other activities, taking place simultaneously
Incremental Impacts	Impacts that progress with time or as the project activity proceeds.
Residual Impacts	Impacts that would still remain after mitigation measures have been applied

Impact Assessment defines the criteria and processes against which potential project impacts can be measured and mitigated. A multidisciplinary team comprising engineers, scientist, environmentalists etc were involved in the identification and characterisation of impacts of the approximately 1.3km 132kV Transmission Line project.

Impacts can be induced during the construction of the facility, and later during its operation. In the case of transmission line facilities, the main potential receptors are soil, surface water bodies, flora and fauna, occupational health, in addition to socio-economic amenities.

5.2.4 Impact Evaluation

At this stage, the potential and associated impacts identified and characterized in the previous stage of the assessment process (**sections 5.2.1 – 5.2.3**) were evaluated. The evaluation which was based on clearly defined criteria (legal/regulatory requirement, risk, frequency of occurrence, importance and public interest/concern) was used to determine the significance or otherwise of the impacts. The criteria and weighing scale adopted for the evaluation are described below.

Legal/Regulatory Requirements (L)

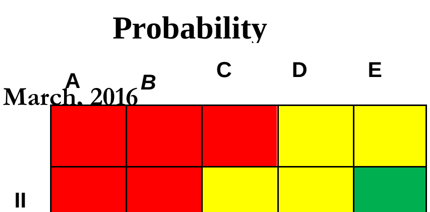
Here, the proposed project activities that resulted in impacts were weighed against existing legal / regulatory provisions to determine the requirement or otherwise for permits prior to the execution of such activities. Such legal/regulatory requirements were identified from the laws/guidelines, which have been reviewed in opening chapter 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 **subsections 5.2.1 – 5.2.2**. The weighting scale used was as follows:

Legal/Regulatory Requirements Criterion:

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

Risk Posed by Impact (R)

The health, safety and environmental risks associated with each impact were assessed and ranked as “low”, “medium” or “high”, using the Risk Assessment Matrix (RAM). Reference was also made to the source references listed in the previous sections. Three criteria (consequence, probability of occurrence and severity) were used as basis for ranking the risks of the impacts. These were determined using the RAM as shown in **Figure 5.3**.



Consequences

Probability Category	Definition
A	Possibility of Repeated Incidents
B	Possibility of Isolated Incidents
C	Possibility of Occurring Sometime
D	Not Likely to Occur
E	Practically Impossible

Consequence Category	Considerations			
	Safety / Health	**Public Disruption**	**Environmental Aspects**	**Financial Aspects**
I	Fatalities / Serious Impact on Public	Large Community	Major/Extended Duration/Full Scale Response	**High =5**
II	Serious Injury to Personnel / Limited Impact on Public	Small Community	Serious / Significant Resource Commitment	**Medium =3**
III	Medical Treatment for Personnel / No Impact on Public	Minor	Moderate / Limited Response of Short Duration	**Low =1**
IV	Minor Impact on Personnel	Minimal to None	Minor / Little or No Response Needed	**None**

Fig. 5.3: Risk Assessment Matrix

The risks (measure of the likelihood and magnitude of an adverse effect) associated with such project operations were evaluated in terms of:

- risk to human health;
- risk to asset (commercial and economic risk);
- risk to the biophysical environment; and
- risk to the Inner Galaxy Steel Company Ltd's reputation.

Based on the matrix above, the weighting used was as follows:

Risk Criterion

Risk	Attribute – Environmental, Human Health, Safety and Reputation
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 modifications
5=High	• This means that the impact require avoidance or major control/mitigation

Frequency of Impacts Occurrence (F)

Evaluation of the frequency of occurrence of each impact was also carried out. Frequency of occurrence was rated as "high", "medium" or "low" based on the historical records of accidents/incidents, consultation with experts and professional judgment. The frequency criterion is summarised below.

Frequency Criterion

Frequency	Attribute – Environmental, Human Health and Safety
High = 5	• Major degradation in quality in terms of scale (>1% of study area or habitat within the study area), appearance, duration (beyond duration of project) • Irreversible or only slowly recoverable (change lasting more than 1 year) degradation of environmental ecosystem level (population, abundance, diversity, productivity) • High frequency of impact (occur continuously and almost throughout the project execution period (< 4months) • Geographic extent of impact (e.g. encompassing areas beyond study area)
Medium =3	• Degradation in quality in terms of scale (>0.1% of study area, habitat), appearance, duration (a few months)

	• Effect beyond naturally occurring impacts variability • Slow reversibility (change lasting a few months before recovery), lasting residual impact • Potential for cumulative impact • Intermittent frequency of impact (occur in only a few occasions during the project execution period) • Limited geographic extent of impact (large area within study Area)
Low = 1	• Minor degradation in quality in terms of scale (<0.1% of study area, habitat, very localized), appearance, duration (a few days to a month) • Effect within range of naturally occurring impacts, changes, dynamics • Rapid reversibility (change lasting only a few weeks before recovery), no lasting residual impact of significance • No potential for significant cumulative impact • Low frequency of impact (occur in just about one occasion during the project execution period) • Only very localized geographic extent of impact (e.g. not more than a few meters from impact source point)

Importance of Impact (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 and other stakeholders in the proposed project. The importance criterion is summarized below.

Importance Criterion:

Importance	Attribute – Environmental, Human Health and Safety
High = 5	• Highly undesirable outcome (e.g., impairment of endangered, protected habitat, species) • Detrimental, extended flora and fauna behavioral change (breeding, spawning, molting) • Major reduction or disruption in value, function or service of impacted resource

	• Impact during environmentally sensitive period • Continuous non-compliance with international best practices
Medium = 3	• Negative outcome • Measurable reduction or disruption in value, function or service of impacted resource • Potential for non compliance with international best practices
Low =1	• Imperceptible outcome • Insignificant alteration in value, function or service of impacted resource • Within compliance, no controls required

Public Interest/Perception (P)

Here, the interest/perception of the public on the proposed project and the identified potential/ associated impacts were determined through consultation with proposed project stakeholders. The ratings of "high", "medium" or "low" were assigned based on consensus of opinions among consulted known stakeholders.

The public perception/interest criterion is summarised below.

Public perception /interest criterion

Public Perception	**Attribute – Environmental and Human Health**
High (5)	• Elevated incremental risk to human health, acute and/or chronic • Possibility of life endangerment for community inhabitants and site personnel • Major reduction in social, cultural, economic value • Continuous non-compliance with international best practices • Any major public concern among population in the project region
Medium (3)	• Limited incremental risk to human health, acute and/or chronic • Unlikely life endangerment for community inhabitants and site personnel • Some reduction in social, cultural, economic value • Possibility of adverse perception among population

	• Potential for non-compliance
Low (1)	• No known risk to human health, acute and/or chronic • No known risk of life endangered for community inhabitants and site personnel • Minor reduction in social, cultural, economic value • Unlikely adverse perception among population

5.3 Result of Impact Assessment

The results of the impact assessment exercise as discussed in the previous sections are presented in **Table 5.4**. The various project phases, planned project activities, the environmental aspects of the proposed project as well as the identified associated and potential impacts are reflected in Table 5.4. Also included in Table 5.4 are impact significance evaluation criteria:(legal/regulatory requirements (**L**), risk posed by impact (**R**), frequency of occurrence (**F**), importance of affected environmental component (**I**) and public perception (**P**). In addition, the overall ratings of impact significance (**High** or **Medium** or **Low**) of each impact considered have been included. The overall significance ratings were based on the following considerations:

High = $(L+R+F+I+P) \geq 15$ or $(F+I) \geq 6$ or $P = 5$

Medium = $(L+R+F+I+P) \geq 8$ but < 15

Low = $(L+R+F+I+P) <8$

Table 5.4: Potential and Associated Impact Assessment of the Proposed Project

Project Phase	Project Activity	Associated and Potential Impact	Impact Characterisation	Significance Evaluation Criteria					Sum	Significance Ranking
				L	R	F	I	P		
Pre-Construction	Land acquisition	Conflict over land ownership amongst natives	Normal, direct, short term and reversible	5	5	1	5	1	17	High
		Conflict over payment of compensation for acquired land	Normal, direct, short term and reversible	5	5	1	5	1	17	High
	Movement of personnel, materials and equipment to site using Low – Loaders and other trucks, vehicles	Interference with public utilities (electric wires and poles), market activities along mobilisation route	Normal, direct, short term and reversible	1	3	3	1	3	11	Medium
		Release of SO_X, NO_X, CO_X, etc from exhausts which could lead to atmospheric pollution / GHG emission	Normal, direct, short term and reversible	5	1	1	1	1	9	Low
		Increase noise level in the area due to movement of heavy duty engines	Normal, direct, short term and reversible	5	1	1	1	1	9	Low
		Incident/accident resulting from the movement of materials and equipment from low loader	Normal, direct, short term and reversible	5	5	1	5	1	17	High
		Increase road traffic accident (RTA)	Normal, direct, short term and reversible	5	5	1	5	1	17	High

		Risks of militant/youths attack leading to personnel injury / death	Adverse, direct, abnormal, short term	**5**	**5**	**1**	**5**	**1**	**17**	**High**
		Movement of workers into host communities and resultant increase in population.	Adverse, direct, abnormal, short term	**3**	**2**	**1**	**3**	**3**	**12**	**Medium**
		Conflicts between host communities especially youths arising from recruitment of local labour	Normal, direct, short term and reversible	**5**	**5**	**5**	**5**	**3**	**23**	**High**
		Conflict with native cultures, traditions and life styles	Normal, direct, short term and reversible	**5**	**5**	**1**	**5**	**3**	**19**	**High**
		Increased demand on social infrastructure	Adverse, direct, abnormal, short term	**5**	**5**	**1**	**1**	**1**	**13**	**Medium**
		Recruitment of Local hands/labour.	Adverse, indirect, abnormal, long term	**-**	**-**	**-**	**-**	**-**	**-**	**Beneficial**

Project Phase	General	Associated and Potential Impact	Impact Characterisation	Significance Evaluation Criteria					Sum	Significance Ranking
Pre construction	Site Survey, Removal of vegetation and de-stumping	Creation of job and job opportunities	Direct, Beneficial, Cumulative, Short term, Normal	-	-	-	-	-		**Beneficial**
		Loss of topsoil. Decreased soil fertility and agricultural production	Adverse, direct, abnormal, long term	**3**	**3**	**3**	**5**	**1**	**15**	**medium**
		Loss of biodiversity (flora and fauna) including loss of plants of economic value	Adverse, direct, abnormal, short term	**3**	**3**	**3**	**5**	**1**	**15**	**medium**
		Fragmentation of habitats; Disruption of wildlife migration routes	Adverse, indirect, abnormal, long term	**3**	**3**	**3**	**5**	**1**	**15**	**medium**
		Alteration of natural drainage patterns	Normal, direct, short term and reversible	**3**	**3**	**3**	**5**	**1**	**15**	**medium**
		Personnel injury/death resulting from malfunction and mal-operation of equipment etc.	Normal, direct, short term and reversible	**3**	**3**	**5**	**3**	**3**	**17**	**High**
		Soil erosion and run off from access road creation	Normal, direct, short term and reversible	**3**	**3**	**3**	**5**	**1**	**15**	**medium**
		Wildlife attack (e.g snake bite, bee sting)	Adverse, direct, normal, long term	**3**	**3**	**5**	**3**	**3**	**17**	**High**

		Pollution (dust) from soil surface.	Direct, Short term, Normal, reversible	**3**	**3**	**3**	**5**	**1**	**15**	**medium**
		Secondary development of modern amenities/infrastructures	Direct, Beneficial, Cumulative, Short term, Normal	**-**	**-**	**-**	**-**	**-**		**Beneficial**
		Increased demand on existing local infrastructures (road, housing etc) due to influx of workers and job seekers.	Direct, Adverse, Residual, Short –term, Abnormal	**3**	**3**	**5**	**3**	**3**	**17**	**High**
		Influx of predominantly male population) job seekers) into stakeholders communities leading to increased extramarital sexual activity, and introduction of commercial sex workers	Direct, Adverse, Residual, Short –term, normal	**3**	**3**	**5**	**3**	**3**	**17**	**High**
		Potential effects on air quality from emission of pollutants from engines eg bull-dozers and supportequipment .	Normal, direct, short term and reversible	**5**	**1**	**l**	**1**	**1**	**9**	**Low**

		Conflict over employment issues among stakeholders	Direct, Adverse, Residual, Short –term, Abnormal	**5**	**3**	**5**	**3**	**5**	**21**	**High**
		Localised increase in ambient noise levels from operations. This could lead to loss / scare birds and mammals	Normal, direct, short term and reversible	**5**	**3**	**5**	**1**	**1**	**15**	**Low**
Construction Phase	All construction activities	Creation of job and job opportunities	Direct, Beneficial, Cumulative, Short term, Normal	**5**	**3**	**5**	**3**	**5**	**21**	**Beneficial**
		Improvement on the economic status of the stakeholder community due to increased demand for local goods and services	Direct, Beneficial, Cumulative, Short term, Normal	**5**	**3**	**5**	**3**	**5**	**21**	**Beneficial**
		Provision of modern amenities/infrastructures	Direct, Beneficial, Cumulative, Short term, Normal	**5**	**3**	**5**	**3**	**5**	**21**	**Beneficial**
		Conflict over employment issues among stakeholders	Direct, Adverse, Residual, Short –term, Abnormal	**5**	**3**	**5**	**3**	**5**	**21**	**High**

		Localised increase in ambient noise levels from operations.	Normal, direct, short term and reversible	**5**	**1**	**5**	**1**	**1**	**13**	**High**
		Potential effects on air quality from emission of pollutants from engines.	Normal, direct, short term and reversible	**5**	**1**	**1**	**1**	**1**	**9**	**Low**
		Increased demand on existing local infrastructures (housing etc) due to influx of workers and job seekers.	Direct, Adverse, Residual, Short –term, Abnormal	**3**	**3**	**5**	**3**	**3**	**17**	**High**
		Influx of predominantly male population) job seekers) into stakeholders community leading to increased extramarital sexual activity, and introduction of commercial sex workers	Direct, Adverse, Residual, Short –term, Abnormal	**3**	**3**	**5**	**3**	**3**	**17**	**High**
		Work place accidents / incidents duringconstruction activities. This may lead to injury/death of personnel	Abnormal, direct, short term and reversible	**5**	**5**	**1**	**5**	**5**	**21**	**High**
		Degradation of air quality by emissions of air pollutants from internal combustion engines	Abnormal, direct, short term and reversible	**5**	**1**	**1**	**1**	**1**	**9**	**Low**

		Injury from welding burns	Abnormal, direct, short term and reversible	**5**	**5**	**l**	**5**	**5**	**21**	**High**
		Possibility of vision impairment from exposure to light emitted from welding sparks and foreign particles/objects entering the eyes.	Abnormal, direct, short term and reversible	**5**	**5**	**1**	**5**	**5**	**21**	**High**
Operational Phase	Manufacturing of Steel, Hazardous chemical handling/ joint observation for leakages/waste management	Localized increase in the ambient concentration of air pollutants due to chemical fumes	Normal, direct, short term and reversible	**5**	**1**	**1**	**1**	**1**	**9**	**Low**
		Possibility of injury to skin due to burns resulting from chemicals.	Abnormal, direct, long term and may be reversible or irreversible	**5**	**5**	**3**	**5**	**3**	**21**	**High**
		Surface water contamination from chemical spills	Normal, direct, short term and reversible	**3**	**1**	**5**	**1**	**1**	**11**	**High**
		Risk of injury / death of personnel as a of industrial accident	Abnormal, direct, short term and irreversible	**5**	**5**	**1**	**5**	**5**	**21**	**High**

		Waste generation/discharge (packaging materials/ containers, food wastes/pigging wastes etc) and associated environmental effects.	Normal, direct, short term and reversible	**3**	**1**	**5**	**1**	**1**	**11**	**Medium**
		Possibility of fire explosion	Abnormal, direct, short term and irreversible	**5**	**5**	**3**	**5**	**3**	**21**	**High**
		Employment opportunities during maintenance	Beneficial							Beneficial
		Incineration of hazardous waste	Normal, direct, short term and reversible	**3**	**1**	**5**	**1**	**1**	**11**	**Medium**
Demobilization Phase	Demobilization from site	Interference with public utilities (electric wires and poles), market activities along demobilisation route	Normal, direct, short term and reversible	**1**	**3**	**3**	**1**	**3**	**11**	**Medium**
		Release of SO_X, NO_X, CO_X, etc from exhausts which could lead to atmospheric pollution / GHG emission	Normal, direct, short term and reversible	**5**	**1**	**1**	**1**	**1**	**9**	**Low**
		Increase noise level in the area due to movement of heavy duty engines	Normal, direct, short term and reversible	**5**	**1**	**1**	**1**	**1**	**9**	**Low**
		Incident/accident resulting from the movement of materials and equipment onlow loader	Normal, direct, short term and reversible	**5**	**5**	**1**	**5**	**1**	**17**	**High**

		Increase road traffic accident (RTA)	Normal, direct, short term and reversible	**5**	**5**	**1**	**5**	**1**	**17**	**High**
		Risks of militant/youths attack leading to personnel injury / death	Adverse, direct, abnormal, short term	**5**	**5**	**1**	**5**	**1**	**17**	**High**
Abandonment Phase	**Abandonment/ Decommissioning**	Return of land to Owners	Normal, direct, long term and irreversible, beneficial	**-**	**-**	**-**	**-**	**-**		**Beneficial**
		Environmental pollution from corrosion of abandoned structure	Normal, direct, short term and reversible	**5**	**5**	**1**	**1**	**1**	**13**	**Medium**
		Loss of lives due to accident/incident caused by abandoned structures left at site	Adverse, indirect, abnormal, long term and irreversible	**5**	**5**	**1**	**1**	**5**	**17**	**High**

Table 5.5: Summary of Identified Impacts associated with the Transmission Line Construction Project's activities

Environmental and Social Components	Associated and Potential Impacts' Description
Physical Environment	
Geology	The geology in the line route and subsequent different soil formation shall require use of different construction methods for foundations. Blasting and drilling may cause rock movement and breakages thereby, disturbing the general geology in localized areas and spots. However, such disturbance shall be confined to the construction period only. In the hilly parts of the project area, the rocks are held in place by lose soils. Clearing vegetation along the wayleave may induce mudslides and rock falls.
Topography	The study area is generally undulating with few hills in places making it conducive to work through. However, the region experiences high rainfall hence any disturbance to the natural cover could lead to accelerated water induced soil erosion. This, however, is not confined to hilly areas, but throughout the route as the route falls within the high rainfall zone of the country.
Soils	The soils in the study area have serious rooting limitation due to subsoil acidity hence prone to water induced erosion. Construction of the line might open up areas that could be exposed to soil erosion. The variability in soil texture in the study area entails that certain sections of the route could be exposed without any serious threat to water induced erosion. For instance, clayey top soils are highly prone to water induced erosion once exposed.

	Vegetation removal exposes soil to weather conditions.
Hydrology	The drainage density comprising perennial and ephemeral streams in the area makes the whole route prone to water induced erosion. Opening up of the area could also lead to the disturbance in the natural flow regimes of the streams especially when establishing appropriate crossing points. Increase in turbidity due to expose of soil surface run-offs carry sediment drainage pattern due to changes in topography and improper re-instatement. Inflow of run-offs may cause change in water quality.
Wetlands	The movement of surface water in wetlands contributes to the character of the existing ecosystem. Cut and fill activities may inhibit, enhance, or redirect the flow of water and, in so doing, change the nature of both the established water regime and the biological community of a site. Engineering structures in wetlands can often affect both the timing and duration of water regime fluctuations. When the changes are pronounced, they may have significant effects (e.g., alteration of vegetation assemblages) on the wetlands involved. A shift in wetland habitat composition (such as distribution and abundance of wetland habitat types within the wetland) is a community level effect that may result from altered water levels and may occur to a lesser extent from changes in periodicity or sedimentation. Wetland habitat composition is a major determinant of wildlife found in the area, especially wetland mammals. Any changes in composition of wetland can result in wildlife disturbance.
Air Quality	The construction of the 132kVline shall have little impact on air quality since such pollution shall be confined to the construction period and during maintenance. The construction activities that may cause air pollution during construction are equipment operation and movement, clearing and grubbing and excavation

	activities. Release of gaseous emissions and particulate may also cause an effect on the quality of air. Emission of exhaust gases from fuel consumption engines can alter the local ambient air quality; with increase in dust during the dry season.
Noise	Noise shall be created during construction especially since heavy-duty equipment shall be used in excavating, stringing and tower erection. Noise pollution shall, however, be limited to the construction and routing maintenance period. However, during operations transmission conductors will produce noise under certain conditions because of corona discharge. Corona discharge is the ionisation of the air next to the conductor by the electric field which is related to the voltage on the conductors. The loudness of the noise depends on conductor conditions, voltage level, and weather conditions, making a hissing, popping or cracking sound.
Biological Environment	
Fauna: **Mammals,** **Reptiles,** **Birds,** **Fish**	The wayleave for the proposed transmission line could open or truncate some migratory routes for wild animals. However, open areas under the wayleave could provide new browsing grounds for various animals/wildlife. The presence of the construction workers in the project area may induce poaching. Leftover Aluminum conductors from construction works may give rise to snare wire that poachers eventually use to trap animals in the area. Tower foundation works could disturb habitats for smaller mammals such as rodents and cane rats,

	especially in the grassy areas. Most of reptiles are water, ground and tree dwellers and therefore the unmanaged removal of vegetation, especially the under-storey layer would impact adversely on the reptiles' habitat and lives. Feeding of browsers may also be affected negatively resulting into migration of reptiles that may not adapt to the new environment. This may eventually lead to either evolution due to change in environment or extinctions from failure of adaptation. The impact may finally result in reduction of biodiversity. Adverse impacts may arise, from erected transmission lines, through accidental ramming of large birds into the power lines during their normal or regional and seasonal migratory flights. All vegetation layers, emergent, canopy and under-storey, allows for birds' habitat and nesting and therefore, the removal of vegetation may impact negatively on these activities. Erection of towers close to rivers and streams banks and on areas such as dambos may impact negatively of water flow regimes and water recharge patterns. This in turn impacts on the fish habitat and eventually disturbs their productivity and their biodiversity. The excavation of soils, resulting from tower erection, may cause soil erosion that will result into siltation and sedimentation, impacting on water quality. This may adversely affect the fish and other forms of aquatic life in the river resulting in biodiversity loss. Most water polluting agents, such as; oil, silt, vegetative material and other debris, impact negatively on the Dissolved Oxygen content in water bodies. This results in fish kills through asphyxiation.

Flora	The proposed transmission line stretches approximately 1.3km. The wayleave clearance will result in loss of vegetation. Removal of riverine vegetation as a result of tower construction may result in erosion and loss of natural river flow regimes. In general vegetation removal shall result in reduction of biodiversity as valuable trees such as those of medicinal importance, wild fruits, and endangered species may be adversely impacted upon. Fauna providing habitat for most birds, snakes and other predators may also be affected, as vegetation of the understorey is reduced. Disturbance to flora will lead to reduction in biodiversity.
Social Economic Impacts	
Population	During construction, there will be an influx of people from outside the project in search of jobs. The Contractor is also expected to come with a team of skilled personnel for various specialized tasks during the entire construction phase.
Settlement Patterns and Traditional Authority	There will be no significant impact on settlement patterns in the project areas as few houses in the villages will be demolished because most of the houses will be avoided. During construction, the contractor will build temporal camps in different places along the proposed route for the power line. They will not alter the settlement patterns in the areas because the camps will be demolished upon completion of the construction activities.
Social and Cultural Set-up	Experience derived from past projects, shows that most of the construction workers leave their spouses in their respective places of residence as it is assumed to be burdensome. Arising from this, some workers

	develop the tendency of getting women from the areas where they have camped. This could create conflict between the villagers and the construction workers which could even culminate into social strife leading to delays in work schedules. The influx of people into the project area may breed social problems such as theft, prostitution and drug abuse. Some of the people coming into these areas could be people with questionable characters and may bring their bad habits into the area.
Local Economy	Besides infrastructural development (by the availability of electricity supply, for steel-bar manufacturing), employment opportunities shall be availed to the locals during construction. This shall lead to an improvement in the income levels and, in turn, in the standard of living with people being able to buy foodstuffs, groceries, clothes and other essential commodities resulting in a multiplier effect. Some of the income will be used for paying school fees, medical expenses and other domestic needs. Materials such as sand and crushed stones may be bought within the Districts, benefiting the local economy. Other materials like cement, timber, poles and conductors may also be bought within the Districts and other parts of the Country, benefiting the national economy. Electricity provides an important source of energy that can boost the development of any area. It is expected that the availability of firm and reliable power supply will lead to the development of the Districts and the nation as a whole.
Land Tenure/Land Use	The existing land tenure will not be disturbed. Chiefs, local authorities, the state and farmers will maintain their land ownership during both during the construction and operation phases of the project.

	Utilization of the land under the power line and within the wayleave will be restricted. Building of houses, planting of fruit and other trees and similar activities under the power line will not be allowed. However, growing of low crops such as groundnuts, beans, sweet potatoes and maize maybe permitted, but no ploughing is allowed at the foot of the tower to avoid destabilizing the foundations.
Agriculture	There shall be significant impacts on agriculture, both positive and negative. Since crops grown in the wayleave are restricted, crop diversity is negatively affected. On the other hand, provision of firm and reliable supply of power shall for the use of mechanized electrical agricultural equipment, such as center pivots. The line may also traverse a few existing agricultural fields with a possibility of crops being damaged, especially during the construction period. The wayleave cleared of vegetation will provide good grazing grounds for cattle, sheep, goats and other livestock. During construction, the workforce will provide a ready market for various agricultural produce and will boost farmers' incomes.
Employment	There shall be temporary employment opportunities to the local communities during the period of construction, especially for works such as; bush clearing and excavation of foundations for the towers. When recruiting workers, the Contractor shall ensure that the local people are given priority. Some construction materials, such as crushed stones and sand will be obtained within the area and this will indirectly contribute to employment creation for those engaged in crushing stones and mining of sand.

Education	No significant pressure is anticipated on the existing education facilities in the project area. However, reliable and firm power supply will improve the quality of education delivery through; the use of computers, laboratory facilities, etc. Night schooling will also be encouraged, therefore increasing literacy levels. In addition, teachers will be attracted to work in an area with a ready power supply.
Health	The interaction of construction workers from outside the project areas with the local people may lead to the spread of HIV/AIDS and other communicable diseases. This interaction could also lead to spread of water borne diseases such cholera, dysentery and typhoid. The workers may also be exposed to the risk of accidents during construction phase which may lead to injuries. In view of the above, this shall exert pressure on the existing health facilities. On the other hand, provision of power will enable the use of advanced medical equipment such as X-rays, CT scans, Spectrophotometers, electron microscopes and refrigerated storage facilities.
Water and Sanitation	There is likely to be more pressure on the existing water and sanitation facilities resulting from an increase in the population during the construction phase. It is envisaged that appropriate and adequate sanitary facilities like pit latrines and places to bath shall be constructed for the workers. (mitigation) Domestic waste generated at the camps for workers could adversely affect the sanitation in the area. Domestic waste such as leftover foodstuffs and human waste could pollute the environment if not well managed.

	Provision of power will enhance the efficiency of existing of water treatment plants and promote the use of water borne toilets.
Infrastructure and Social Services	The availability of power will promote infrastructure development and provision of social services. Investment will be encouraged in activities such as; trading, telecoms, ICTs, and other social amenities. During project implementation, some feeder roads will be upgraded and bridges repaired to facilitate the movement of construction equipment and materials. The improvements in some of the roads will greatly benefit the local people and open up the area for numerous opportunities. The reinforcement of power supply enhance the production capacity of existing industries in the area and promote the development of new industrial activities.
Archaeological and Cultural Sites	The proposed power line will not affect any known archaeological or cultural site.
Safety	During construction, construction workers may be exposed to risks such as falls during tower erection and stringing of the conductor, snake bites and injuries from various construction activities. There are also risks of road traffic accidents for both construction workers and other road users. However, the Contractor is to develop and implement a construction HSE management plan to manage the impact of construction disturbances on the environment. This, as other details are specified in the next chapter of mitigation measures.

5.4 IMPACT DISCUSSION

In this section, for the sake of consistency all potential impacts to the environment were summarised in tables. These impacts were then discussed in line with the two major project phases (pre-construction has been merged with the construction phase). Mitigation was typically considered in all the project phases of the transmission line.

Chapter 6 however, summarises all mitigation and enhancement measures proffered for the identified impacts of the proposed project as per Table 5.3&4 in this chapter. Also included is residual impact ranking after mitigation.

The discussions presented in this section are intended to provide a summary insight into the nature and level of significance of the identified impacts as well as a description of mitigation measures outlined in the various phases of the development.

Construction Phase

This refers to all construction and construction-related activities that will occur within the study area until the EPC contractor leaves the area. The construction activities will take approximately eighteen months to complete and will occur in two distinct phases. The first phase will involve the pre-construction activities. The construction phase will be treated as an integrated whole, as dictated by the nature of the activities and impacts under discussion.

Operational and Maintenance Phase

All post-construction activities, including the operation and maintenance of the Transmission line are included in this phase.

Decommissioning Phase

Being permanent electricity infrastructure, it is not envisaged that the transmission power line will be decommissioned in the foreseeable future. However, after operational design lifespan of 50 years, a reassessment of the current status of the transmission line shall be carried out.

5.4.1 SOCIO-ECONOMIC IMPACTS

Activity	*Construction and operation of the 1.3km 132kV Transmission line*
Impact	• Effectively evacuate power to generated by the Afam Power Plant subStation for distribution to Inner Galaxy Facility/Project site; • Improvement in quality of life for adequately compensated locals; • Employment and skill acquisition opportunities arising from local, regional and national recruitment of technical and non-technical line workers; • Improved business opportunities and economies (small scale and large scale) through sub-contracting and supply activities; • Induced secondary development within host and neighbouring communities from increased economic activities along the area; • Development of agricultural land due to easier access and consequent discovery of new arable farm lands along ROW accesses; • Addition to the government of Nigeria's plan to meet subsequent development of new infrastructures and improvement of existing ones. • Uncertainty and increased perturbation due to improper consultation and sensitization; • Agitations resulting to strife from grievances over compensation issues, employment quota, land disputes, wrong stakeholder identification, leadership tussles, etc.; • Pressure on basic infrastructural amenities resulting from influx of resident and non-resident workers into project area which may indirectly lead to increased social vices; • Socio-cultural conflicts between construction workers and indigenous peoples due to contrasts in believes and traditions.

Status Quo

The socio-economic and health survey discussed in chapter four of this report provided the baseline social profile of the study area. The proposed route for the transmission power line will cut across two (2) communities (AhalaUkwu Village, Umuahala Community, ObuzorUkwu Autonomous, and Umuacheke Village, Umuigwe/Umuogogo

Community, IsimiriUmuorie Autonomous) in Ukwa-West local government area of Abia State.

Construction Phase

Demography

The inflow of workers who choose to reside along communities during the construction phase of the development may not have any impact on the demography of the area. The numbers of workers anticipated to be employed during the construction phase is estimated at 200 workers who will be directly or indirectly employed in this phase. This number of workers will not necessarily have an impact on demography on the communities which currently show no evidence of overcrowding. There is no impact on the demography of the area hence no mitigation is proposed.

Employment Opportunities

Based on the results of the socio-economic assessment, the un-employment rates in the area are low to average. The locals are however optimistic about the increase in job availability that the development of the transmission line will bring. Any available jobs will provide an immediate positive impact on the employment and income situation at the level of the study area as well as at the regional and national levels. The impact is beneficial.

Employment of casual un-skilled labour would occur, for short-term contracts or for the entire construction phase. This could result in a positive spin-off during the construction phase as any level of employment in this region of moderate unemployment and low wage levels will have a beneficial social spinoff. The impact is beneficial.

Contracting

During the construction phase, there will be provision for sub-contracting to local supplies. Supplies will include raw materials that meet standards as required for the construction of the transmission line facilities. Equal opportunities will be given to sub-contractors from the hot communities. This is a positive impact and as such does not require mitigation.

Information Management

Improper dissemination of information about the project and its activities may pose a risk. This is because lack of information and improper sensitization of stakeholders such as men and women groups, religious groups, vulnerable groups (e.g. aged and widowed) youths, etc about the project may result in local disturbances. This impact is assessed as medium.

Mitigation measures for this identified impact will include:

• Early engagement of stakeholders

• Provide the opportunities for all affected groups (women, youths, religious, etc) to participate in consultations and ensure that all concerns are duly addressed

• Project will establish and publicize a grievance procedure.

• Plan and execute consultations to educate community members and stakeholders on project activities, schedules and potential impacts.

• Ensure consultation throughout project life span.

Implementation of the above measures reduces the impact to negligible.

Community Agitations

After ROW acquisition by the proponent, there is tendency for agitations by some groups of people or individuals over non-satisfactory engagement and compensations over land and other associated properties. This could lead to strife within communities or groups. This impact has been assessed and ranked with a major significance.

During labour recruitment and prior to full construction activities, there is also potential for conflicts between neighbouring communities or individuals over employment quota systems, sub-contracting procedures or recruitment methodology. This will pose major significant impact on the project construction phase.

Mitigation measures for this impact will include:

• The EPC will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities; as stipulated in a developed Community Relations and Engagement Plan

• Project will also develop and implement a resettlement action plan to ensure equitable settlement of all project affected persons

• Project will develop, establish and publicise grievance procedures;

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

• All affected stakeholders and legacy issues are identified early, clearly defined, and agreed on.

• Stakeholders (communities, Govt., land owners, etc.) are adequately consulted and relevant issues addressed

• Agreed fair compensation/rent for land are paid to identified owners promptly as per set standards.

• As far as possible employ persons from the surrounding communities during the construction phase of the development to reduce the numbers of persons that will migrate to the area seeking employment. This will also avoid any feelings of resentment and will ensure that the communities derive the most benefits from the development.

Implementation of the above measures reduces the impact to negligible.

Socio-cultural Conflicts:

Other potential socio-economic impacts are expected to arise from socio-cultural conflicts between the construction workforce and natives due to contrast in believes and religion. Another challenge in this direction is increased demand on existing infrastructures due to influx of people to project area.

These impacts have been ranked with a medium significance level.

Mitigation measures include:

• Brief all employees to ensure awareness of any sensitivity to the local cultures, traditions and lifestyles

• Continuous consultation

• Establish and publicise grievance procedure

• Implementation of community relations and engagement plan by the EPC

• Encourage hiring, as practicable, of appropriately qualified workers from areas in the vicinity of the project to discourage preventable influx of persons

• Work with contractors to ensure that specialised skill workers from outside the areas have access to proper accommodations and other basic infrastructure

• Educate all workers to enhance their Health, Safety, Security, and Environment awareness, and performance on the job

• Maintain medical emergency response plan so that all injured or ill persons can promptly access appropriate care

Implementation of the above measures reduces the impact to negligible.

Visual Effects:

Setting up of tower may create visual intrusion by altering the normal land form pattern along the ROW.

This impact has been ranked with a minor significance level.

Mitigation measures include:

• Where practically possible, provide a minimum of 1 km buffer area between the transmission line camp sites and sensitive visual receptors; and

• Rehabilitate disturbed areas around pylons as soon as practically possible after construction. This should be done to restrict extended periods of exposed soil.

• Existing facilities might be used for lay-down and camp site areas to reduce environmental and aesthetic effects

Implementation of the above measures reduces the impact to negligible.

Loss of Land:

Acquisition and utilization of land for the transmission line and associated facilities may result in temporary and permanent loss of land, some of which are regarded as arable.

The impact was ranked with a medium significance.

Mitigation measures will include:

• Project will develop and implement a resettlement action plan to ensure equitable settlement of all project affected persons

• The final ROW shall traverse in an existing disturbance corridor like other transmission lines or pipelines, where farming activities have already been impacted. In this way negative agricultural and economic impacts would be minimised.

• Land owners shall be compensated for potential loss in revenue and reduction in future development potential. Compensation should be agreed between Inner Galaxy Steel Compamy Ltd. and the landowners.

Implementation of the above measures reduces the impact to negligible.

Loss of Income:

Completion of the construction phase of the project will lead to loss of employment and business opportunities.

This impact has been assessed with a medium significance level.

Mitigation measures will include:

• Organise career development workshops, skills acquisition and enhancement programs to further empower the workforce

• Project will develop, establish and publicise grievance procedures;

• Adequately pay due wages for worked period and settle all financial commitments to workforce before demobilisation

Implementation of the above measures reduces the impact to negligible.

Operational and Maintenance Phase

Community Agitations

After the construction phase of the project there exist the possibility of community or groups of individuals or individual dissatisfaction with the conduct of the proponent regarding compensation issues, recruitment of labour as well as general conduct during the construction and prior to operation. This impact could arise some few months to years after construction activities and could result in strife thereby affecting the operations of the transmission line.

This impact has been assessed to have a major significant level.

Mitigation Measures include:

• The EPC will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities

• Project will also develop and implement a resettlement action plan to ensure equitable settlement of all project affected persons

• Project will develop, establish and publicise grievance procedures;

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

• All affected stakeholders and legacy issues are identified early, clearly defined, and agreed on.

• Stakeholders (communities, Govt., land owners, etc.) are adequately consulted and relevant issues addressed

• Agreed fair compensation/rent for land are paid to identified owners promptly as per set standards.

• As far as possible employ persons from the surrounding communities during the construction phase of the development to reduce the numbers of persons that will migrate to the area seeking employment. This will also avoid any feelings of resentment and will ensure that the communities derive the most benefits from the development

Implementation of the above measures reduces the impact to negligible

Unauthorised Access

Prior to the operation of the transmission line, unchecked and unauthorised encroachment by locals or individuals into the transmission line ROW may lead to land use conflict and possible accidents.

This impact significant is ranked as medium.

Mitigation measures will include:

• Provide warning signs at access roads to warn against unauthorised entry

• Through consultations, sensitize stakeholders and members of the communities on government policies along established ROW

Implementation of the above measures reduces the impact to negligible.

Socio-cultural Conflicts

Also the interference with traditional festivals and other socio-cultural programs of the natives as a result of unscheduled maintenance visits may lead to strife on the maintenance operations of the transmission line. This impact has been adjudged with a major significant level.

Maintenance procedures could also interfere with hunting, farming operations and other activities in the area. For instance, large scale maintenance operations could be considered a noisy and intrusive event for which locals within the area should normally receive advance warning.

Mitigation measures include:
• Plan activities to minimize work activities during local events
• Operators will obtain information about planned local activities and avoid disturbing them by shifting maintenance activities to other days whenever possible
• Formal notice of any maintenance work should be given in advance to the communities along the area. Access to the line must be via the approved access roads and corridors (agreed with the host communities)
• Project will develop, establish and publicise grievance procedures;
• The notice shall give details of the purpose of the access, the contact person and number of people to be involved, time frames and machinery that will be used.
• Schedule and implement recommendations of the Community Relations and Engagement Plan and approved work procedures
Implementation of the above measures reduces the impact to low.

5.4.2 BIODIVERSITY

Activity	***Clearing of vegetation, site preparation and other construction activities along the 1.3km 132kV transmission line***
Impact	• Destruction of vegetation due to clearance of vegetation at ROW, access roads, lay down areas, marshalling sites, tower sites etc; • Disturbance to freshwater swamps, palm forest, farmlands and pockets of mangrove flora; • Loss of forest products (fuel wood, timber, medicinal plants) due to site clearing and preparation. • Ecosystem fragmentation and habitat loss • Faunal disturbance from construction noise, light, and presence of equipments • Uncertain electromagnetic field impacts to fauna.

	• Disturbance of avifauna due to collisions with the earth wire of the transmission line, habitat destruction and disturbance and impact of birds on quality of supply. • Increase in poaching due to an easier access for the local population and non-resident workers.

Status Quo

The construction of the 1.3km 132kV transmission line will result in the removal of approximately eighty-five (85) hectares of natural vegetation in the area. The development may have a major, long-term, irreversible negative impact on the floral composition along the ROW.

Results from biodiversity studies conducted in the area shows that five different ecological zones were identified: (lowland forests, seasonal freshwater swamps, cultivated farmlands, bush fallows, and mangrove forests) along the transmission line.

Based on the vegetation and faunal investigations, the most sensitive ecological zones are considered to be the freshwater and mangrove river crossings. This finding has also been affirmed from literature review of past studies in the area. In addition, the vegetation zones that were identified along the transmission line, are well represented outside of the study area, and are thus not considered threatened ecosystems.

Data on the floristic composition and fauna assemblage along the transmission line and in the immediate vicinity of the proposed transmission line ROW indicate presence of a varied assemblage of forest resources and plant species, some of which are economic and of ethno botanical importance to the people of the communities. However, from an ecological stand-point the area is not one of very high ecological importance.

The main impacts of clearing the vegetation may however be secondary and will affect the species that depend on the area for survival through habitat loss, fragmentation and the impacts of edge effects. This will be further discussed in the sections below.

Construction Phase

The construction phase is the most destructive part of the planned development. During the construction phase various impacts could cause loss and disturbance of vegetation and animal habitats.

Vegetation Clearing

The ROW is approximately 1.3km. Selective clearing (stumping) within the confines of the ROW is expected to be carried out to the minimum foot print required during the construction phase to allow for foundations, erection of towers and placement of conductors on the towers. However total area permanently lost due to vegetation clearing (including lay-down areas, marshalling yards as well as access roads) is anticipated to be approximately 6ha. In general, because of the linear nature of the ROW, the effects are distributed across a substantial length and losses in any given area (including the sensitive mangrove patches) are not expected to represent a substantial portion of the available resources.

Localised impact on mangrove forest ecology is expected on the ROW segment. Impacts are expected during construction activities (access roads along mangrove paths, as well as movement of construction materials and workers through the creeks to tower sites). This activity, if not managed, may result in significant local damage to the mangrove ecosystem as well as constituent fauna. Given the total 85ha of vegetation along the ROW, the mangrove area envisaged to be affected is less than 2% of this mass.

There is no plan to construct lay-down areas or marshalling yards along mangrove areas. Overall, the impacts on vegetation and habitat loss due to vegetation clearing and other site preparation activities are put at a medium significant level.

Mitigation measures will include:

• Inclusion of threatened and endangered species strategies in the site specific Environmental Management Plan to be developed by EPC Contractors for the project. This plan shall indicate lists of animals and plant species of concern, development and implementation of a training program that would include photos and other information to identify the various species, procedures for responding if one of the species is found (such as contacts, stopping work until relocation or protection is effected, reporting the incident in routine progress reports, etc.), where appropriate to ensure the designation of certain areas as sanctuaries for species that may be displaced by the project and requirement for a survey by qualified biologist(s) ahead of ROW clearing, as well as strict prohibition for the workforce on killing or capturing any of the species.

• Clearance of mangrove will be kept to a minimum, and material storage areas will not be located in mangrove;

• provision of adequate culverts to maintain natural drainage channels and tidal flushing along the mangrove paths as much as practicable;

• Clear briefings and instructions to EPC regarding the clearance procedures will be undertaken to minimise any mangrove area that may be disturbed;

• Vegetation clearing will be limited to minimum required for work

• Felling of trees of >30cm girth is to be minimized during vegetation clearing

• Vegetation clearing will be limited to the minimum required for work. This would be done with considerations to environmental protection.

• Utilisation of existing accessible tracks as much as possible

• Establish a perimeter of protection around sensitive ecosystems such as mangroves along the ROW and their unique habitats.

• Plan work activities to minimise presence and duration of work in ecologically sensitive areas (mangrove paths, river banks, fresh water swamps).

• Limit vegetation clearing to footprint required for construction purposes to minimize disturbances along proposed transmission line ROW.

• Allow re-growth, within height restrictions, of native ground cover beneath lines (along ROW, lay-down areas and access roads)

• The final ROW shall traverse in an existing disturbance corridor like other transmission lines or pipelines, where farming activities have already been impacted. In this way negative agricultural economic impacts would be minimised.

• Land owners shall be compensated for potential (financial) loss

• Compensation shall be agreed between Inner Galaxy Steel Company Ltd. and the landowner and implemented accordingly

Implementation of the above measures reduces the impact to negligible.

Erosion:

Erosion may take place when vegetation is removed, by the continual movement of vehicles and people, and where vegetation is cleared for construction. Areas of particular concern would be along the access roads, areas in which the lay-down areas are placed, disturbed areas around the towers, and the marshalling yards.

Impacts resulting from erosion around lay-down areas, access roads, etc have been ranked with a medium significance.

Mitigation measures will include:

• Implement where appropriate sediment run-off controls and visually inspect after rainfall

• Laydown areas/Marshalling yards are designed to include erosion control

• Reclaim as practicable topography of excavated or compacted upland areas upon completion of activities.

• Limit vegetation clearing to footprint required for construction purposes; i.e. minimize disturbances along proposed transmission line ROW.

• Allow re-growth, within height restrictions, of native ground cover beneath lines (along ROW, lay-down areas and access roads)Where possible contractor shall reclaim devegetated areas with topsoil, reclaim compacted floors with native plant species, etc.

• Auditing EPC contractor to verify reclamation of work sites, marshalling yards, laydown areas etc

Implementation of the above measures reduces the impact to negligible.

River Bank Disturbances *(not really an applicable issue, as at current visit to project-location)*

Damage to river systems could occur where towers are erected close or within the rivers, and/or when maintenance tracks or construction camps are placed within river banks. Rivers are sensitive to disturbance and therefore should the afore-mentioned impacts occur, they would be on medium significance. Fortunately rivers are relatively small in area, or not present at all (especially during dry season) at the project-location. It is not anticipated that the towers will be erected within the river beds at all. The transmission line is designed to ensure that it spans over the rivers. Similarly, if the maintenance tracks do not cross the rivers and construction camps are not built directly next to rivers, there will be no impact. However, specific mitigation measures have been included to ameliorate any possible impacts.

Mitigation measures proffered include

• The transmission line has been designed to have a minimum clearance of about 50m to river banks;

• Marshalling yards, storage areas and/or construction camps shall not be located along river bank areas.

Wildlife Disturbance

During construction there is expected faunal disturbance along the entire length of the transmission line, in which sensitive ground dwelling animals like the squirrels, grass cutters, civet cats etc will move out of the area during construction.

This is likely short termed, and once construction is finished, fauna will recolonise the area. The impact is anticipated to be medium.

Mitigation measures proffered include

• Vegetation clearing to only unavoidably necessary ones. This should be done with considerations to environmental protection.
• Utilisation of existing accessible tracks as much as possible
• Plan work activities to minimise presence and duration of work in ecologically sensitive areas (mangrove paths, river banks, fresh water swamps).
• Plan and execute construction works to minimize interference on wildlife
• Maintain construction equipments to optimal function conditions
• Monitor presence of wildlife species during construction activities

Implementation of the above measures reduces the impact to negligible.

Avifauna:

Although the most severe impacts are the likelihood of electrocutions, collisions, as well as habitat loss and disturbance, the particular design of the transmission line also has a bearing on the inherent risks for birds. There is no peculiar bird breeding areas/migration routes identified along the line.

The impact is low and therefore no mitigation is provided.

Operational and Maintenance Phase

During this phase the impacts on the vegetation and habitat of the fauna would be relatively low.

Faunal Disturbance from Electromagnetic Fields

The electromagnetic fields emitted from the transmission lines may result in some form of faunal disturbance, i.e. faunal species (invertebrates and small mammals) may choose not to spend prolonged periods under the transmission lines due to the electric magnet fields. In the majority of situations, the faunal species will simple move into the large expanses of nearby similar vegetation.

Impact significance is medium.

Mitigation measures include:

• The design of the transmission line shall be in line with standards observed by International bodies as well as Inner Galaxy Steel Company Ltd.

• Inner Galaxy Steel Company Ltd. shall assure during transmission line component testing that national and international standards and limits are met.

Impacts on Birds

The earth wire is the biggest risk, since it is much thinner and could be unseen by a bird in flight. Electrical faults caused by bird excreta being deposited on electricity infrastructure show that birds could also have negative impacts on transmission lines. Baseline avifauna studies did not identify any bird migratory routes / breeding sites along the transmission line route. Large waterfowl/raptors are also not predominant in the area.

This impact is ranked as medium.

Mitigation:

• It is not considered practical to recommend marking all line through open areas to mitigate for bird collisions, as this would be a large proportion of the line, and the risk does not warrant it. Also it will create a negative visual impact on those people living nearby. Instead it is recommended that the routine line patrols by Inner Galaxy Steel Company Ltd. maintenance crew be used to detect any bird collisions. If any collision "hot spots" are identified, these can be mitigated reactively. Implementation of the above measures reduces the impact to negligible.

5.4.3 HYDROLOGY AND AQUATIC SYSTEMS

Activity	***Constructing the transmission line in sensitive hydrological and surface water resources along the route***
Impact	• Leakage of fuel or lube oil onto land or into water bodies during transportation and storage may lead to increased chemical toxicity • Contamination of surface water as a result of siltation caused by increased erosion, during site preparation. • Erosion of stream banks resulting in increased sedimentation in adjoining surface water bodies • Disturbance of hydrological regimes and drainage patterns on a micro scale.

The activities involved in these phases of the development may cause a negative short to long-term impact on the surface hydrology and ground water quality along the project area. This will be as a result of activities which are slated to take place which include storage of hazardous substances on the site such as diesel and motor oil for the operation of machinery and stand-by generators, and similar materials for the construction of towers and foundations.

Wetlands in the area include perennial rivers and streams, mangrove swamps, seasonal rivers and streams and several creeks and creeklets. Rivers are exposed to anthropogenic impacts, including water pollution, and shoreline erosion, etc.

Construction Phase

Erosion of stream banks

Access of construction vehicles and construction personnel onto the stream banks, and swampy areas can result in the onset of erosion. The clearance of vegetation will reduce the capacity of the land surface to retard the flow of surface water, thus decreasing infiltration, and increasing both the quantity and velocity of surface water runoff and erosion. Human activities, which disturb the soil structure, such as the compaction of soil along footpaths and vehicle tracks, and the disturbance of soil structure through movement of soil, can result in increased susceptibility to erosion. Roads and pathways created during the construction phase have the potential to become preferred drainage lines, resulting in gully erosion.

This impact has been ranked to possess a medium significance level.

Mitigation measures include:

• Install siltation traps within the drainage design to collect silt and sediments ensuring that they do not end up in adjacent aquatic areas.

• Construction on steep slopes and in soft or erodible material will require erosion control measures and correct grassing methods.

• Where possible contractor shall reclaim de-vegetated areas with topsoil, reclaim compacted floors with native plant species, etc.

• Auditing EPC contractor to verify reclamation of work sites, marshalling yards, laydown areas etc

• Appropriate flow diversion and erosion control structures i.e. earth embankments must be put in place where soil may be exposed to high levels of erosion due to steep slopes, soil structure etc. Implementation of the above measures reduces the impact to negligible.

Sedimentation of streams and rivers

Clearance of existing vegetation will expose the upper layers of the soil horizon to soil erosion. The transport of eroded soil into the surface water resources, especially the rivers will impact on water quality. The movement of construction vehicles and personnel can also result in the onset of erosion and associated sedimentation of streams and rivers. The stockpiling of excavated earth and construction materials can result in contamination of runoff, through erosion of stockpiles. On the overall, impacts resulting to sedimentation problems as a result of soil erosion are adjudged to have a medium significance.

Mitigation measures include:

• Implement where appropriate sediment run-off controls and visually inspect after rainfall events

• Laydown areas/Marshalling yards are designed to include erosion control

• Reclaim as practicable topography of excavated or compacted upland areas upon completion of activities

• Install siltation traps within the drainage design to collect silt and sediments ensuring that they do not end up in adjacent aquatic areas.

• Construction on steep slopes and in soft or erodible material will require erosion control measures and correct grassing methods.

• Avoid crossing permanent waterways with machinery; if necessary, locate the crossing where the banks are stable and the waterway at the most narrow part of the water way.

Implementation of the above measures reduces the impact to negligible.

Aquatic Life disturbance

The riparian zone is an important corridor for the movement of wildlife, and as such the construction activities may temporarily impact on the movement of certain faunal species along the Riverine corridor. The construction related activities that will result in a deterioration of the water quality, will ultimately influence aquatic species such as macroinvertebrates, fish, amphibians and birds.

This impact would however be limited in terms of duration and is ranked at a medium significance level.

Mitigation measures will include:

• Limit work areas outside vegetation along water bodies and near wetlands.

• Avoid crossing permanent waterways with machinery; if necessary, locate the crossing where the banks are stable and the waterway at the most narrow part of the water way.

• Provide workers at the development site with mobile toilets during this phase of the development. A reasonable ratio would be ten (10) workers per toilet. Periodic transfer of sewage in tanks for treatment is planned.

• If diesel and motor oil are to be stored on site, ensure that they are properly contained in a bunded area (with capacity to contain 1½ times the amount of substances stored). This area must be situated away from all water bodies and signs indicating the storage of these substances erected.

Implementation of the above measures reduces the impact to negligible.

Surface water pollution

Hydrocarbons-based fuels or lubricants spilled from construction vehicles, construction materials that are not properly stockpiled, and litter deposited by construction workers may be washed into the surface water bodies. Should appropriate toilet facilities not be provided for construction workers at the construction crew camps, the potential exists for surface water resources and surroundings to be contaminated by untreated sewage effluents, lubricants and other hazardous substances from accidental leaks and spillages. Depending on the nature of the contaminant the impact could range from either medium significance to major significance categories.

Mitigation measures proffered include:

• Safe operating practices are enforced during construction activities.

• project emergency/spill response measures and equipment are available, and personnel are capable of effectively using it for cases of accidental spill.

• hydrocarbon/chemical spill containment and prevention measures and equipment are functional and effective on site and for equipment and vehicles

• hydrocarbon and chemical transfers in safely contained areas

• Double handling to be avoided where possible

• When transfer has to take place, ensure it is effected in lined and secured areas where containment is possible

• Educate personnel on hydrocarbon and chemical handling risks/hazards, through HSE briefings/tool box meetings

• Implement where appropriate sediment run-off controls and visually inspect after rainfall events

• Plan and set on-site sanitary facilities for the disposal of wastewater.

• Maintain vehicles, machinery and equipment in good condition in order to avoid leaks and spill of hazardous materials (lube oils, chemicals, etc.)

• Ensure safe management of hazardous materials (chemicals, etc.)

• If diesel and motor oil are to be stored on site, ensure that they are properly contained in a bunded area (with capacity to contain 1½ times the amount of substances stored). This area must be situated away from all water bodies and signs indicating the storage of these substances erected.

• train personnel in safe fuel handling procedures of chemicals and hydrocarbons

• Monitoring during maintenance of equipment to ensure that there is no discharge to the environment

• Enforce good environmental demobilisation procedures (e.g. cleaning sites and reclaiming to original status)

• Use of drip pans during transfer of fuels and hazardous substances

• Carry out internal environmental auditing to check activities of construction team and status of lay-down areas, marshalling yards, tower sites, etc prior to demobilisation.

Implementation of the above measures reduces the impacts from low to negligible

Disturbance of Hydrological Regimes and Drainage Patterns

The presence of construction vehicles, personnel and material in floodplains and riparian zones, can result in a local change in flow patterns. This can result in a change in the flow patterns in these areas due to the presence of obstructions (i.e. vehicles, construction material, construction crew camps etc.). Human activities, which disturb the soil structure, such as the compaction of soil along footpaths and vehicle tracks, and the disturbance of soil structure through movement of soil, can also result in a change in the micro scale hydrology. Impact significance is ranked as major.

Mitigation measures will include:

• Do not hamper drainage of surface water and plan for reclamation measures after construction.

• Avoid crossing permanent waterways with machinery; if necessary, locate the crossing where the banks are stable and the waterway at the most narrow part of the water way.

• Limit work areas outside vegetation along water bodies and near wetlands.

• Maintain a minimum flow to prevent salt water intrusion through standard procedures

Implementation of the above measures reduces the impacts to negligible.

Operation and Maintenance Phase

The presence of the transmission power line and associated towers would not result in a substantial increase in erosion during the operational phase. Erosion of stream banks would mainly take place during this phase as a result of the movement of maintenance vehicles and personnel. No impact is anticipated and no mitigation proffered.

Floral disturbance (riparian zone and floodplains)

The presence of the transmission line will result in a disturbance of the flora found in the riparian zone and floodplains. Clearing of the ROW to prevent fire hazard, will result in floral disturbance. This will however be limited to the footprint area of the ROW. Access roads to the transmission line may also need to pass through wetland areas and / or the riparian zone, which will also result in floral disturbance. A medium significance level was assigned to this impact.

Mitigations measure includes:

• Periodically carry out ROW maintenance activities to manage growths of weeds and other creeping plants on the tower bases in a manner that minimizes adverse impacts on vegetation.

Implementation of the above measures reduces the impacts to negligible.

5.4.4 AIR QUALITY AND NOISE POLLUTION

Activity	***Site preparation and construction of 1.3km 132kV Transmission line***
Impact	• Nuisance (noise and vibrations) due to movement from heavy duty equipment and vehicles affecting public and wildlife. • Increase of dust particles and vehicular emissions. • Noise and attendant vibration effects from, piling activities, fabrication and associated welding equipments.

Status Quo - Air Quality

Air pollution is a major criterion for the design of transmission line insulators. Pollution has a negative effect on the insulation system of power lines, which could result in the shutdown of the power line. The baseline data on the level of pollutant gases along the transmission line route has been assessed and found to be compliant to set regulatory limits for their natural environment *(see Chapter 4)*. Data obtained were also consistent with past studies around the project area.

Construction Phase

The construction of the approximately 1.3km 132kV transmission line will generate minor amounts of pollutant gases (SOx, NOx, VOCs, etc) from fuel combustion (light fuel oil) used for supply trucks and heavy duty equipments. Such pollutants will include airborne particulates that would especially result during dry/windy conditions as a result of equipment movements and localised earthworks. Emissions during construction activities will be localised and short termed, impact will therefore be minor.

In addition, it is expected that there would be increase in dust particles (SPM) along earthed access roads and also on the generality of the ROW during construction activities. Increase in SPM levels will specifically result from vehicular movements and construction earthworks (excavations, trenching, etc).

These are expected to last for a short term and have a minor significance ranking.

Mitigation measures include:

• Ensure that all vehicles involved in the transport of construction material and staff and machinery involved in the construction is properly maintained and serviced.

• Extra care must be taken to reduce dust in periods when wind speed are greatest and the rainfall amounts are lowest which is between November and February (dry season), e.g. This will involve extra wetting of the construction area to suppress dust particles.

• Ensure that all material (sand and aggregate) stockpiled along the site to be used in construction activities are regularly sprayed to reduce the effects of wind whipping.

• All staff employed at the construction site must be provided with dust masks and be asked to use them.

• Implement a traffic system that involves use of appropriate signals and signs to ensure the smooth flow of traffic. This will reduce the idling of vehicles that may occur and therefore reduce the emissions in the area.

• Reduce speed along earth roads

• Plan journey to reduce travel times

• Vehicles carrying earth materials should be covered

• Install and operate air pollution control equipment e.g. mufflers.

Implementation of the above measures reduces the impacts to negligible.

Operation and Maintenance Phase

The only anticipated impact is pollutant gases falling on insulators to produce a conductive film on the surface which causes the surface leakage current to increase, eventually resulting in flashover / local arcing on insulators. Flashovers occur mainly on transmission lines when, in combination with condensation, light rain or ash or dust build-up cause arcing across insulators and dips and spikes in power supplies. This weakens the insulators, and repeated arcing can cause the shutdown of the power line. However, dust and emissions generation during operations is envisaged to be low and requires no mitigation.

Noise

Noise has the potential to damage health, to detract from the quality of life, and to disturb or affect wildlife. During the wet season the baseline noise levels along the project area were within acceptable limits. Results from dry season measurements show significant increase but remained within acceptable limits.

Construction Phase

Presently, the study area is impacted by minimal noise from the surrounding land uses as populated settlements are approximately 5km distance of the transmission line ROW. However, agricultural activities are taking place within the study area.

The construction period could result in a temporary increase of the noise levels due to construction and delivery vehicles moving to and from the site as well as general installation activities. Increase in traffic flow within the study area could increase the nuisance levels in terms of noise generation. These impacts from increase in noise levels are evaluated and ranked to pose minor significance levels during construction period as they will be short termed.

Mitigation measures will include:

• Machinery, vehicles and instruments that emit high levels of noise should be used on a phased basis to reduce the overall impact.

• Workers, especially those working with machinery, vehicles and instruments that emit high levels of noise should be supplied with ear plugs and ear muffs to reduce the risk of hearing impairment. Prolonged exposure to this impact shall be reduced by engaging workers on shift basis.

• Regularly maintain construction equipment to optimal function
• Limit heavy duty construction works to day hours only where practicable
• Ensure use of appropriate PPEs (ear plugs) by workers in areas with noise level above FMENV (90dBA) hourly work area limits.
• Conduct daily HSE briefings prior to work
• Plan work activities to avoid heavy duty movement during peak hours

Operation Phase

During operation phase, some noise is generated by the corona in form of humming sound around the live conductors. Previous studies have showed that the noise (modest) level will have limited impact on the health of people who live closest to the ROW (100m) or to the wildlife that will occasionally venture pass the ROW.
The impact as ranked with a minor significance level.

Mitigation measure includes:
• The design of the transmission line shall be in line with standards observed by International bodies.
Implementation of the above measures reduces the impacts to negligible.

5.4.5 HEALTH, SAFETY AND SECURITY ASPECTS

Activity	***Site preparation and construction of the 1.3km 132kV Transmission line.***
Impact	• Increased traffic during mobilisation on road with risks of accidents leading to injury/death and loss of asset • Risks of armed robbery attack and hostage taking leading to injury/ death of personnel • Work place accidents/incidents from the use of cranes, forklifts, etc. during loading and offloading of materials/equipment as well as construction and maintenance operations. • Increase of communicable diseases due to influx of people and

	poor living conditions around pre-construction sites • Waste Disposal (scrap metal, wood, sand, concrete, paper, domestic waste from lay-down area from grubbing of ROW. • Risk of electrocution and burns (to onsite workers) from welding flashes and high currents during welding • Workplace accidents / incidents (trip/falls etc) from heights during conductor wire stringing and bolt/nuts tightening project activities. • Risks of injury / death and loss of assets resulting from accidents associated with road transportation to and fro construction sites • Risks of fire/explosions resulting from accidental ignition of onsite diesel storage tanks • Site conditions leading to increased malaria epidemic from uncontrolled mosquito breeding in swamp areas as well as water borne diseases e.g. diarrhoea and cholera associated with poor sanitary conditions • Risk of collision of low flying air planes with transmission towers and lines

Construction Phase

In any civil works, public as well as construction staff HSE risks can arise from various constructions activities such as earth works, operation, and movement of heavy equipment and vehicles, storage of hazardous materials, traffic, waste disposal etc. Because of the long duration of the construction phase, such activities need to be controlled and consequently the associated risks reduced to as low as reasonably practicable.

Transportation Related Aspects

Construction and transportation activities will increase traffic congestion, risk of injuries, hostage and kidnapping as well as damage to assets. These impacts are expected to be of medium to major significance depending on the severity of the impact. Accidents arising from road trips (transport of materials and personnel) along mobilisation routes may result in injury or loss of life of personnel as well as damage to company assets. The possibility of hostage taking of expatriate personnel or locals during the construction of the project is likely. This may also result to injuries or fatality.

These impacts are ranked from medium to major significance.

Mitigation measures will include:

• All vehicles and boats are certified road / water worthy prior to being mobilized for work activities.

• Compliance to all roads and water ways safety transport rules including speed limits

• Competency training and certification of drivers before mobilisation.

• Limit movement to day time only

• Setting and enforcing speed limits of 100km/hr (major roads) 40-60km/hr (built-up areas) and 10-30km/hr (construction sites);

• Develop a project security plan that addresses all project related security concerns

• Ensure security procedures are strictly enforced and continually improved based on updated risk information.

• Consultation and good public relation with the stakeholder communities.

• Ensure government approved security personnel is used on transport vehicles and boats when warranted

• Coordinate work activities to avoid heavy traffic periods

• Use warning signs and traffic wardens/directors

• Ensure activities causing blockages at road crossings are carried out within shortest time practicable

• In the case of longer blockages, divert traffic to approved alternate routes in liaison with appropriate authorities

• Consult with affected communities prior to road closures to provide warnings and alternatives.

Implementation of the above measures reduces the impacts to negligible.

Workplace Accidents

The probability of an accident occurring at the project site during the phases of the development is high. This is due to the intense use of machinery and other heavy-duty equipment used especially in the construction phase.

Work related incidents and accidents resulting from trips, falls, object at height during construction activities are likely to occur. These impacts pose a medium to major significance ranking all depending on the severity of the impact. If the impact results in fatality it is ranked as a major significant impact.

Mitigation measures proffered will include:

• All personnel are qualified and certified for their relevant works

• Approved safe work procedures are provided and complied with at all times prior to commencement of work

• Inner Galaxy Steel Company Ltd. shall ensure HSE briefings, job hazards identification and controls, prior to commencement of work activities

• Use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site

• Limit work activities to daytime only

• Ensure availability of first aid facilities onsite

• Ensure retainer clinics are engaged and site medical personnel are available in case of accidents

• Maintain medical emergency response plan so that injured or ill persons can promptly access appropriate care.

• Inner Galaxy Steel Company Ltd. shall design work area to internationally acceptable standards

Implementation of the above measures reduces the impacts to negligible

Communicable Diseases

Construction activities have the potential to create new malaria vector (mosquito) habitats. An influx of workers with no partial immunity to malaria parasite (Plasmodium sp) increases the risk of serious illness which may result to death. This impact if not managed is expected to pose a major significance characteristic.

Influx of resident and non resident workers into the project area also increases the risks of sexually transmitted diseases (STDs) and could impact adversely on the spread of these illnesses especially relating to Acquired Immunodeficiency Syndrome (AIDS). This impact if left unmanaged may result in long term health issues which may eventually lead to fatality. Impact arising from this is ranked as major.

Mitigation measures include:
• Project will develop a health plan to address potential health issues
• Initiate /enforce Inner Galaxy Steel Company Ltd. corporate health awareness programs for malaria, AIDS, etc)
• Provision of site medical personnel to attend to emergency situations
• Engage the services of retainer clinics to manage health issues
• Educate workforce on the prevention of malaria as well as encourage the use of mosquito nets in construction camps.
• Ensure personnel use appropriate PPE
• Project shall prepare and implement emergency response plan
• Ensure availability of first aid facilities onsite
• Provide appropriate domestic water supply to address additional needs.
• Facilitate the implementation of appropriate toilet and other sanitation facilities.
• Provide information, education and communication about safe uses of water and occupational hygiene and safety
• Environmental management for vector control; avoidance via settlement location and design and use of bed nets and repellents; rapid diagnosis and treatment; focal insecticide and molluscicide application.
• Develop and implement safe food storage and handling practices.
Implementation of the above measures reduces the impacts to low.

Fires and Explosions

Fire and explosions may be described as technological hazards, which can cause serious injury or result in loss of lives and damage to properties and the environment. Flammable substances including diesel and motor oil may be stored or used on the project site for heavy-duty equipment. These substances are precursors for fires and explosions. Envisaged impacts from accidental explosions resulting in fire have been ranked with a major significance level.

Mitigation measures will include:

• All fuel storage tanks are kept at safe distances from work areas

• Storage areas will be identified with caution signs.

• Educate workforce on risks associated around storage areas and prohibit activities (such as smoking) that can ignite storage tanks

• Designate no-smoking and smoke areas

• Hold HSE meetings and talks on fire hazard

• Design work area to internationally acceptable standards

Implementation of the above measures reduces the impacts to negligible.

Waste Handling and Disposal

A significant amount of solid waste (including, wood, metal scarps, office and domestic wastes, etc.) will be generated in this phase of the project. The methods put in place for handling and disposing of these wastes to be generated play an important role in the significance of impacts expected from wastes management. Waste handling and disposal have been assessed to pose a medium impact to the environment.

Mitigation measures will include:

• Develop project specific waste management plan and ensure proper implementation

• Provide adequate containers for waste collection

• Periodically audit contractor activities to check the level of compliance to regulatory and Inner Galaxy Steel Company Ltd. waste management requirements.

• Design work area to internationally acceptable standards

• Ensure engagement of government approved waste management contractors

• Safe operating practices are enforced during construction

Implementation of the above measures reduces the impacts to negligible.

Operation Phase

During the operational phase, public and occupational SHE risks are not as significant as during the construction phase. The design clearances according the Inner Galaxy Steel Company Ltd. Standard guarantee safe limits for the possibility of farming and also cattle rearing.

Collisions

After the transmission line has been constructed and is put into operation there is the possibility of low flying aircraft colliding with the towers. If this happens, it will result to injury, asset damage as well fatality in the worst case. Impacts resulting from collision of aircraft with towers have been ranked at major significance level.

Mitigation measures will include:

- Inner Galaxy Steel Company Ltd. shall provide Aircraft Warning spheres and tower signs in areas where air traffic might occur in order to minimize risk of low flying aircraft colliding with towers and wires.

Implementation of the above measures reduces the impacts to negligible.

Collapse of Transmission Towers

There exists the possibility of shock and burns to unauthorised ROW users or visitors due to collapse of transmission line towers which could lead to injury or fatality of affected persons. This is a major significant impact.

Mitigation measures will include:

- Towers shall be installed following the best engineering standards
- Towers shall be collapse tested to prove the tower design is in line with the Inner Galaxy Steel Company Ltd. requirements
- Inner Galaxy Steel Company Ltd. shall carry out routine inspection of towers in order to allow early detection of damaged towers
- Reported cases of damaged or fallen towers shall be promptly attended to.
- Adequate and automatic fault/damage detection system shall be installed.
- Personnel shall be trained on the detection/handling of such emergencies arising from accidental damage

Implementation of the above measures reduces the impacts to negligible.

Electromagnetic Fields

The electromagnetic effects of a transmission line on the environment have been a concern in the last decades. Intense electric fields may occur at the surface of conductors and other “live” elements of transmission lines. Several studies with varying conclusions have been carried out on harmful consequences that the electrical and magnetic fields produced by overhead lines could have on humans, animals and plants. In view of this, the electric industry including national and international, established maximum acceptable limits for biological effects of transmission lines, which should be complied with when a new overhead transmission line is designed and constructed (Cigre, 1992).

The magnitude of electrical and magnetic fields in proximity to a transmission line is dependent on the superposition of the fields due to the three-phase conductors. Usually, limitations are imposed to the maximum electrical field at the edge of or within the right-ofway. There will be no testing after commissioning to confirm that electrical field and magnetic induction do indeed fall below the safe limits. This is because clearances according the Inner Galaxy Steel Company Ltd. Standard guarantee the safe limits. This is the case for clearances in all international standards.

The range of maximum electrical and magnetic fields below overhead lines is given in Table 5.6 below.

Table 5.6: Range of Maximum Electrical and Magnetic Fields

Voltage (kV)	**Electrical Field (at ground level under a line) (kV/m)**	**Magnetic Induction (at ground level) (uT)**
765	8-13	28-32
525	5-9	25-30
420	4-8	22-28
245	**2-3.5**	**20-25**
123	1-2	12-15
70	1-1.5	2-2.5

Source: ICNIRP, 1998

In line with set precaution values for a 245kV transmission line, the electromagnetic impact of the proposed 132kV transmission line still falls below set limits and thereby ranked as a minor significant impact.

Mitigation measures will include:

• Alternative analysis of the ROW options ensured minimal to no exposure of public to electromagnetic fields by selecting the farthest routing option from human settlements and activities.

• Provide and ensure use of appropriate PPE for maintenance workers

• Transmission line has been designed in line with ICNIRP/WHO standards for biological exposures

Implementation of the above measures reduces the impacts to negligible.

Generally, proper supervision, high workmanship performance, and provision of adequate safety measures will alleviate public and occupational HSE risks.

Table 5.7: Suggested Power Line Wayleave Sizes

TRANSMISSION LINES	SUGGESTED DISTANCE BETWEEN PARALLEL POWER LINES	SUGGESTED WAYLEAVE
765 kV	60 meters	80 meters
533 kV	40 meters	60 meters
500 kV	40 meters	60 meters
420 kV	35 meters	55 meters
400 kV	35 meters	55 meters
330 kV	35 meters	50 meters
275 kV	32 meters	47 meters
132 kV	25 meters	31 meters
88 kV	15 meters	31 meters
66 kV	15 meters	31 meters
33 kV (H-Pole)	14 meters	31 meters
33 kV	14 meters	22 meters
22 kV	12 meters	15 meters
11 kV	5 meters	10 meters

Source: *Southern African Power Pool Environmental Subcommittee, 2012*

5.4.6 DECOMMISSIONING

Activity	***Demolition of structures, transportation of demolished structures, restoration, etc.***
Impact	• Increased sedimentation process close to river banks and floodplains along the tower sites. • Risk of soil and adjoining surface water contamination from accidental oil and hazardous substance leakages and wastes from decommissioning. • Increase in ambient noise levels and pollutant gases above baseline conditions from movement and activities of decommissioning equipments and vehicles. • Risk of accident and injury to worker during demolition of structures

The decommissioning phase refers to all the activities which relate to the proposed transmission line when it is no longer in use. Potential issues that relate to the decommissioning phase refers to impacts such as the towers lying strewn around, lack of rehabilitation of the access roads, overgrown vegetation along the ROW etc.

During the decommissioning phase, the demolition activities are likely to have similar impacts on the environment as were identified for the construction phase. These include potential impacts such as sedimentation, surface water, visual impact, dust and noise pollution, a risk of fires and explosions, safety and security and traffic impacts etc. Impacts arising from decommissioning activities have been ranked with significance levels of minor to major.

Mitigation measures for impacts during decommissioning will be implemented in line with practices as at the time of decommissioning. However, to a minimum the following mitigation measures have been put in place for impacts arising due to decommissioning process:

• Develop and implement a decommissioning plan in line with requirements as at the time of decommissioning.

• Ensure that excavated and stockpiled soil material is stored and bermed on the higher lying areas along the site and not in any run-off channels where it is likely to cause erosion.

• Decommissioning activities should preferably take place during the dry season months to prevent soil erosion caused by heavy rains.

• Wet all unprotected cleared areas and stockpiles with water to suppress dust pollution.

• Institute noise control measures (e.g. regular equipment maintenance) throughout the decommissioning phase for all applicable activities.

• Take cognisance of peak traffic times and plan transportation of decommissioned structures and personnel so as to avoid obstruction of local traffic by vehicles, heavy machinery/trucks.

• The decommissioning contractor as at the time of decommissioning will have to develop a decommissioning security plan and implement its use.

• Ensure effective waste management from cradle to grave for all wastes generated during and after the decommissioning period.

• Enforce proper waste management policies in line with FMENV standards and requirements as at time of decommissioning.

• Ensure use of road worthy vehicles and equipment as well as skilled operators and drivers

Implementation of the above measures reduces the impacts to negligible.

CHAPTER SIX
IMPACTS' MITIGATION-MEASURES

6.1 Introduction

EIA has as its principal and most important objective the development and establishment of suitable procedures (mitigation measures) for the identified significant and adverse impacts of a proposed project. Equally identified is the aim of enhancing the potentially beneficial aspects of the development.

Project activities evaluated in Chapter 5 show that the various components of the environment will be impacted positively or negatively, as well as some mitigation measures. This chapter of the report presents in details the mitigation (preventive, reduction and control) measures and alternatives considered to ensure that the associated and potential impacts of the proposed projects (Steel-manufacturing project and the proposed 1.3km 132kV Transmission Line construction project) on the ecological and socio-economic environment are eliminated or reduced to As Low As Reasonably Practicable (ALARP), thus preserving the ecological integrity of the existing environment. Also, stated here are details of the control technology and compliance with health and safety hazards requirements including a table showing potential impacts of proposed project with their proffered mitigation measures (Table 6.1).

6.2 Approaches to Impact Mitigation

The approaches to the mitigation measures include enhancement (for the positive impacts), prevention, reduction, avoidance and compensation (for the significant negative impacts). The mitigation measures for each (significant and adverse) impact of the proposed project activities were generally identified, based on the associated effect to the environment and human health/safety. The significance of the impact, probability or likelihood that the impact would occur and the severities of its consequence (as determined from the risk assessment matrix) were indices used for determining the mitigation requirements as illustrated in Figure 6.1. Subsequently, the specific mitigation measures satisfying the mitigation requirement were established putting into consideration available resources and competencies, on-site conditions, public concerns and technology.

The framework for determining the form of mitigation measures to be applied for the significant impacts identified for the project is presented below (Figure 6.1).

The frequency, severity, sensitivity, scale, magnitude and nature of the impacts were taken into consideration during these assessments.

Subsequently, the specific mitigation measures satisfying the mitigation criteria were established putting the following into consideration;

• regulatory requirements

• available resources and competencies;

• on-site conditions;

• technology and

• public concerns

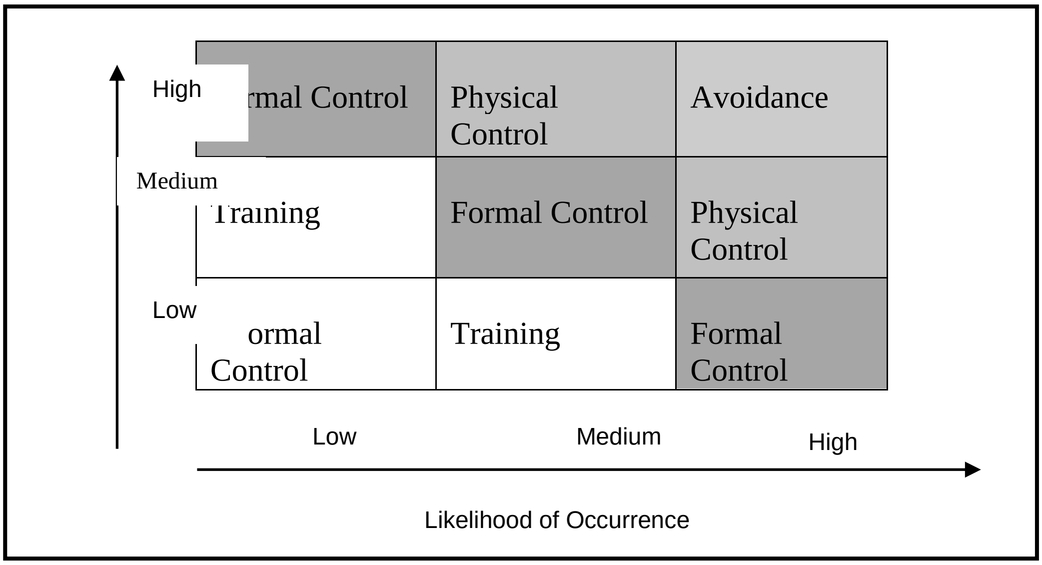


Figure 6.1: Matrix for Determination of Mitigation measures

The definitions of the various approaches to impact mitigation (which are the primary objectives in proffering mitigation measures) considered are presented below.

Enhancement: These are measures proffered to ensure that significant beneficial impacts of the existing facilities and proposed project are encouraged.

Prevention: These are measures proffered to ensure that significant and adverse potential impacts and risks do not occur.

Reduction: These are measures proffered to ensure that the effects or consequences of those significant associated and potential impacts that cannot be prevented are reduced to a level as low as reasonably practicable.

Formal control: This involves the application of documented policy, process or procedure in mitigating the impacts of the project activities.

Informal Control: This involves the application of sound judgment and best practice in mitigating the impacts of project activities.

Physical control: This involves the application of physical processes or instruments (pegs, flags, sign post etc), not necessarily requiring any special technology, in order to mitigate the impacts of a project or impacts.

Avoidance: This involves the modification of plans, designs or schedules in order to prevent the occurrence of an impact or impacts.

Training: This involves personnel awareness in specific / specialized areas.

6.3 Management Procedure for Mitigation Measures

The management procedures employed for the establishment of mitigation measures for the identified impacts is presented in **Figure 6.2**. Mitigation measures were subsequently proffered for adverse significant potential impacts. These measures (prevention, reduction, control strategies) were developed for the adverse impacts through review of industry experience (past project experience), consultations and expert discussions with multi-disciplinary team of engineers and scientists.

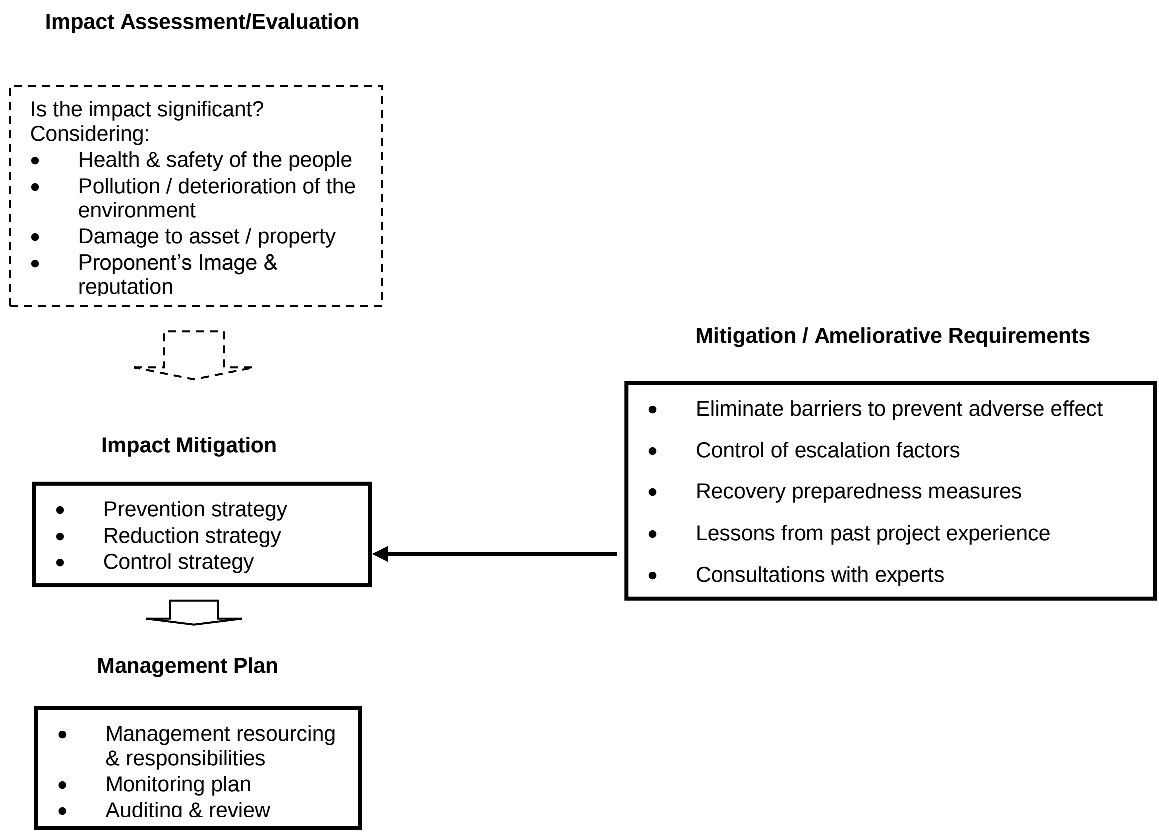


Fig. 6.2: Management Procedure for Mitigation Measures

6.4 Proffered Mitigation Measures

Accordingly, this section presents the mitigation measures proffered for the significant (medium and high) adverse impacts of the proposed (a) steel-manufacturing project and (b) transmission line project; separate tables. These cost effective measures have been proffered with reference to best industry practice and HSE considerations.

Based on the impact assessment matrix in the previous section, the overall ratings of impact significance **High** or **Medium** or **Low** was established for each identified impact. The proffered mitigation measures and the expected final residual impact rating for the identified potential significant impacts are presented in the **Table 6.1&2.**

A. Table 6.1: Mitigation Measures for the Potential and Associated Impacts of the Proposed Steel-Manufacturing Project-Site

Project Phase	Project Activity	Associated and Potential Impact	Significance Ranking	Mitigation Measures	Residual Impact
Pre-Construction	Land acquisition	Conflict over land ownership amongst natives	**High**	Inner Galaxy Steel Company Ltdshall liaise with local CDC, community head and relevant local organizations to identify actual land owners.	**Medium**
		Conflict over payment of compensation for acquired land	**High**	Inner Galaxy Steel Company Ltdshall liaise with local CDC, community head and relevant local organizations to identify actual land owners.	**Medium**
	Movement of personnel, materials and equipment to site using Low – Loaders and other trucks, vehicles	Interference with public utilities (electric wires and poles), market activities along mobilisation route	**Medium**	Inner Galaxy Steel Company Ltd shall: • use standard warning notice (e.g. side rides, signal lights and horn) to other road users; • ensure a practicable journey management programme is developed and adhered to; • carry out pre-mobilisation route survey and ensure that mobilization is carried out after due consultation with relevant authorities and other stakeholders to minimize interference along the route	**Low**

		Release of SO_X, NO_X, CO_X, etc from exhausts which could lead to atmospheric pollution / GHG emission	**Low**	Inner Galaxy Steel Company Ltd shall: • ensure vehicles, trucks and other heavy duty engines are maintained at optimal working condition in accordance with operating manual; and • encourage the use of mufflers on equipment manifold where necessary to filter particulates and thus reduce its emission into the air. Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	**Low**
		Increase noise level in the area due to movement of heavy duty engines	**Low**	Noise levels increase are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	**Low**

		Incident/accident resulting from the movement of materials and equipment from low loader	**High**	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	**Low**
		Increase road traffic accident (RTA)	**High**	Inner Galaxy Steel Company Ltd shall • ensure that speed limits are adhere to. • use standard warning notice (e.g. signal lights and horn) to other road users. • ensure a practicable journey management programme is developed and adhered to.	**Low**

		Risks of militant/youths attack leading to personnel injury / death	**High**	Inner Galaxy Steel Company Ltdshall • carry out security assessment along mobilization route prior to mobilization • ensure security operatives (navy/mopol/army) accompany mobilization vessel to project site • activate emergency response plan in the event of threat	**Medium**
		Movement of workers into host communities and resultant increase in population.	**Medium**	Inner Galaxy Steel Company Ltd shall • liaise with local CDC, community head and relevant local organizations to work out formula for recruitment from the host communities	**Low**
		Conflicts between host communities especially youths arising from recruitment of local labour	**High**	Inner Galaxy Steel Company Ltd shall • liaise with local CDC, community head and relevant local organizations to work out formula for recruitment from the host communities • be transparent in working out the formula for recruitment	**Low**

		Conflict with native cultures, traditions and life styles	**High**	Inner Galaxy Steel Company Ltd shall • brief its contractors and project personnel prior to deployment on proper conduct within stakeholder communities; • provide periodic follow-up awareness training to educate the workers on the importance of proper conduct within the stakeholder communities; and • continue to consult community leaders on issues of importance and encourage goodwill between the project personnel and the locals in order to foster tolerance between the communities and the non-local personnel.	**Low**
		Increased demand on social infrastructure	**Medium**	Inner Galaxy Steel Company Ltd shall • Embark on community development programmes in line with the desires and needs of the people. • Establishment of base camps for workers with medical facilities.	**Low**

		Recruitment of Local hands/labour.	**Beneficial**	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	**Beneficial**
Pre construction	Site Survey, Removal of vegetation and de-stumping	Creation of job and job opportunities	**Beneficial**	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	**Beneficial**
		Loss of topsoil. Decreased soil fertility and agricultural production	**Medium**	Inner Galaxy Steel Company Ltdshall keep to area approved for the job	**Low**

		Loss of biodiversity (flora and fauna) including loss of plants of economic value	**Medium**	Inner Galaxy Steel Company Ltd shall • Ensure that vegetation clearing will be limited to the surveyed area • Ensure that plants of economic value are transplanted	**Low**
		Fragmentation of habitats; Disruption of wildlife migration routes	**Medium**	Inner Galaxy Steel Company Ltdand its contractors shall: • limit vegetation clearing to approved widths and, as practicable, to minimum required ; and • for disturbed areas that are no longer required for project operations, monitor regrowth and, if necessary, initiate actions to enhance regrowth or revegetation with appropriate species consistent with operation requirement	**Low**
		Alteration of natural drainage patterns	**Medium**	Inner Galaxy Steel Company Ltdshall • Ensure that site preparation is carried out in such a way as not to alter the natural topography of the project area. • sediment traps/screens shall be used to control runoff and sedimentation	**Low**

		Personnel injury/death resulting from malfunction and mal-operation of equipment etc.	**High**	Inner Galaxy Steel Company Ltdshall ensure: • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work activities; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel.	**Low**
		Soil erosion and run off from access road creation	**Medium**	Inner Galaxy Steel Company Ltd and its contractors shall: • ensure natural drainage patterns are preserved during clearing; • ensure only areas specifically required for safe operations are cleared, and consider the use of geo-textiles or other erosion control structure in areas prone to erosion.	**Low**

		Wildlife attack (e.g snake bite, bee sting)	**High**	Inner Galaxy Steel Company Ltdand its contractors shall ensures: • Work force are provided with and use appropriate PPE (cover all, safety boots, hard hats, hand gloves and safety goggles) before venturing into the bush; • Work force are provided assistants/experienced guides from the local communities to look out for signs of wild animals (including bees and wasps) in the bush; and trips into the work in inclement weather e.g., periods of low visibility, are avoided	**Low**
		Pollution (dust) from soil surface.	**Medium**	Inner Galaxy Steel Company Ltd shall • ensure that there is regular and frequent watering of the work way especially during the dry season.	**Low**

		Secondary development of modern amenities/infrastructures	**Beneficial**	These are beneficial impact; Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • adopting policies to encourage short-term employees (through periodic briefings or other means as practicable) and save for future needs following their employment; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement policies and practices favouring local merchants and service providers where practicable and when goods and services meeting quality requirements can be provided in a timely manner at competitive prices	**Beneficial**
		Increased demand on existing local infrastructures (road, housing etc) due to influx of workers and job seekers.	**High**	Inner Galaxy Steel Company Ltd shall • Embark on community development programmes in line with the desires and needs of the people. • Establishment of base camps for workers with medical facilities.	**Low**

		Influx of predominantly male population) job seekers) into stakeholders communities leading to increased extramarital sexual activity, and introduction of commercial sex workers	**High**	Inner Galaxy Steel Company Ltd shall ▪ Maintain regular medical examinations for all staff. ▪ Abstinence/safe sex shall be encouraged ▪ Employment of indigenes shall be encouraged	**Low**
		Potential effects on air quality from emission of pollutants from engines eg bull-dozers and supportequipment .	**Low**	Inner Galaxy Steel Company Ltd shall: • ensure vehicles, trucks and other heavy duty engines are maintained at optimal working condition in accordance with operating manual; and • encourage the use of mufflers on equipment manifold where necessary to filter particulates and thus reduce its emission into the air. Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	**Low**
		Conflict over employment issues among stakeholders	**High**	Inner Galaxy Steel Company Ltd shall • liaise with local CDC, community head and relevant local organizations to work out formula for recruitment from the host communities • be transparent in working out the formula for recruitment	**Low**
		Localised increase in ambient noise levels from operations. This could lead to loss / scare birds and mammals	**Low**	Noise levels are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	**Low**

Construction Phase	All construction activities	Creation of job and job opportunities	**Beneficial**	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	**Beneficial**
		Improvement on the economic status of the stakeholder community due to increased demand for local goods and services	**Beneficial**	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	**Beneficial**
		Provision of modern amenities/infrastructures	**Beneficial**	Inner Galaxy Steel Company Ltd shall • embark on community development programmes in line with the desires and needs of the people.	**Beneficial**

		Conflict over employment issues among stakeholders	**High**	Inner Galaxy Steel Company Ltd shall • liaise with local CDC, community head and relevant local organizations to work out formula for recruitment from the host communities • be transparent in working out the formula for recruitment	**Low**
		Localised increase in ambient noise levels from operations.	**High**	Noise levels are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	**Low**
		Potential effects on air quality from emission of pollutants from engines.	**Low**	Inner Galaxy Steel Company Ltd shall: • ensure vehicles, trucks and other heavy duty engines are maintained at optimal working condition in accordance with operating manual; and • encourage the use of mufflers on equipment manifold where necessary to filter particulates and thus reduce its emission into the air. Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	**Low**
		Increased demand on existing local infrastructures (housing etc) due to influx of workers and job seekers.	**High**	Inner Galaxy Steel Company Ltd shall • Embark on community development programmes in line with the desires and needs of the people. • Establishment of base camps for workers with medical facilities.	**Low**

		Influx of predominantly male population) job seekers) into stakeholders community leading to increased extramarital sexual activity, and introduction of commercial sex workers	**High**	Inner Galaxy Steel Company Ltd shall ▪ Maintain regular medical examinations for all staff. ▪ Abstinence/safe sex shall be encouraged ▪ Employment of indigenes shall be encouraged	**Low**
		Work place accidents / incidents duringconstruction activities. This may lead to injury/death of personnel	**High**	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	**Low**

		Injury from welding burns	**High**	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	**Low**

		Possibility of vision impairment from exposure to light emitted from welding sparks and foreign particles/objects entering the eyes.	**High**	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	**Low**
Operational Phase	Manufacturing of Steel, Hazardous chemical handling/ joint observation	Localized increase in the ambient concentration of air pollutants due to chemical fumes	**Low**	Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	**Low**

	for leakages/waste management	Possibility of injury to skin due to burns resulting from chemicals.	**High**	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	**Low**
		Surface water contamination from chemical spills	**High**	Inner Galaxy Steel Company Ltd shall develop an appropriate Waste Management Plan before project commencement • As a minimum all operational waste shall be separated at source to enhance efficiency in waste handling and disposal • Also, training on waste management will be conducted for project site personnel	**Low**

		Risk of injury / death of personnel as a of industrial accident	**High**	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	**Low**
		Waste generation/discharge (packaging materials/ containers, food wastes/pigging wastes etc) and associated environmental effects.	**Medium**	Inner Galaxy Steel Company Ltd shall develop an appropriate Waste Management Plan before project commencement • As a minimum all operational waste shall be separated at source to enhance efficiency in waste handling and disposal • Also, training on waste management will be conducted for project site personnel .	**Low**
		Possibility of fire explosion	**High**	Inner Galaxy Steel Company Ltd shall enforce the principles of safety management	**Medium**

		Employment opportunities during operation and maintenace	Beneficial	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	**Beneficial**
		Incineration of hazardous waste	**Medium**	Inner Galaxy Steel Company Ltd shall develop an appropriate Waste Management Plan before project commencement • As a minimum all operational waste shall be separated at source to enhance efficiency in waste handling and disposal • Also, training on waste management will be conducted for project site personnel .	**Low**

Demobilization Phase	Demobilization from site	Interference with public utilities (electric wires and poles), market activities along demobilisation route	**Medium**	Inner Galaxy Steel Company Ltd shall: • use standard warning notice (e.g. side rides, signal lights and horn) to other road users; • ensure a practicable journey management programme is developed and adhered to; • carry out pre-mobilisation route survey and ensure that mobilization is carried out after due consultation with relevant authorities and other stakeholders to minimize interference along the route	**Low**
		Release of SO_X, NO_X, CO_X, etc from exhausts which could lead to atmospheric pollution / GHG emission	**Low**	Inner Galaxy Steel Company Ltd shall: • ensure vehicles, trucks and other heavy duty engines are maintained at optimal working condition in accordance with operating manual; and • encourage the use of mufflers on equipment manifold where necessary to filter particulates and thus reduce its emission into the air. Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	**Low**
		Increase noise level in the area due to movement of heavy duty engines	**Low**	Noise levels increase are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	**Low**

		Incident/accident resulting from the movement of materials and equipment onlow loader	**High**	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	**Low**
		Increase road traffic accident (RTA)	**High**	Inner Galaxy Steel Company Ltd shall • ensure that speed limits are adhere to. • use standard warning notice (e.g. signal lights and horn) to other road users. • ensure a practicable journey management programme is developed and adhered to.	**Low**

		Risks of militant/youths attack leading to personnel injury / death	**High**	Inner Galaxy Steel Company Ltdshall • carry out security assessment along mobilization route prior to mobilization • ensure security operatives (navy/mopol/army) accompany mobilization vessel to project site • activate emergency response plan in the event of threat	**Medium**
Abandonment Phase	**Abandonment/Decommissioning**	Return of land to Owners	**Beneficial**	-	**Beneficial**
		Environmental pollution from corrosion of abandoned structure	**Medium**	♦ All decommissioned metal scraps, pipes etc, shall be recycled . ♦ Inner Galaxy Steel Company Ltd shall re-vegetate the area with indigenous species after decommissioning.	**Low**
		Loss of lives due to accident/incident caused by abandoned structures left at site	**High**	♦ Appropriate warning signs shall be used to alert residents of the presence of such machines/equipment	**Low**

B. Table 6.2: Mitigation Measures for the Potential and Associated Impacts of the Proposed Construction of 1.3km 132kV Transmission Line Project

Project Activities / Environmental Aspects	Potential and Associated Impacts	Significance Before Mitigation	Mitigation / Enhancement Measures	Residual Ranking
Pre-Construction				
Permitting & ROW Acquisition • Consultations • Acquisition of license to operate • Stakeholder identification • ROW Acquisition	Acceptance and co-operation/ participation from stakeholders (communities and government) leading to peaceful and timely execution of the project	Beneficial	Inner Galaxy Steel Company Limited and EPC contractor shall: • All relevant stakeholders are identified • Early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed	Beneficial
	Uncertainty and increased perturbation due to a lack of information and communication.	Medium	Inner Galaxy Steel Company Limited shall: • Early engagement of stakeholders • Establish and publicize grievance procedure • Provide the opportunities for all affected groups (women, youths, religious, etc) to participate in consultations and ensure that all concerns are duly addressed. • Plan and execute consultations to educate community members and stakeholders on project activities, schedules and potential impacts. • Ensure consultation throughout project life span.	Negligible
	Integration of men and women concerns into the project design	Beneficial	Inner Galaxy Steel Company Limited and EPC contractor shall: • Due consultation of relevant groups at all phases of the project. • Provide the opportunities for all affected groups to participate in consultations and that all concerns are duly addressed. • Establish and publicize grievance procedure	Beneficial
	Exclusion of vulnerable groups from consultations	Medium		Negligible

	which may lead to strife			
	Community agitations over compensations, land disputes, wrong stakeholder identification, leadership tussles, etc	Major	Inner Galaxy Steel Company Limited and EPC contractor shall: • Project will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities • Project will also develop and implement a resettlement action plan to ensure equitable settlement of all project affected persons • Early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed. • Establish and publicize grievance procedure • Stakeholders (communities, Govt., land owners, etc.) are adequately consulted and relevant issues addressed • Agreed fair compensation/rent for land are paid to identified owners promptly as per set standards. • As far as possible employ persons from the surrounding communities during the construction phase of the development to reduce the numbers of persons that will migrate to the area seeking employment. This will also avoid any feelings of resentment and will ensure that the communities derive the most benefits from the development.	Negligible
	Improvement in quality of life for adequately compensated individuals	Beneficial	Consulting all relevant stakeholders and legacy issues identified early, clearly defined , and agreed on • Fair compensations in line with national standards are agreed upon and paid	Beneficial
Transport of Personnel and Construction Elements • Aba – PortHarcourt Federal Highway	Increased traffic during mobilisation on road with risks of accidents leading to injury/death and loss of asset.	Major	Inner Galaxy Steel Company Limited and its contractors shall ensure; • All vehicles and boats are certified road / water worthy prior to being mobilized for work activities.	Negligible

			• Compliance to all roads and water ways safety transport rules including speed limits • Competency training and certification of drivers before mobilisation. • Limit movement to day time only	
	Risks of armed robbery attack and hostage taking leading to injury/ death of personnel	Major	• Develop a project security plan that addresses all project related security concerns • Ensure security procedures are strictly enforced and continually improved based on updated risk information. • Consultation and good public relation with the stakeholder communities. • Ensure government approved security personnel is used on transport vehicles and boats when warranted • Limit movements of personnel and equipment to daytime only	Moderate
	Nuisance (noise and vibrations) due to movement from heavy duty equipment and vehicles affecting public and wildlife.	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Machinery, vehicles and instruments that emit high levels of noise should be used on a phased basis to reduce the overall impact. These pieces of equipment such as drills, graders and cement mixers should also be used when the least number of residents can be expected to be affected. • Workers, especially those working with machinery, vehicles and instruments that emit high levels of noise should be supplied with ear plugs and ear muffs to reduce the risk of hearing impairment. Prolonged exposure to this impact should be reduced where possible. • Plan work activities to avoid heavy duty movement during peak hours • Consult with host communities and plan project activities	Negligible

			accordingly • Limit movement and work activities to daytime only • Ensure equipments are properly maintained	
	Increase of dust particles and vehicular emissions.	Minor	Inner Galaxy Steel Company Limited and EPC contractor shall: • Ensure that all vehicles involved in the transport of construction material and staff and machinery involved in the construction is properly maintained and serviced. • Extra care must be taken to reduce dust in periods when wind speed are greatest and the rainfall amounts are lowest which is between November and February (dry season), e.g. This will involve extra wetting of the construction area to suppress dust particles. • Ensure that all material (sand and aggregate) stockpiled along the site to be used in construction activities are regularly sprayed to reduce the effects of wind whipping. • All staff employed at the construction site must be provided with dust masks and be asked to use them. • Implement a traffic system that involves appropriate signals and signs to ensure the smooth flow of traffic. This will reduce the idling of vehicles that may occur and therefore reduce the emissions in the area. • Reduce speed along earth roads • Plan journey to reduce travel times • Vehicles carrying earth materials should be covered • Install and operate air pollution control equipment e.g. mufflers.	Negligible

	Work place accidents/incidents from the use of cranes, forklifts, etc. during loading and offloading of materials/equipment.	Medium	Inner Galaxy Steel Company Limited and its contractors shall ensure; • All personnel are qualified and certified for their relevant works • That approved safe work procedures are provided and complied with at all times • Use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site • Limit work activities to daytime only	Negligible
	Obstruction of/damage to existing roads due to increased usage during mobilisation.	Medium	Inner Galaxy Steel Company Limited and EPC contractors shall: • Roads to be assessed prior to commencement of work to establish the status and its capability to safely handle material and personnel transportation, and after completion to determine extent of impact and where necessary, take steps to reclaim areas damaged by project activities • Plan work execution to reduce travels and restrict where necessary, use of access roads.	Negligible
	Interference with other road users along mobilisation route.	Medium	Inner Galaxy Steel Company Limited and its contractors shall ensure that • Equipment, materials and personnel are mobilised after due consultation with relevant transportation authorities (FRSC, NMA, NURTW, etc) and other stakeholders to minimise interference along mobilisation routes. • Travels to and from sites shall be planned to maximize each trip and minimize number of travels	Negligible

	Leakage of fuel or lube oil onto land or into water bodies during transportation and storage may lead to increased chemical toxicity.	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall ensure: • Safe operating practices are enforced during mobilisation • Implementation of project specific spill and emergency response plan • hydrocarbon/chemical spill containment and prevention measures and equipment are functional and effective on site and for equipment and vehicles • hydrocarbon and chemical transfers in safely contained areas • Double handling to be avoided where possible • When transfer has to take place, ensure it is effected in lined and secured areas where containment is possible • Educate personnel on hydrocarbon and chemical handling risks/hazards, through HSE briefings/tool box meetings	Negligible
Recruitment of Labour	Employment opportunities arising from recruitment of technical and non technical transmission line workers	Beneficial	Inner Galaxy Steel Company Limited and EPC contractor shall: enhance this beneficial impact by • Creating requirements for contractors to hire local labour • Ensure skills acquisition and development • Recognise and commend personnel with outstanding performance	Beneficial
	Skill acquisition and enhancements to local indigenes and workforce.			
	Influx of people (migrant workers, subcontractors and suppliers) and increased pressure on existing social infrastructure	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Brief all employees to ensure awareness of any sensitivity to the local cultures, traditions and lifestyles • Continuous consultation while project is in progress • Implementation of community relations and engagement plan • Encourage hiring, as practicable, of appropriately qualified workers from areas in the vicinity of the project to discourage	Negligible

			preventable influx of persons • Work with contractors to ensure that specialised skill workers from outside the areas have access to proper accommodations and other basic infrastructure • Educate all workers to enhance their Health, Safety, Security, and Environment awareness, and performance on the job • Maintain medical emergency response plan so that all injured or ill personnel can promptly access appropriate care	
	Increase of communicable diseases due to influx of people and poor living conditions around pre-construction sites	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Project will develop a health plan to address potential health issues • Carry out health awareness program (malaria, corporate stop AIDS program, etc) • Provision of site medical personnel to attend to emergency situations • Engage the services of retainer clinics to manage health issues • Educate workforce on the prevention of malaria as well as encourage the use of mosquito nets in construction camps.	Negligible
	Increase in social vices (like theft, prostitution) resulting from increased number of people	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Ensure its personnel and contractors undergo preemployment background screening as required • Periodically discuss health and social education issues during toolbox/HSE meetings • Promptly deal with reported cases of misconduct to check recurrences	Negligible
	Conflicts/community agitations over employment issues (quotas and methods)	Major	Inner Galaxy Steel Company Limited and EPC contractor shall: • Project will develop a community relations and engagement plan that identifies fair strategies of engagement for all	Low

			communities • Project will also develop and implement a resettlement action plan to ensure equitable settlement of all project affected persons • Establish and publicize grievance procedure • Early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed. • All affected stakeholders and legacy issues are identified early, clearly defined , and agreed on. • Stakeholders (communities, Govt., land owners, etc.) are adequately consulted and relevant issues addressed • Agreed fair compensation/rent for land are paid to identified owners promptly as per set standards. • As far as possible employ persons from the surrounding communities during the construction phase of the development to reduce the numbers of persons that will migrate to the area seeking employment. This will also avoid any feelings of resentment and will ensure that the communities derive the most benefits from the development.	
Site Preparation • Access to ROW creation • Service roads • Camping and campsites	Business opportunities for local contractors through sub contracting activities	Beneficial	Inner Galaxy Steel Company Limited and EPC contractor shall: • Encouraging indigenous contractors and suppliers providing them opportunities to supply materials of acceptable standards • Encourage contractors to hire and to develop local labour • Workers are paid promptly as at when due	Beneficial
	Local support services from road side supply markets and shops etc	Beneficial		
	Contamination of surface water as a result of siltation caused by increased erosion, during site preparation.	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Employ appropriate industry practices in transmission line construction and ancillary facilities in order to avoid adverse alteration drainage pattern	Negligible

			• Implement where appropriate sediment run-off controls and visually inspect after rainfall events • Laydown areas/Marshalling yards are designed to include erosion control • Reclaim as practicable topography of excavated or compacted upland areas upon completion of activities.	
	Disturbance of the vegetation cover / loss of forest products (fuel wood, timber, medicinal plants) due to site clearing and preparation.	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora and fauna management. • Vegetation clearing will be limited to minimum required for work • Felling of trees of >30cm girth is to be minimized during • vegetation clearing to only unavoidably necessary ones. This should be done with considerations to environmental protection. • Utilisation of existing accessible tracks as much as possible • Establish a perimeter of protection around sensitive ecosystems and their unique habitats. • Plan work activities to minimise presence and duration of work in ecologically sensitive areas (mangrove paths, river banks, fresh water swamps).	Negligible
	Loss/disturbance of wildlife due to habitat loss/fragmentation from vegetation clearing along ROW and access roads	Medium		
	Soil compaction, destabilisation from excavation and runoff erosion resulting in sedimentation problems.	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Implement where appropriate sediment run-off controls and visually inspect after rainfall events • Install siltation traps within the drainage design to collect silt and sediments ensuring that they do not end up in adjacent aquatic areas.	Negligible

			• Construction on steep slopes and in soft or erodible material will require erosion control measures and correct grassing methods. • Laydown areas/Marshalling yards are designed to include erosion control • Reclaim as practicable topography of excavated or compacted upland areas upon completion of activities	
	Fragmentation of wildlife habitats/increase in poaching due to an easier access for the local population and non-resident workers.	Medium	• Where possible plan site clearing to allow species the opportunity to relocate to suitable nearby habitats and to reduce the shock to the various habitats that may be disturbed. • Relocate non-motile and weak species to safe grounds prior to commencement of work • Allow re-growth, within height restrictions, of native ground cover beneath lines (along ROW, lay-down areas and access roads) • Prohibit poaching particularly by workers and educate workers on good biodiversity conservation policies.	Negligible
	Waste Disposal • scrap metal, wood, sand, concrete, paper, domestic waste • Waste from laydown area from grubbing of ROW (Material and wood)	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall : • Develop project specific waste management plan (Chapter 7) and ensure proper implementation • Provide adequate containers for waste collection • Periodically assess contractor activities to check the level of compliance to regulatory and Inner Galaxy Steel Company Limited waste management requirements. • Safe operating practices are enforced during construction • Ensure use of only government approved waste management contractors	Negligible

Project Activities / Environmental Aspects	Potential and Associated Impacts	Significance Before Mitigation	Mitigation / Enhancement Measures	Residual Ranking
Construction phase				
Fabrication and Metal works • Cutting, bending and welding tower steel components • Painting • Handling of conductor wires, strings, insulators and fittings	Workplace accidents from burns, cuts, bruises, trips and falls, objects at height, leading to injury or fatalities.	Major	Inner Galaxy Steel Company Limited and its contractors shall ensure; • All personnel are qualified and certified for their relevant works • That approved safe work procedures are provided and complied with at all times • Use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site • Limit work activities to daytime only where practicable	Negligible
	Employment of local labour and skills acquisition for workers taking advantage of new opportunities	Beneficial	Inner Galaxy Steel Company Limited and its contractors shall enhance this beneficial impact by • Creating requirements for contractors to hire local labour • Ensure skills acquisition and development	Beneficial
	Risk of electrocution and burns (to onsite workers) from welding flashes and high currents during welding	Major	Inner Galaxy Steel Company Limited and its contractors shall ensure; • All personnel are qualified and certified for metal works • That approved safe work procedures are provided and complied with at all times • Use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety goggles, etc. by all metal works personnel	Negligible
	Noise and attendant vibration effects from fabrication and	Minor	Inner Galaxy Steel Company Limited and EPC contractor shall: • Machinery, vehicles and instruments that emit high levels of	Negligible

	associated welding equipments		noise should be used on a phased basis to reduce the overall impact. These pieces of equipment such as drills, graders and cement mixers should also be used when the least number of residents can be expected to be affected. • Workers, especially those working with machinery, vehicles and instruments that emit high levels of noise should be supplied with ear plugs and ear muffs to reduce the risk of hearing impairment. Prolonged exposure to this impact should be reduced where possible. • Ensure use of appropriate PPEs (ear plugs) by workers in areas with noise level above FMENV (90dBA) hourly work area limits. • Conduct daily HSE briefings prior to work	
	Inhalation by onsite workers of cement dust and toxic fumes during foundation works and welding of tower components	Medium	Inner Galaxy Steel Company Limited shall and its contractors shall: • Utilise environmentally friendly electrodes, spray and paint liquids for welding as well as painting. • Use of appropriate personal protective equipment such as welding masks by welders shall be enforced. • Inner Galaxy Steel Company Limited shall also install fume expellers or blowers at confined welding areas. • Implement appropriate work-site practices.	Negligible
	Generation of metal scraps from conductor wires, strings and steel elements associated with fabrication of tower components.	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Develop project specific waste management plan and ensure proper implementation • Provide adequate containers for waste collection • Periodically assess contractor activities to check the level of compliance to regulatory and Inner Galaxy Steel Company	Negligible

			Limited waste management requirements. • Safe operating practices are enforced during construction • Ensure use of only government approved waste management contractors	
Foundation / Earth Works • On-site geotechnical tastings • Tower foundations • Pilings and trenching, etc	Increased business and economic activities as well as diversification of income sources due to supply contracting and subcontracting	Beneficial	Inner Galaxy Steel Company Limited shall enhance this by: • Encouraging indigenous contractors and suppliers providing them opportunities to supply materials of acceptable standards • Encourage contractors to hire and to develop local labour	Beneficial
	increase in revenue opportunities for local population due to presence of non-resident workers and travellers	Beneficial		
	Interruption of surface water flows and potentials for salt-water intrusion in identified tidal zones of the project areas during construction.	Major	Inner Galaxy Steel Company Limited and EPC contractor shall: • Do not hamper drainage of surface water and plan for reclamation measures after construction. • Avoid crossing permanent waterways with machinery; if necessary, locate the crossing where the banks are stable and the waterway at the most narrow part of the water way. • Limit work areas outside vegetation along water bodies and near wetlands. • Maintain a minimum flow to prevent salt water intrusion through standard procedures	Negligible
	Soil / groundwater contamination resulting from accidental leakages and spills of hazardous substances	Major	Inner Galaxy Steel Company Limited and EPC contractor shall: • Plan and set on-site sanitary facilities for the disposal of wastewater. • Maintain vehicles, machinery and equipment in good condition	Low

	(diesel, cleaning agents, lubricants, hydraulic oil)		in order to avoid leaks and spill of hazardous materials (lube oils, chemicals, etc.) • Ensure safe management of hazardous materials (chemicals, etc.) • Ensure handling of fuels such as fuelling of vehicles and machinery, and fuels transfers, take place in contained areas, where sufficient measures are in place to ensure containment of spills. • Plan emergency response measures and equipment are available, and personnel are capable of effectively using it for cases of accidental spill.	
	Increased jobs and job opportunities from local labour hire and sub-contracting to indigenous suppliers.	Beneficial	Inner Galaxy Steel Company Limited and EPC contractor shall enhance this by: • Encouraging indigenous contractors and suppliers by providing them opportunities to supply materials of acceptable standards	Beneficial
	Generation of dust and automobile / heavy duty equipment emissions from construction earth works.	Minor	Inner Galaxy Steel Company Limited and EPC contractor shall: • Ensure that all vehicles involved in the transport of construction material and staff and machinery involved in the construction is properly maintained and serviced. • Extra care must be taken to reduce dust in periods when wind speed are greatest and the rainfall amounts are lowest which is between November and February (dry season), e.g. This will involve extra wetting of the construction area to suppress dust particles. • Ensure that all material (sand and aggregate) stockpiled along the site to be used in construction activities are regularly sprayed to reduce the effects of wind whipping.	Negligible

			• All staff employed at the construction site must be provided with dust masks and be asked to use them. • Implement a traffic system that involves appropriate signals and signs to ensure the smooth flow of traffic. This will reduce the idling of vehicles that may occur and therefore reduce the emissions in the area. • Reduce speed along earth roads • Plan journey to reduce travel times • Vehicles carrying earth materials should be covered • Install and operate air pollution control equipment e.g. mufflers.	
	Flora/habitat loss and disturbance through vegetation clearing and earthworks along ROW, access roads and at tower sites	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora management. • Limit vegetation clearing to footprint required for construction purposes; i.e. minimize disturbances along proposed transmission line ROW. • Much of the low-lying mangrove vegetation will not be cleared and will be covered with construction material; • provision of adequate culverts to maintain natural drainage channels and tidal flushing along the mangrove paths as much as practicable; • Clear briefings and instructions to EPC regarding the clearance procedures will be undertaken to minimise any mangrove area that may be disturbed; • Allow re-growth, within height restrictions, of native ground	Negligible

			cover beneath lines (along ROW, lay-down areas and access roads)	
	Fauna disturbance and displacement as a result of migration away from construction activity area (this include impact on bird life)	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora management. • Plan and execute construction works to minimize interference on wildlife • Maintain construction equipments to optimal function conditions • Monitor presence of wildlife species during construction activities	Negligible
	Potential collapse of transmission towers as a result of unsuitable geotechnical conditions	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Carry out side by side geotechnical investigations during construction to determine suitability of soil to carry towers • Recommendations from geotechnical appraisals shall be appropriately implemented • Construction of tower foundations shall follow good industry engineering practices.	Negligible
	Reduction in wildlife population as a result of poaching due to easier access created by ROW clearing	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Prohibit poaching by personnel • Periodically educate workforce on good principles of biodiversity conservation • Limit workforce concentration to project area and prohibit the possession of fire arms by members of workforce • Practice wildlife conservation principles (e.g. release back into the wild any wildlife incidentally caught by dug-up foundations	Negligible

			or tranches.	
	Noise nuisance (including impulsive noise) from construction activities (e.g. piling) resulting to temporary migration of sensitive mammals and rodents.	Minor	Inner Galaxy Steel Company Limited and EPC contractor shall: • Machinery, vehicles and instruments that emit high levels of noise should be used on a phased basis to reduce the overall impact. These pieces of equipment such as drills, graders and cement mixers should also be used when the least number of residents can be expected to be affected. • Workers, especially those working with machinery, vehicles and instruments that emit high levels of noise should be supplied with ear plugs and ear muffs to reduce the risk of hearing impairment. Prolonged exposure to this impact should be reduced where possible. • Regularly maintain construction equipments to optimal function • Limit heavy duty construction works to day hours only where practicable	Negligible
Tower Construction and Erection • Crane lifting and erections • Bolts and nuts tightening • Anti climbing guards and step bolts • Insulators and fittings • Conductor wire stringing • Connectors fixing, etc	Pollution of soil/water as a result spilled fuel and other waste oil discharge during tower construction and installation processes	Major	Inner Galaxy Steel Company Limited and EPC contractor shall: • Develop and implement spill response plan • maintain storage facilities at optimal holding condition • train personnel in safe fuel handling procedures of chemicals and hydrocarbons • ensure all fuel storage facilities are bunded and lined with impermeable materials • vehicle and equipment maintenance activities implemented using proper containment or other strategies to guide against spills • Monitoring during maintenance of equipment to ensure that there is no discharge to the environment	Low

	Traffic diversion and congestion along local roads during installation at road crossings.	Minor	Inner Galaxy Steel Company Limited and EPC contractor shall: • Coordinate tower construction and stringing activities to avoid heavy traffic periods • Use warning signs and traffic wardens/directors • Ensure activities causing blockages at road crossings are carried out within shortest time practicable • In the case of longer road blockages, divert traffic to approved alternate routes in liaison with appropriate authorities • Consult with affected communities prior to closures to provide warnings and alternatives.	Negligible
	Workplace accidents / incidents (trip/falls etc) from heights during conductor wire stringing and bolt/nuts tightening project activities.	Medium	• Inner Galaxy Steel Company Limited shall ensure HSE briefings prior to commencement of work activities • Develop standard work procedures where work hazards are identified and addressed • Inner Galaxy Steel Company Limited shall ensure personnel use appropriate PPE • Inner Galaxy Steel Company Limited shall design work area to internationally acceptable standards • Ensure availability of first aid facilities onsite • Ensure retainer clinics are engaged and site medical personnel are available in case of accidents • Maintain medical emergency response plan so that injured or ill personnel can promptly access appropriate care.	Negligible
	Risks of injury / death and loss of assets resulting from accidents associated with road transportation to and fro construction sites	Medium	Inner Galaxy Steel Company Limited and its contractors shall ensure; • All vehicles and boats are certified road worthy prior to being mobilized for work activities. • Compliance to all roads safety transport rules including speed	Negligible

			limits • Competency training and certification of drivers before mobilisation. • Limit movement to day time only	
	Risks of fire/explosions resulting from accidental ignition of onsite diesel storage tanks	Major	Inner Galaxy Steel Company Limited and its contractors shall ensure; • All fuel storage tanks are kept at safe distances from work areas • Educate workforce on risks associated around storage areas and prohibit activities (such as smoking) that can ignite storage tanks • Designate no-smoking and smoke areas • Hold SHE meetings and talks on fire hazard	Negligible
	Waste Disposal • scrap metal, wood, sand, concrete, paper, domestic waste • used oil and replaced/obsolete equipment pars that may contaminate soil/groundwater • Waste from lay-down area and tower sites from grubbing of ROW	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall: • Develop and implement a waste management plan • Provide adequate containers for waste collection • Periodically assess contractor activities to check the level of compliance to regulatory and Inner Galaxy Steel Company Limited waste management requirements. • Ensure engagement of government approved waste management contractors	Negligible
	Localised economic benefits from materials supplies by local contractors	Beneficial	Inner Galaxy Steel Company Limited and its contractors shall enhance this by: • Encouraging indigenous contractors and suppliers by providing them opportunities to supply materials of acceptable standards	Beneficial
	Induced secondary	Beneficial		

	development within the neighbouring host communities from increased economic activities.		• Encourage contractors to hire and to develop local labour	
	Socio-cultural conflicts between the construction team and indigenous populace due to contrasts in believes and traditions	Medium	Inner Galaxy Steel Company Limited and its contractors shall • Brief all employees to ensure awareness of any sensitivity to the local cultures, traditions and lifestyles • Establish and publicize grievance procedure • Continuous consultation while project is in progress • Implementation of community relations and engagement plan	Negligible
	Visual intrusion as a result of alterations to normal landforms and aesthetic beauty of construction sites	Minor	• Where practically possible, provide a minimum of 1 km buffer area between the transmission line camp sites and sensitive visual receptors; and • Rehabilitate disturbed areas around pylons as soon as practically possible after construction. This should be done to restrict extended periods of exposed soil. • Existing facilities might be used for lay-down and camp site areas	Negligible
	Increased demand on existing infrastructure (roads, housing, medical facilities, etc) due to influx of workers / induced secondary development in the area during construction activities resulting in squatter settlements.	Medium	Inner Galaxy Steel Company Limited shall • Encourage hiring, as practicable, of appropriately qualified workers from areas in the vicinity of the project • Work with contractors to ensure that specialised skill workers from outside areas have access to proper accommodations and other basic infrastructure • Educate all workers to enhance their Health, Safety, Security, and Environment awareness, and performance on the job • Maintain medical emergency response plan so that injured or ill personnel can promptly access appropriate care	Negligible

	Permanent loss of land (some with arable potentials) potentials along the transmission line ROW	Medium	• The final ROW shall traverse in an existing disturbance corridor like other transmission lines or pipelines, where farming activities have already been impacted. In this way negative agricultural economic impacts would be minimised. • Land owners shall be compensated for potential loss in revenue • Compensation shall be agreed between Inner Galaxy Steel Company Limited and the landowner and implemented accordingly	Negligible
	Site conditions leading to increased malaria epidemic from uncontrolled mosquito breeding in swamp areas, snake bites, as well as water borne diseases e.g. diarrhoea and cholera associated with poor sanitary conditions	Major	Inner Galaxy Steel Company Limited shall ensure: • Develop project health and safety plan to address all potential health issues • Inner Galaxy Steel Company Limited shall ensure personnel use appropriate PPE • Provide on-site emergency response plan • Ensure availability of first aid facilities onsite • Ensure retainer clinics are engaged and site medical personnel are available to attend to emergency cases • Ensure that workers are provided with training on health risks, exposure, and management • Provide appropriate domestic water supply to address additional needs. • Facilitate the implementation of appropriate latrines and other sanitation facilities. • Provide information, education and communication about safe uses of water and occupational safety. • Environmental management for vector control; avoidance via settlement location and design and use of bed nets and repellents; rapid diagnosis and treatment; focal insecticide and	Low

			molluscicide application. • Safe food storage and handling.	
Demobilisation • Demobilisation after construction phase	Workplace accidents from burns, cuts, bruises, trips and falls, objects at height, leading to injury or fatalities.	Medium	Inner Galaxy Steel Company Limited shall ensure: • HSE briefings prior to commencement of work activities • Develop standard work procedures where work hazards are identified and addressed • Inner Galaxy Steel Company Limited shall ensure personnel use appropriate PPE • Inner Galaxy Steel Company Limited shall design work area to internationally acceptable standards • Ensure availability of first aid facilities onsite • Ensure retainer clinics are engaged and site medical personnel are available in case of accidents • Maintain medical emergency response plan so that injured or ill personnel can promptly access appropriate care.	Negligible
	Soil / groundwater contamination resulting from accidental leakages and spills of hazardous substances (diesel, cleaning agents, lubricants, hydraulic oil)	Major	Inner Galaxy Steel Company Limited shall: • enforce good environmental demobilisation procedures (e.g. cleaning sites and restoring to original status) • Use of drip pans during transfer of fuels and hazardous substances • Reclaim storage tank areas or contaminated soils • Carry out internal environmental assessment to check activities of construction team and status of lay-down areas, marshalling yards, tower sites, etc prior to demobilisation.	Negligible
	Traffic congestion during transportation of demobilised equipments and personnel	Minor	Inner Galaxy Steel Company Limited and EPC contractor shall : • Coordinate demobilisation activities to avoid heavy traffic periods • Use warning signs and traffic wardens/directors	Negligible

			• Ensure activities causing blockages at road crossings are carried out within shortest time practicable • Consult with affected communities prior to demobilisation to provide warnings and alternatives.	
	Generation of dust and automobile / heavy duty equipment emissions.	Minor	• Ensure that all vehicles involved in the transport of construction material and staff and machinery involved in the construction is properly maintained and serviced. • Extra care must be taken to reduce dust in periods when wind speed are greatest and the rainfall amounts are lowest which is between November and February (dry season), e.g. This will involve extra wetting of the construction area to suppress dust particles. • Ensure that all material (sand and aggregate) stockpiled along the site to be used in construction activities are regularly sprayed to reduce the effects of wind whipping. • All staff employed at the construction site must be provided with dust masks and be asked to use them. • Implement a traffic system that involves appropriate signals and signs to ensure the smooth flow of traffic. This will reduce the idling of vehicles that may occur and therefore reduce the emissions in the area. • Reduce speed along earth roads • Plan journey to reduce travel times • Vehicles carrying earth materials should be covered • Install and operate air pollution control equipment e.g. mufflers.	Negligible

	Reclamation of marshalling yards, tower sites, access roads (to prevent unauthorised access) and lay-down areas	Beneficial	Inner Galaxy Steel Company Limited shall enhance this by: • Where possible contractor shall reclaim de-vegetated areas with topsoil, • Where possible, reclaim compacted floors with native plant species, etc. • Audit EPC contractor to verify reclamation of work sites, marshalling yards, lay-down areas etc	Beneficial
	Waste disposal (scrap metal, wood, sand, concrete, paper, domestic waste)	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall : • Provide adequate containers for waste collection • Ensure all waster are removed from site • Audit contractor on waste disposal activities to check the level of compliance to regulatory and Inner Galaxy Steel Company Limited waste management requirements before leaving site.	Negligible
	Loss of employment and business opportunities due to completion of construction phase	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall • Shall ensure skills acquisition and enhancement programs to further empower the workforce for meaningful employment opportunities after the project • Establish and publicize grievance procedure • Pay due wages for worked period and settle all financial commitments to workforce before demobilisation	Negligible
	Illegal access to transmission line towers leading to accident, sabotage, asset damage, and loss	Major	Inner Galaxy Steel Company Limited and EPC contractor shall : • Provide warning signs at access roads created to warn against dangers associated with transmission lines • Through consultations, sensitize stakeholders and members of the communities on need to stay clear of the transmission line and hazards associated with it • As much as practicable provide restrictions (e.g. anticlimbers) to unauthorised access to transmission lines	Low

	Soil runoff and erosion resulting in sedimentation problems	Medium	Inner Galaxy Steel Company Limited shall: • Install siltation traps within the drainage design to collect silt and sediments ensuring that they do not end up in adjacent aquatic areas. • Construction on steep slopes and in soft or erodible material will require erosion control measures and correct grassing methods. • Where possible contractor shall reclaim de-vegetated areas with topsoil, reclaim compacted floors with native plant species, etc. • Appropriate flow diversion and erosion control structures i.e. earth embankments must be put in place where soil may be exposed to high levels of erosion due to steep slopes, soil structure etc. • Auditing EPC contractor to verify reclamation of work sites, marshalling yards, lay-down areas etc	Negligible
Operation phase				
Project Activities / Environmental Aspects	**Potential and Associated Impacts**	**Significance Before Mitigation**	**Mitigation / Enhancement Measures**	**Residual Ranking**
Operations • Commissioning and testing • Testing and Turnover	Community dissatisfaction regarding the conduct of Inner Galaxy Steel Company Limited on compensation issues may lead to strife before full operations of transmission line	Major	• Project will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities • Project will also develop and implement a resettlement action plan to ensure equitable settlement of all project affected persons • Establish and publicize grievance procedure • Early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed.	Negligible

			• All affected stakeholders and legacy issues are identified early, clearly defined, and agreed on. • Stakeholders (communities, Govt., land owners, etc.) are adequately consulted and relevant issues addressed • Agreed fair compensation/rent for land are paid to identified owners promptly as per set standards. • As far as possible employ persons from the surrounding communities during the construction phase of the development to reduce the numbers of persons that will migrate to the area seeking employment. This will also avoid any feelings of resentment and will ensure that the communities derive the most benefits from the development	
	Development of agricultural land due to easier access and consequent discovery of new arable lands for farming	Beneficial	• Take into account the various land uses while designing the project in order to minimise the loss of land, particularly productive land. • Timely completion of the project so that associated benefits such as reduction in environmental pollution, business opportunities, quality of life, etc shall take effect.	Beneficial
Operations • Electric power transmission using the installed lines after commissioning. `	Increased electricity transmission and distribution capacities within the national grid	Beneficial		
	Increased business opportunities and quality of life (small, medium, large scale) due to enhanced power delivery	Beneficial		
	Improvement in environmental standards due	Beneficial		

	to reduced emission from standby diesel or fuel generators, use of fuel wood.			
	Reduced demand on petrol and diesel used for power generation and further reduction in greenhouse gases and noise emissions.	Beneficial		
	Uncertain effects of electromagnetic radiation on ROW users exposed to (and residents near to) transmission line generating electromagnetic field	Medium	• Provide and ensure use of appropriate PPE • Alternative analysis of the ROW options ensured minimal to no exposure of public to electromagnetic fields • Also transmission line has been designed in line with ICNIRP/WHO standards for biological exposures	Negligible
	Risk of collision of low flying air planes with transmission towers and lines	Major	• Alternative analysis of the ROW options ensured minimal to no interference with air traffic • Inner Galaxy Steel Company Limited shall provide Aircraft Warning spheres and tower signs in areas where air traffic might occur in order to minimize risk of low flying aircraft colliding with towers and wires.	Negligible
	Electric shock and burns to members of the public in the event of tower collapse or damage to transmission wires	Major	• Towers shall be installed following the best engineering standard • Towers shall be collapse tested to prove the tower design is in line with the Inner Galaxy Steel Company Limited requirements • Inner Galaxy Steel Company Limited shall carry out routine inspection of towers in order to allow early detection of damaged towers • Reported cases of damaged or fallen towers shall be promptly	Negligible

			attended to • Adequate and automatic fault/damage detection system shall be installed. • Personnel shall be trained on the detection/handling of such emergencies arising from accidental damage	
	Unchecked encroachment on the ROW, leading to land-use conflicts and accident.	Medium	Inner Galaxy Steel Company Limited and EPC contractor shall : • Provide warning signs at access roads to warn against unauthorised entry • Through consultations, sensitize stakeholders and members of the communities on government policies along established ROW	Negligible
	Noise along the transmission line due to corona effects (humming sound)	Minor	• The design of the transmission line shall be in line with standards observed by International bodies as well as TCN Standards • Inner Galaxy Steel Company Limited shall assure during transmission line component testing that national and international standards and limits are complied with.	Negligible
	Distortion of transmission signals and electrostatic circuit due to electromagnetic induction.	Medium		
	Use of track corridors for other facilities (TLine, communication cables as well as water pipes etc)	Beneficial	Inner Galaxy Steel Company Limited shall enhance this : • By providing platform for consultation and communication to future developments along the project area	Beneficial
	Local fauna disturbances from electromagnetic field along the TL ROW	Medium	• The design of the transmission line shall be in line with standards observed by International bodies as well as Inner Galaxy Steel Company Limited. • Inner Galaxy Steel Company Limited shall assure during transmission line component testing that national and international standards and limits are met.	Negligible
	Mortality of birds, due to		• The routine line patrols by Inner Galaxy Steel Company	

	collision with earth wires on towers.	Medium	Limited maintenance crew will look out for any bird collisions. If any collision "hot spots" are identified, these can be mitigated reactively.	Negligible
	Effectively evacuate power to be generated by Afam-Alaoji Power Plant for further distribution within the Ukwa-West (to the project site of Inner Galaxy Steel Co. Ltd.).	Beneficial	• Impact is beneficial and shall be enhanced by sustaining the transmission line life span, through adequate and effective maintenance activities as well as complying with federal government's policies and laws on power transmission and distribution.	Beneficial
	Aid in meeting the demands of steel-bars materials by the powering of the steel-manufacturing plant.	Beneficial		
	Development of new infrastructures or improvement to existing ones.	Beneficial		
Maintenance • Tower inspection and checks • Line element replacements • ROW maintenance • Substation maintenance	Proliferation of weeds around towers and below ROW	Minor	Inner Galaxy Steel Company Limited shall to extent practicable periodically carry out ROW maintenance activities to manage growths of weeds and other creeping plants on the tower bases in a manner that minimizes adverse impacts on vegetation.	Negligible
	Disturbance of bird habitats and avifauna from activities of maintenance crew.	Medium	• Disturbance of grassland during construction and operation should be kept to a minimum. • The activities of the construction and operations staff shall be restricted to the ROW and immediate surrounds. • Develop policies that prohibiting hunting by staffs	Negligible

	Development of local maintenance activities to encourage employment and empowerment within the communities.	Beneficial	• Ensure the participation of men and women in local maintenance activities such as weeding of the ROW.	Beneficial
	Interference with local traditional festivals or activities by unscheduled maintenance work and failure to keep to management plans may lead to community strife.	Major	• Plan activities to minimize work activities during local events • Operators will obtain information about planned local activities and avoid disturbing them by shifting maintenance activities to other days whenever possible • Formal notice of any maintenance work should be given in advance to the communities along the area. Access to the line must be via the approved access roads and corridors (agreed with the host communities). • The notice shall give details of the purpose of the access, the contact person and number of people to be involved, time frames and machinery that will be used. • schedule and implement recommendations of the Community Relations and Engagement Plan and approved work procedures	Low
	Maintenance of towers within sensitive environments e.g. mangrove swamps, river banks may lead to disturbance of hydrological regime (micro scale) in river banks	Medium	• Appropriate flow diversion and erosion control structures i.e. earth embankments shall be put in place where soil may be exposed to high levels of erosion due to steep slopes, soil structure etc. • Access into the riparian zone and floodplains of rivers should be prevented as far as possible. Where access into these areas is required a preferred corridor should be determined. No deviation from these corridors should be allowed. • Areas to be rehabilitated should be identified and reclaimed.	Negligible

	Lack of maintenance along TL ROW may lead to collision of wildlife with the stays that are not visible in the dense vegetation	Medium	• Anchors shall be marked with material that will be visible to animals and Inner Galaxy Steel Company Limited shall ensure that regular clearance of vegetation takes place around the towers.	Negligible
	Limited knowledge on safety measures and behaviours associated with line operation that can lead to accidents	Medium	• Plan information, education and communication activities during and after project implementation to increase awareness of all users (men and women) on dangerous behaviours and safety measures required.	Negligible

Decommissioning and Abandonment phase

Project Activities / Environmental Aspects	**Potential and Associated Impacts**	**Significance Before Mitigation**	**Mitigation / Enhancement Measures**	**Residual Ranking**
Decommissioning / Abandonment • Unstringing of conductor wires • Tower / facilities removal • Waste generation	Increased sedimentation process close to river banks and floodplains along the tower sites.	Medium	• Ensure that excavated and stockpiled soil material is stored on the higher lying areas of the site and not in any stormwater run-off channels or any other areas where it is likely to cause erosion or where water would naturally accumulate. • Decommissioning activities should preferably take place during the dry season months to prevent soil erosion caused by heavy thunderstorms associated with the rainy season in the project area. • The area shall be graded and re-vegetated to ensure that rainwater drains gradually over the site without creating erosion gullies.	Negligible
	Risk of soil and adjoining surface water contamination from accidental oil and	Major	• Ensure that no wastes and hazardous materials generated on the site are dumped or deposited on adjacent/surrounding surface waters including roads or public places during or after the	Negligible

	hazardous substance leakages and wastes from decommissioning.		decommissioning period. • Enforce proper waste management policies in line with FMENV standards and requirements. • Ensure that all project associated wastes and hazardous materials are disposed off in line with project waste management plan.	
	Increased dust and vehicular emissions during transport.	Minor	• Wet all unprotected cleared areas and stockpiles with water to suppress dust pollution. • Cover materials such as sand and other rubble during transport to and from the site with a tarpaulin. • Ensure use of road worthy vehicles and equipment as well as skilled operators and drivers • Limit speed of vehicles and travel time to and from decommissioning site.	Negligible
	Increase in ambient noise levels above baseline conditions from movement and activities of decommissioning equipments and automobiles.	Minor	• Limit work activities to daytime only • Ensure maintenance of vehicles and equipments • Provide and encourage use of PPEs.	Negligible
	Traffic obstruction from transportation of decommissioned structures and equipments to receiving hub.	Medium	• Plan decommissioning activities in consideration of peak traffic times. • Ensure that the handling of equipment and materials is supervised. • Use signs, posts, and guides to manage traffic and direct users accordingly	Negligible
	Risk of accident and injury to worker during demolition of	Medium	• Develop a work plan for safe demolition • Ensure hazards are identified and addressed prior to	Negligible

	structures		commencement of work. • Provide and enforce the use of PPE • Ensure that decommissioning and demobilisation vehicles are under the control of competent personnel. • Provide adequate facilities on site to treat emergencies to staff.	
	Risks of pirate attacks and possible hostage taking which may lead to injury or fatality of personnel.	Major	Inner Galaxy Steel Company Limited and contractors shall ensure: • Ensure implementation of project security plan during decommissioning • Approved procedures are strictly enforced and continually improved based on updated risk information. • Maintain ongoing cordial relationships with the stakeholder communities. • Certify government approved security guards are used on demobilisation vehicles when warranted • when necessary Inner Galaxy Steel Company Limited shall activate its emergency response procedure • Implement effective journey management plan.	Low
	Availability of land for alternative uses	Beneficial	This is a beneficial impact and Inner Galaxy Steel Company Limited, relevant government agencies together with stakeholders shall work out processes for land relinquishment or alternative uses as at the time of decommissioning.	Beneficial

Table 6.3: Summary of Mitigation Measures (to reduce identified impact) of Transmission Line Project's Aspect

Project Phase	Type of Impact identified	Mitigation Measures Recommended
Operational phase	Risk of Bird-Electrocution	Provide artificial bird safe perches and nesting platforms placed at a safe distance from the energized parts Cross-arms, insulators and other parts of the power lines can be constructed so that there is no space for birds to perch where they can be proximate to energized wires. All terminal structures (transformers) should be constructed with sufficient insulation on jumper wires and surge arrestors Keeping cables far apart >60cm, will certainly minimize or eliminate this risk of electrocution along the lines. Where wide spacing of electric cables is not practical then insulation is recommended
Pre-construction and Construction phase	Disturbance, alteration and destruction of Natural habitats	Destruction of woody grassland during construction should be minimized. Destruction of riparian habitats and water pans during construction and operation should not be allowed The activities of the construction and operations staff must be restricted to the wayleave and immediate surrounds. Birds should not be exposed to more disturbance than is inevitably brought about by construction and operations activities. Care should be taken in sensitive areas such as grassland, wetland and valleys not to create more disturbance than is necessary. Access of machinery and vehicles to these areas should be carefully controlled and maintenance and construction activities must be restricted to the wayleave where practical Use of existing tracks and roads in the general as far as possible will help minimize construction of access roads to deliver materials.

		Clearance of plants (trees and shrubs especially) should be minimized unless necessary. This should be easy to observe as trees and shrubs in the area are already short below overhead cables.
Pre-construction and Construction phase	Waste-generation at construction-site	Comprehensive waste management is being developed to help in minimizing waste accumulation on site. Oil spill handling strategy especially mopping up oil immediately after spill, engine maintenance particularly oil change off site plan should help avoid pollution due to oils. Old transformers should be changed on time to minimize leakages. They should be stored in concrete floors and rooms with roofs to avoid precipitation.
Pre-construction and Construction phase	Dust/particulate matter impact	This impact is low but can be made less in magnitude and extent when dust mufflers are used and watering is done on the construction sites where dust more likely to be an issue. Construction can be timed when the ground is not too dry and dusty and bats are not desperate
Pre-construction and Construction phase	Noise from construction plant	Silencers fitted to the engines could significantly reduce impact of noise Switching off engines not in use can also reduce noise duration and intensity
Pre-construction and Construction phase	Terrestrial woody plant alteration	The impact could influence the decision to develop in the area unless it is effectively mitigated. Traditional construction of a wayleave that involves grading of the belt should be avoided. This causes damage to vegetation and habitats that they provide to animals. Avoid grading in areas with high slope angles to avoid future possible erosion Minimize grading of rugged areas by looking for alternative passage within the 60 m wayleave. Avoid cutting of short trees that heights are lower than the power line. Height difference should be maintained at least 15 m. When points of erecting pylons is exactly on cluster of bushes, offset backwards or forward

		within the proposed line to avoid destruction of the potential habitats or refugia for reptiles and small mammals
Pre-construction and Construction phase	Introduction of Alien Invasive Plant Species (AIPS)	Equipment to be used should be decontaminated e.g. washing equipment to remove soil potentially carrying AIPS propagates Avoid importing soils/gravels to use for level grounds for vehicles to pass in ROW. If brought from outside, the surface of the soil should be removed to avoid mixing of soils potentially harboring AIPS propagates with the lower soil profiles. Since AIPS appears later after soil disturbance, aftermath proliferation of AIPS should be controlled by reducing their population and recruitment
Pre-construction and Construction phase	Aquatic Habitat Alteration	There is need to ensure sedimentation is not caused in the drainage system. Minimization of activities that disturb soil layer near the river valley would contribute to the conservation of the system
Pre-construction and Construction phase	Temporary obstruction of movement of wild-herbivores	Speed of vehicles should be controlled at a maximum limit of 40 km/h. Once a driver notices a herd of gazelles is crossing s/he should wait until all have crossed or slow down to avoid hitting individuals Avoid grading or clearing of vegetation where the mounds of moles and Aardvark holes occur. These are probably their hidings from predators and severe climate conditions. Construction activities should be restricted to day time from 6am to 6pm. This provides time for foraging for nocturnal animals. This group is normally sensitive to presence of human activities and flood lights at night. During dry season the upland is dry of grasses but the lowland still has grass, herbs and shrub reserves. Most of herbivores migrate to this area thus construction activities during dry season can affect utilization of this area. Construction should therefore be scheduled after the onset of rainfall. Generally, vegetation in the area responds quickly to rainfall hence herbivores will disperse to avoid any adverse impacts.

		Impact on the species will be localized. Disturbance of their habitats would affect negatively the hidings of geckos and lizards in the rock outcrop area. Implementation of operation times, speed limit and driver's keenness can potentially reduce this impact.
Operations phase	Exposure of wild herbivore to electric and magnetic fields	Excessive clearing of vegetation should be avoided to prevent incidences of wild herbivores congregating along the wayleave. In case there will be possible electric inductions on wire fences, rubber breaks should be introduced on wires to avoid possible conduction of electric domains.
Operational phase	Exposure to Electromagnetic Field (EMF)	No permanent structures will be allowed within the 1.3km wayleave; this will be enforced by Inner Galaxy Residents should limit their exposure by staying away from the wayleave Inner Galaxy Steel Co. Ltd. should have periodic engagement sessions with the local community on the hazards associated with the 132kV transmission line Also consider providing surveillance mechanism of the transmission line corridor

CHAPTER SEVEN

ENVIRONMENTAL MANAGEMENT PLAN

7.1 *Introduction*

This chapter presents the Environmental Management Plan (EMP) developed for the proposed 1.3km construction of 132kV Transmission Line project and establishment of a Steel-manufacturing factory (project site).

An Environmental Management Plan (EMP) is essentially a management tool and standalone component of an EIA that provides the assurance that the mitigation measures developed for the significant impacts of a proposed project are implemented and maintained throughout the project lifecycle. It outlines management strategies for safety, health and environment stewardship in the proposed project implementation. It states in specific terms how the project proponent's commitments will be implemented to ensure sound environmental practice.

EMP is developed to ensure that the mitigation measures as described in chapter six of this report and monitoring requirements as outlined in this EIA and any environmental compliance review shall actually be carried out in subsequent stages of the project. EMP is therefore an important management tool which sets out conditions and targets to be met during project implementation.

Inner Galaxy Steel Company Ltd Nig. Ltd has designed the EMP of the proposed project in line with its Health, Safety and Environment (HSE) policy and in accordance with ISO 14001 Environmental Management System specifications. The EMP for the proposed steel-manufacturing project shall be a "life document" which shall be reviewed periodically with the incorporation of various mitigation measures for potential impacts and shall form the basis for the actual project implementation.

EMP contains among others the following key items:

• Summary of potential impacts

• Planned mitigation measures

• Planned environmental monitoring

• Planned public consultation process

• Responsibilities and authorities for implementation of mitigation measures and monitoring requirements

• Mechanisms for feedback and adjustment

Compliance with the legal standards on safety and environment is regarded as the minimum requirement, and must be satisfied during all phases of the Project development. In order to reduce the risk of an adverse effect on the environment to the lowest level that is reasonably practicable, an objective of the engineering design will be to apply the ALARP principle. **Figure 7.1** illustrates this principle graphically.

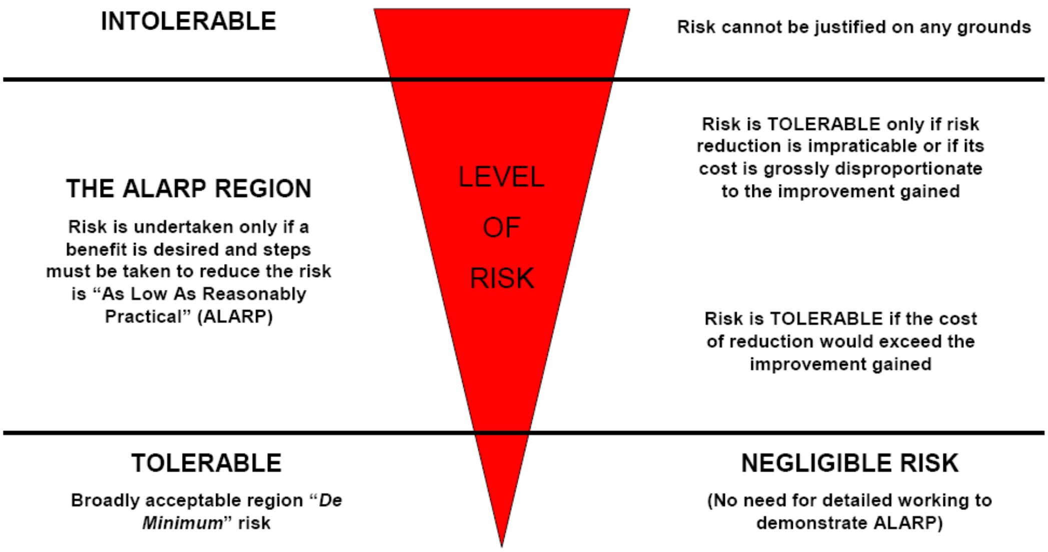


Figure 7.1: Level of Risk and ALARP

7.2 EMP Objectives

The EMP is designed to:

- ensure that all mitigation measures prescribed in the EIA document for eliminating, minimizing, and enhancing the project adverse and beneficial impacts are fully implemented; and
- provide part of the basis and standards needed for overall planning, monitoring, auditing and review of environmental and socio-economic performance throughout the project activities.

This has been developed to manage negative impacts/effects, enhance benefits and ensure good standards of practice are used throughout the project. These objectives shall be achieved by:

- ensuring compliance with all stipulated legislation on protection of the biophysical and socio-economic environment and Inner Galaxy Steel Company Ltd HSE policy;
- integrating environmental and socio-economic issues fully into the project development and operational philosophies;
- promoting awareness on the management of the biophysical and socio-economic environment among workers;
- rationalizing and streamlining existing environmental activities to add value to efficiency and effectiveness;
- ensuring that only environmentally and socially sound procedures are employed during the project implementation; and
- continuous consultations with the relevant regulatory bodies, community leaders (local heads/chiefs, clan heads, landlords, etc), youth leaders, community based organizations (CBOs), and other stakeholders throughout the project lifecycle.

7.3 Core Elements of the EMP

In line with the objectives summarized in section 7.2 above, the main elements of this EMP are:

- Overall project organizational chart (including HSE) organogram;

- Preliminary EMP guidelines;
- Guidelines for waste management;
- Guideline for Consultation;
- Noise Minimization Guideline;
- Overall safety philosophy/guidelines;
- Emergency/Contingency plan;
- Communication plan;
- Security plan;
- Plan for Training and Awareness;
- Environmental monitoring plan;
- Guidelines for audit and review;
- Guidelines on maintenance and facility management; and
- Guidelines for decommissioning and abandonment

7.4 Structure and Responsibility

The roles and responsibilities (HSE) for the proposed steel-manufacturing project include:

Resident Engineer

- HSE management on the project.
- Provide visible leadership, systems and resources for environmental management.
- Initiate action to maintain compliance with requirements.
- Specify and participate in project audits/reviews as required.

Assistant Project Manager(s)

- Review procedures for environmental aspects.
- Follow up actions from project risk assessments and environmental reviews.
- Be focal point for environmental matters with subcontractors as required.
- Participate in project audits/review as required.

HSE Advisor

- Be pro-active in promoting HSE.

- Follow-up /monitor requirements with responsible parties.
- Provide specialist HSE advice.
- Facilitate project risk assessment as required.
- Lead/participate in audits, as required.
- Maintain HSE Activities matrix and monitor close out of Project Environmental Review.
- Development of Project HSE documentation.

Environmental Lead

- Provide specialist environmental advice.
- Jointly monitor project Environmental aspects with Project Team.
- Review relevant project documentation on circulation by Project Team.
- Facilitate project environmental review.
- Lead / participate in audits and inspections as required.
- Review project environmental documentation.

7.5 Framework for Implementing the EMP

The framework for the implementation of this EMP is strongly based on a repeated process of continuous improvement which comprises of eleven (11) elements, each with underlying principle and set expectations.

Overview of each of the eleven primary elements is presented as follows.

- Management Leadership, Commitment, and Accountability: Ensures that the workers understand the goals and management commitment to excellence in safety, health, environment, and operational integrity.
- Risk Assessment and Management: Ensures that risks involved in operations are recognized so that they can be appropriately addressed through facility design and/or operating practices.
- Facilities Design and Construction: Ensures elements for the protection of people and the environment are incorporated into the design of facilities and the plans for installation and operation.
- Process and Facilities Information/Documentation: Ensures that the systems designed to protect people and the environments are appropriately documented.

- Personnel and Training: Ensures that personnel understand the systems that are in place and are appropriately trained to perform required roles with respect to their functions.
- Operations and Maintenance*:* Ensures that facilities are maintained and operated in ways that ensure the protection of people and the environment.
- Management of Change: Ensures that new personnel are informed of existing systems that all affected personnel are informed of changes in the systems, and that safety and environmental aspects are considered when making changes.
- Third Party Services: Through contract, oversight and other mechanisms, third party contractors are held to the same standards as Inner Galaxy Steel Company Ltd.
- Incident Investigation and Analysis: Seeks to understand the causes of any incidents so that effective controls or systems can be implemented to prevent recurrence.
- Community Awareness and Emergency Preparedness: Ensures appropriate outreach and awareness programmes are implemented to establish effective emergency procedures and to allay concerns.
- Operations Integrity Assessment and Improvement: Ensures that the safety and environmental performance is monitored against targets to ensure Inner Galaxy Steel Company Ltd meets its goals to protect people and the environment and seeks the means to improve the systems and processes, particularly when goals are not being met.

7.6 EMP Guidelines

Preliminary EMP guidelines have been developed to cover the entire steel-manufacturing project activities. These include: waste management, consultation, noise minimization, overall safety philosophy, emergency/contingency plan, communication plan, security plan, training and awareness, environmental monitoring etc.

7.6.1 Environmental Management Guideline

Inner Galaxy Steel Company Limited has set objectives and targets in managing significant environmental aspects in line with ISO 14001 Environmental Management System requirement for the proposed project during construction and operation phases. Commensurate resources shall be allocated to meet specific plans. These plans shall be reviewed yearly by Inner Galaxy Steel Company Limited management to monitor progress.

Inner Galaxy Steel Company Limited management through HSE engineer shall be responsible for implementing the mitigation measures for environmental aspects/impacts of the proposed transmission line.

This shall be within the scope of relevant HSE policies and regulatory requirement as well as standard industry practice. At construction phase however, the EPC contractor shall be responsible for ensuring that all HSE requirements are met. The contractor shall report to the Inner Galaxy Steel Company Limited management through the HSE engineer.

The Environmental Aspects that are likely to be significantly impacted by all the phases of the project such as pre-construction, construction, operation, and decommissioning have been identified and addressed in the environmental management plan. In addition to this, project specific plans that will incorporate implementation of recommended measures for each work phase and aspect will be developed by the contractors to ensure that all health, safety, and environmental concerns are fully covered for the entire project. Since these plans will be developed at stages where specific project details are available, they will therefore present comprehensive steps for the implementation, monitoring, and reporting from inception to projects completion and decommissioning.

Based on project related information available at the time of this study, the management objectives, set target, required actions, monitoring and reporting for various aspects/impacts are also presented below.

Table 7.1 ENVIRONMENTAL MANAGEMENT PLAN SCHEDULE/PROGRAMME FOR PROJECT'S ASPECT

ENVIRONMNETAL MANAGEMENT PLAN	OBJECTIVE	TARGET	ACTION	MONITORING AND REPORTING	Responsibility
AIR QUALITY MANAGEMENT PLAN	To minimise the release of emissions (combustion products and particulate/dust) to air during all construction phases of the project	Limit emissions of pollutant gases like NOx, SOx, CO, in addition to dust, smoke, and fumes, within acceptable standards through all construction phases of the project work activities	•Maintenance programme shall be developed and implemented for all associated power generators and heavy duty equipment • Controlling fuel consumption for all equipment and vehicles through prudent work execution and effective journey management • Implement basic environmental awareness management program • Limit use of diesel powered generators to minimum required to sustain uninterrupted operation. • Vehicle speeds in construction area and unpaved local roads shall be limited to a maximum of 30km/h. • Where practicable, vehicles and machinery that are used intermittently should not be left idling for long periods of time. • Re-vegetate disturbed areas as soon as possible. • Wet areas that have the potential of raising significant dusts during work activities • No open burning of waste to be undertaken. • During construction, particulate matter (dust-generation) will be controlled by the use of water sprays and dust suppressants, as required.	Visual inspection shall be undertaken by the HSE focal person/Contractors to check for evidence of excessive dust generation. If necessary, dust monitoring shall be undertaken in areas likely to generate dust that would affect nearby residents and workplaces to determine whether controls are being applied effectively. Maintenance schedule and records shall be kept. Maintain a log book for site fuel consumption and estimate emission from consumption. All issues shall be documented, acted on and reported in accordance with site procedures.	Site Environmental Officer

NOISE AND VIBRATION MANAGEMENT PLAN	To minimise the generation of noise emissions during all the construction phases of activities and to mitigate any potential noise impacts	Construction activities undertaken to comply with FMENV recommended ambient noise level guidelines	Contractors during the construction phase shall implement the following strategies: • Notify residents in affected areas of the project prior to commencement of construction. The notification would include the type of works to be undertaken, the duration of the proposed works, and a contact for any questions or concerns that may arise in the course of the work • Ensure that all equipment have effective noise control measures. Effective noise controls include: o Monthly inspection and maintenance of all vehicle and construction equipment and generators used in operation. o Use of sound suppressive device such as mufflers and silencers where possible. o Where practicable, vehicles and machinery that are used intermittently should not be left idling for long periods of time. • Noisy activities during construction/decommissioning shall be conducted during the day. • Best available work practices shall be engaged on-site to minimise occupational noise levels. • Haul routes for construction traffic entering and leaving the site shall be selected in a way that ensures noise levels at noise sensitive receptors are kept at a minimum. • Use of personal protective equipment(PPE) e.g. ear plugs for personnel working in areas where	Monitor high noise areas for proper use of PPE equipment in accordance with WHO / FMENV guidelines and standards. Schedule maintenance shall be undertaken for construction equipment and power generators to ensure an optimal working condition. All complaints shall be documented, acted on and reported in accordance with site procedures.	Site Safety, Health and Environmental Officers

			noise is a concern i.e. above 90dB(A) • Define high noise level working areas by engineering analysis of equipment for which hearing protection is required and provide appropriate warning signs		
WATER QUALITY MANAGEMENT PLAN	Avoid the contamination of surface water during construction.	Surface water is not contaminated during construction activities	• Implement controls such as berming, use of secondary containment and trays to ensure all transfer of fuels and chemicals are properly managed to prevent spillage outside of bunded areas. • Provide bunded storage areas for fuels and hazardous substances with spill clean-up kits in accordance with FMENV requirements/standard. • The project shall ensure that measures are adopted to avoid incursion into areas adjacent to the work site or any secondary effects from pollution, sedimentation, or accidental spills. • Suitable site drainage system to be constructed in lay-down areas and marshalling yards	Inspections of construction areas and assessment of the condition and operability of site drains shall be conducted. Weekly inspection of all fuels and chemicals storage areas to ensure adequate containment and handling. All complaints shall be documented, acted on and reported in accordance with site procedures. • Incidents of water contamination or spills • Results of inspections • Results of any corrective actions	Site Health and Environmental Officers
SOIL-Contamination MANAGEMENT PLAN	Prevent soil contamination	No incidents of soil contamination by hazardous substances (diesel, petrol, hydraulic oil, lubricants and paints)	• Avoid the risk of soil contamination from all construction activities. Measures to be adopted shall include: • Construct spill containment facilities (containment walls). • Train operators on safe handling of chemicals and enforce the implementation of safe work practices/procedures. • Develop and implement site specific emergency	• Weekly inspection of all fuels and chemicals storage areas. • Maintain records of inspections. • During construction, records of any contamination incidents shall be reported according to approved procedures	Site Environmental Officers

			and spills response plan • Provide emergency and spills response equipment and training of personnel on effective and timely use • Use drip pans during fuel transfer operations • Identified contaminated area shall be promptly cleaned up, reported and monitored in accordance with regulatory and project approved Requirements		
FLORA MANAGEMENT PLAN	To minimise disturbance and loss of local flora population.	No disturbance of flora outside of designated construction areas.	Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate flora management. This plan shall indicate lists of animals and plant species of concern, development and implementation of a training program that would include photos and other information to identify the various species, procedures for responding if one of the species is found (such as contacts, stopping work until relocation or protection is effected, reporting the incident in routine progress reports, etc.), where appropriate to ensure the designation of certain areas as sanctuaries for species that may be displaced by the project and requirement for a survey by qualified biologist(s) ahead of ROW clearing, as well as strict prohibition for the workforce on killing or capturing any of the species. • Limit construction of lay-down areas,	Periodic inspection of the site area. (6 monthly to a year depending on the phase of project to check for disturbances to floristic composition) Any incidents of invasive species shall be reported in accordance with site reporting procedures along the ROW.	Site Environmental Officers

			marshalling yards, access road, ROW clearing etc. to maximum foot print required for safe operation. • Areas of terrestrial habitat that were temporarily disturbed during construction (lay-down areas, marshalling yards, etc) will be reclaimed (e.g. topsoil replacement, backfilling trenches, etc). • The project specific emergency and spill response plan will cover hazardous materials management plan such as fuels, oil, and other potentially hazardous materials on the site. • A project specific waste management plan shall address adequate management of potential wastes to be generated by the project		
FAUNA MANAGEMENT PLAN	To minimise temporary disturbance of terrestrial fauna during transmission line construction and operations	Minimise impact on the local fauna	• Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by EPC contractors to ensure appropriate fauna management. This plan shall indicate lists of animals and plant species of concern, development and implementation of a training program that would include photos and other information to identify the various species, procedures for responding if one of the species is found (such as contacts, stopping work until relocation or protection is effected, reporting the incident in routine progress reports, etc.), where appropriate to ensure the designation of certain areas as sanctuaries for species that may be displaced by the project and requirement for a survey by qualified biologist(s) ahead of ROW	Monitoring for evidence of habitat disturbance or invasive species shall be Undertaken Incidents of non-approved disturbance of fauna shall be reported and addressed to prevent repetition. • Vulnerable species in line with Nigerian conservation ranking (Act 11, 1985) sighted shall be reported. Report should include the date and location (latitude/longitude) of the animal	Site Environmental Officers

			clearing, as well as strict prohibition for the workforce on killing or capturing any of the species. • Work activities to be limited within minimum area required for operations to minimize disturbance to wildlife habitats • Workforce shall be educated on biodiversity and good conservation practices. • Construction workers shall be prevented from transporting or keeping pets in the construction camp. • Species identified to be unable to move from the project site shall be safely relocated prior to commencement of work in the area		
AESTHETICS MANAGEMENT PLAN	Minimise the visual impact of the transmission line corridor on surrounding areas.	Minimize visual impacts as practical	• Landscaping where necessary on the acquired ROW • Identify and incorporate plant species with the potential to effective screening. • Utilise indigenous species, preferably those that are endemic to the area • Good housekeeping practices shall be maintained accordingly to reduce poor aesthetic conditions around construction sites.	Inspection of the health and vigour of the landscaping/ planting areas. Any improvement or deterioration shall be reported in accordance with site reporting procedures	Site Environmental Officers
SOCIAL-CULTURAL MANAGEMENT PLAN	To ensure that there are no adverse effects on the region's cultural values. • Minimise social and/or community impacts associated	• Cultural values understood and protected by Inner Galaxy Steel Company Limited • Receive and respond to	• Develop and implement community relations and engagement plan • Develop a RAP in line with OP 4.12 for The World Bank's approval. • Ensure ROW acquisition strategies in line with the approved RAP prior to commencement of work.	Review feedback from the traditional rulers and the community groups and related Government/non-Governmental Organisations. Monitoring shall be by stakeholder feedback and by review of	Community Relations Officer

	with all work activities. • Maximise opportunities for local engagement and businesses opportunities during the various project phases especially during the construction period.	complains about social or community management issues	• No unauthorised disturbance of cultural activities by the transmission line works • Plan activities in recognition of indigenous cultural activities. • Continue to consult with the indigenous communities. • Accommodation shall be provided for some construction workers (not from surrounding communities) to minimise pressure on existing infrastructure • Basic health and medical services (first level assist, first aid) shall be available to reduce the demand on existing health facilities. • Specify and implement the behaviour standards expected from all construction workers. This shall be formalised in a code of conduct that shall be agreed to and signed by every employee and sub contractor. • Complaints about unacceptable behaviour from construction workers shall be investigated and, appropriate action taken. • Use a wide range of communication tools to ensure that community is kept informed of project progresses. • Offer opportunities for the involvement of local businesses and for the employment of local residents	complaints. All complaints received shall be reported to the project manager. Monthly reports shall be prepared on social and cultural management issues and any corrective actions undertaken	

SECURITY, HEALTH, and SAFETY MANAGEMENT PLAN	To ensure that the project does not adversely affect the security, health, safety of the employees, contractors or the general public as well as the environment.	Zero reportable injuries, spills, and work-related illnesses	• The EPC contractor shall be required to prepare a project specific Security, Health, Safety, and environmental Management Plan in accordance with the requirements of Inner Galaxy Steel Company Limited management system. • Site specific Environmental Management Plan to be prepared by the EPC contractors will be developed prior to construction activities, after specific areas have been determined for project activities to ensure appropriate environmental management strategies. • All workers on the project shall go through a compulsory orientation programme before they start work. • Environmental, Health, Safety, and Security plans, programs, and regulations governing the project would be implemented and complied with. • Every worker would be made to sign a personal commitment to individual and corporate safety while at work. • Health, Security, Safety, and environmental awareness programs e.g. AIDS, and malaria awareness) shall be organized for personnel. Public health risks present significant issues for Inner Galaxy Steel Company Limited operations. Inner Galaxy Steel Company Limited management as well as employees and contractors will be committed to working actively together to	The security, safety, health, and environmental performance shall be monitored in accordance with the project and corporate procedures and reported to the project management team. Monthly/Quarterly audits shall be executed Monthly reports shall be prepared on health, security, environment and safety performance along incidents and corrective actions undertaken	Inner Galaxy Steel Company Limited CR&E unit, Project SHSE Manager, and Project Manager

			mitigate the impact of infectious diseases such as HIV/AIDS and of malaria. In addition, EPC contractor will be required to prepare and submit the project security plan to Inner Galaxy Steel Company Limited for review and approval before mobilisation to site. The project team will also organise a security workshop to identify, evaluate and recommend contingency plans for all security risks.		

7.6.2 Guidelines for Mitigation Measures

The guidelines covering the various project phases, activities/aspects and impacts, mitigation measures and designation of responsibilities for implementation are presented in **Table 7.2.**

Table 7.2: EMP Guidelines for Mitigation Measures Implementation

PROJECT PHASE	PROJECT ACTIVITY	ASSOCIATED AND POTENTIAL IMPACT	MITIGATION MEASURES	RESPONSIBILITY
Pre-Construction	Land acquisition	Conflict over land ownership amongst natives	Inner Galaxy Steel Company Ltdshall liaise with local CDC, community head and relevant local organizations to identify actual land owners.	ELO/Project Engineer
		Conflict over payment of compensation for acquired land	Inner Galaxy Steel Company Ltdshall liaise with local CDC, community head and relevant local organizations to identify actual land owners.	ELO/Project Engineer
	Movement of personnel, materials and equipment to site using Low – Loaders and other trucks, vehicles	Interference with public utilities (electric wires and poles), market activities along mobilisation route	Inner Galaxy Steel Company Ltd shall: • use standard warning notice (e.g. side rides, signal lights and horn) to other road users; • ensure a practicable journey management programme is developed and adhered to; • carry out pre-mobilisation route survey and ensure that mobilization is carried out after due consultation with relevant authorities and other stakeholders to minimize interference along the route	ELO/Project Engineer

		Release of SO_X, NO_X, CO_X, etc from exhausts which could lead to atmospheric pollution / GHG emission	Inner Galaxy Steel Company Ltd shall: • ensure vehicles, trucks and other heavy duty engines are maintained at optimal working condition in accordance with operating manual; and • encourage the use of mufflers on equipment manifold where necessary to filter particulates and thus reduce its emission into the air. Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	ELO/Project Engineer
		Increase noise level in the area due to movement of heavy duty engines	Noise levels increase are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	ELO/Project Engineer

		Incident/accident resulting from the movement of materials and equipment from low loader	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	ELO/Project Engineer
		Increase road traffic accident (RTA)	Inner Galaxy Steel Company Ltd shall • ensure that speed limits are adhere to. • use standard warning notice (e.g. signal lights and horn) to other road users. • ensure a practicable journey management programme is developed and adhered to.	ELO/Project Engineer

		Risks of militant/youths attack leading to personnel injury / death	Inner Galaxy Steel Company Ltdshall • carry out security assessment along mobilization route prior to mobilization • ensure security operatives (navy/mopol/army) accompany mobilization vessel to project site • activate emergency response plan in the event of threat	ELO/Project Engineer
		Movement of workers into host communities and resultant increase in population.	Inner Galaxy Steel Company Ltd shall • liaise with local CDC, community head and relevant local organizations to work out formula for recruitment from the host communities	ELO/Project Engineer
		Conflicts between host communities especially youths arising from recruitment of local labour	Inner Galaxy Steel Company Ltd shall • liaise with local CDC, community head and relevant local organizations to work out formula for recruitment from the host communities • be transparent in working out the formula for recruitment	ELO/Project Engineer

		Conflict with native cultures, traditions and life styles	Inner Galaxy Steel Company Ltd shall • brief its contractors and project personnel prior to deployment on proper conduct within stakeholder communities; • provide periodic follow-up awareness training to educate the workers on the importance of proper conduct within the stakeholder communities; and • continue to consult community leaders on issues of importance and encourage goodwill between the project personnel and the locals in order to foster tolerance between the communities and the non-local personnel.	ELO/Project Engineer
		Increased demand on social infrastructure	Inner Galaxy Steel Company Ltd shall • Embark on community development programmes in line with the desires and needs of the people. • Establishment of base camps for workers with medical facilities.	ELO/Project Engineer

		Recruitment of Local hands/labour.	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	ELO/Project Engineer
Pre construction	Site Survey, Removal of vegetation and de-stumping	Creation of job and job opportunities	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	ELO/Project Engineer
		Loss of topsoil. Decreased soil fertility and agricultural production	Inner Galaxy Steel Company Ltdshall keep to area approved for the job	ELO/Project Engineer

		Loss of biodiversity (flora and fauna) including loss of plants of economic value	Inner Galaxy Steel Company Ltd shall • Ensure that vegetation clearing will be limited to the surveyed area • Ensure that plants of economic value are transplanted	ELO/Project Engineer
		Fragmentation of habitats; Disruption of wildlife migration routes	Inner Galaxy Steel Company Ltdand its contractors shall: • limit vegetation clearing to approved widths and, as practicable, to minimum required ; and • for disturbed areas that are no longer required for project operations, monitor regrowth and, if necessary, initiate actions to enhance regrowth or revegetation with appropriate species consistent with operation requirement	ELO/Project Engineer
		Alteration of natural drainage patterns	Inner Galaxy Steel Company Ltdshall • Ensure that site preparation is carried out in such a way as not to alter the natural topography of the project area. • sediment traps/screens shall be used to control runoff and sedimentation	ELO/Project Engineer

		Personnel injury/death resulting from malfunction and mal-operation of equipment etc.	Inner Galaxy Steel Company Ltdshall ensure: • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work activities; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel.	ELO/Project Engineer
		Soil erosion and run off from access road creation	Inner Galaxy Steel Company Ltd and its contractors shall: • ensure natural drainage patterns are preserved during clearing; • ensure only areas specifically required for safe operations are cleared, and consider the use of geo-textiles or other erosion control structure in areas prone to erosion.	ELO/Project Engineer

		Wildlife attack (e.g snake bite, bee sting)	Inner Galaxy Steel Company Ltdand its contractors shall ensures: • Work force are provided with and use appropriate PPE (cover all, safety boots, hard hats, hand gloves and safety goggles) before venturing into the bush; • Work force are provided assistants/experienced guides from the local communities to look out for signs of wild animals (including bees and wasps) in the bush; and trips into the work in inclement weather e.g., periods of low visibility, are avoided	ELO/Project Engineer
		Pollution (dust) from soil surface.	Inner Galaxy Steel Company Ltd shall • ensure that there is regular and frequent watering of the work way especially during the dry season.	ELO/Project Engineer

		Secondary development of modern amenities/infrastructures	These are beneficial impact; Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • adopting policies to encourage short-term employees (through periodic briefings or other means as practicable) and save for future needs following their employment; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement policies and practices favouring local merchants and service providers where practicable and when goods and services meeting quality requirements can be provided in a timely manner at competitive prices	ELO/Project Engineer
		Increased demand on existing local infrastructures (road, housing etc) due to influx of workers and job seekers.	Inner Galaxy Steel Company Ltd shall • Embark on community development programmes in line with the desires and needs of the people. • Establishment of base camps for workers with medical facilities.	ELO/Project Engineer

		Influx of predominantly male population) job seekers) into stakeholders communities leading to increased extramarital sexual activity, and introduction of commercial sex workers	Inner Galaxy Steel Company Ltd shall ▪ Maintain regular medical examinations for all staff. ▪ Abstinence/safe sex shall be encouraged ▪ Employment of indigenes shall be encouraged	ELO/Project Engineer
		Potential effects on air quality from emission of pollutants from engines eg bull-dozers and supportequipment .	Inner Galaxy Steel Company Ltd shall: • ensure vehicles, trucks and other heavy duty engines are maintained at optimal working condition in accordance with operating manual; and • encourage the use of mufflers on equipment manifold where necessary to filter particulates and thus reduce its emission into the air. Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	ELO/Project Engineer
		Conflict over employment issues among stakeholders	Inner Galaxy Steel Company Ltd shall • liaise with local CDC, community head and relevant local organizations to work out formula for recruitment from the host communities • be transparent in working out the formula for recruitment	ELO/Project Engineer

		Localised increase in ambient noise levels from operations. This could lead to loss / scare birds and mammals	Noise levels are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	ELO/Project Engineer
Construction PHASE	All construction activities	Creation of job and job opportunities	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	ELO/Project Engineer

		Improvement on the economic status of the stakeholder community due to increased demand for local goods and services	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	ELO/Project Engineer
		Provision of modern amenities/infrastructures	Inner Galaxy Steel Company Ltd shall • embark on community development programmes in line with the desires and needs of the people.	ELO/Project Engineer
		Conflict over employment issues among stakeholders	Inner Galaxy Steel Company Ltd shall • liaise with local CDC, community head and relevant local organizations to work out formula for recruitment from the host communities • be transparent in working out the formula for recruitment	ELO/Project Engineer
		Localised increase in ambient noise levels from operations.	Noise levels are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	ELO/Project Engineer

		Potential effects on air quality from emission of pollutants from engines.	Inner Galaxy Steel Company Ltd shall: • ensure vehicles, trucks and other heavy duty engines are maintained at optimal working condition in accordance with operating manual; and • encourage the use of mufflers on equipment manifold where necessary to filter particulates and thus reduce its emission into the air. Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	ELO/Project Engineer
		Increased demand on existing local infrastructures (housing etc) due to influx of workers and job seekers.	Inner Galaxy Steel Company Ltd shall • Embark on community development programmes in line with the desires and needs of the people. • Establishment of base camps for workers with medical facilities.	ELO/Project Engineer
		Influx of predominantly male population) job seekers) into stakeholders community leading to increased extramarital sexual activity, and introduction of commercial sex workers	Inner Galaxy Steel Company Ltd shall ▪ Maintain regular medical examinations for all staff. ▪ Abstinence/safe sex shall be encouraged ▪ Employment of indigenes shall be encouraged	ELO/Project Engineer

		Work place accidents / incidents duringconstruction activities. This may lead to injury/death of personnel	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	ELO/Project Engineer

		Injury from welding burns	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	ELO/Project Engineer

		Possibility of vision impairment from exposure to light emitted from welding sparks and foreign particles/objects entering the eyes.	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	ELO/Project Engineer

Operational PHASE	Manufacturing of Steel, Hazardous chemical handling/ joint observation for leakages/waste management	Localized increase in the ambient concentration of air pollutants due to chemical fumes	Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	ELO/Project Engineer
		Possibility of injury to skin due to burns resulting from chemicals.	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	ELO/Project Engineer

		Surface water contamination from chemical spills	Inner Galaxy Steel Company Ltd shall develop an appropriate Waste Management Plan before project commencement • As a minimum all operational waste shall be separated at source to enhance efficiency in waste handling and disposal • Also, training on waste management will be conducted for project site personnel	ELO/Project Engineer
		Risk of injury / death of personnel as a of industrial accident	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	ELO/Project Engineer

		Waste generation/discharge (packaging materials/ containers, food wastes/pigging wastes etc) and associated environmental effects.	Inner Galaxy Steel Company Ltd shall develop an appropriate Waste Management Plan before project commencement • As a minimum all operational waste shall be separated at source to enhance efficiency in waste handling and disposal • Also, training on waste management will be conducted for project site personnel .	ELO/Project Engineer
		Possibility of fire explosion	Inner Galaxy Steel Company Ltd shall enforce the principles of safety management	ELO/Project Engineer
		Employment opportunities during operation and maintenace	These are beneficial impact and Inner Galaxy Steel Company Ltd shall seek to enhance them by: • creating requirements for contractors to hire labour from the local area; • encouraging contractors to maintain a list of short-term employees for future call-ups when required; and • adopting procurement practices that favour local merchants and service providers where practicable consultation with the locals shall be carried out in terms of provision of jobs.	ELO/Project Engineer

		Incineration of hazardous waste	Inner Galaxy Steel Company Ltd shall develop an appropriate Waste Management Plan before project commencement • As a minimum all operational waste shall be separated at source to enhance efficiency in waste handling and disposal • Also, training on waste management will be conducted for project site personnel .	ELO/Project Engineer
Demobilization Phase	Demobilization from site	Interference with public utilities (electric wires and poles), market activities along demobilisation route	Inner Galaxy Steel Company Ltd shall: • use standard warning notice (e.g. side rides, signal lights and horn) to other road users; • ensure a practicable journey management programme is developed and adhered to; • carry out pre-mobilisation route survey and ensure that mobilization is carried out after due consultation with relevant authorities and other stakeholders to minimize interference along the route	ELO/Project Engineer

		Release of SO_X, NO_X, CO_X, etc from exhausts which could lead to atmospheric pollution / GHG emission	Inner Galaxy Steel Company Ltd shall: • ensure vehicles, trucks and other heavy duty engines are maintained at optimal working condition in accordance with operating manual; and • encourage the use of mufflers on equipment manifold where necessary to filter particulates and thus reduce its emission into the air. Air emissions are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	ELO/Project Engineer
		Increase noise level in the area due to movement of heavy duty engines	Noise levels increase are expected to be short term and minimal at this stage of the operation *No additional measures are recommended*	ELO/Project Engineer

		Incident/accident resulting from the movement of materials and equipment onlow loader	Inner Galaxy Steel Company Ltd and its contractor shall ensure that • relevant personnel are trained on equipment. • daily HSE briefings/tool box meetings are carried out before commencement of work; • conduct of safety inspections of work equipment prior to mobilization; • equipment maintenance programme is developed and adhered to; • PPE as appropriate to the task (e.g., hard hats, coveralls, shoes, gloves, nose masks) are provided and appropriately used by work personnel; and activities are avoided when lighting is inadequate and as practicable in inclement weather e.g. periods of low visibility.	ELO/Project Engineer
		Increase road traffic accident (RTA)	Inner Galaxy Steel Company Ltd shall • ensure that speed limits are adhere to. • use standard warning notice (e.g. signal lights and horn) to other road users. • ensure a practicable journey management programme is developed and adhered to.	ELO/Project Engineer

		Risks of militant/youths attack leading to personnel injury / death	Inner Galaxy Steel Company Ltdshall • carry out security assessment along mobilization route prior to mobilization • ensure security operatives (navy/mopol/army) accompany mobilization vessel to project site • activate emergency response plan in the event of threat	ELO/Project Engineer
Abandonment PHASE	**Abandonment/Decommissioning**	Return of land to Owners	-	CLO/Project Engineer
		Environmental pollution from corrosion of abandoned structure	♦ All decommissioned metal scraps, pipes etc, shall be recycled . ♦ Inner Galaxy Steel Company Ltd shall re-vegetate the area with indigenous species after decommissioning.	ELO/Project Engineer
		Loss of lives due to accident/incident caused by abandoned structures left at site	♦ Appropriate warning signs shall be used to alert residents of the presence of such machines/equipment	CLO/Project Engineer

7.6.3 Training and Awareness – Site Induction

All Contractor employees and subcontractors involved in the project will be given a comprehensive induction before they start work. This environmental training will take place in conjunction with safety awareness training.

The environmental aspects will include:

- An overview of the Environmental Management Plan, goals and objectives.
- Awareness in relation to the risk, consequences and methods of avoiding noise pollution, oil/diesel spills, disturbance to wildlife and disturbance to fisher-folk on the water ways.
- Awareness of individual environmental responsibilities and environmental constraints to specific jobs.
- Location and sensitivity of the proposed project area.

All personnel who have attended the Environmental Induction will sign a Register which will be kept on the Project Files. Toolbox talks, based on the specific activities being carried out, will be given to personnel by the nominated project representative. These will be based on the specific activities being carried out. These talks will take place either on the appropriate accommodation facility on-site and will include environmental issues particular to the proposed project, namely:

- Oil/diesel spill prevention including safe refueling practice.
- Emergency response procedures used to deal with an oil/diesel spill.
- Minimising disturbance to wildlife such as cetaceans.

During the construction phase of the project, the following environmental awareness and trainings programs shall be conducted:

Induction Briefing: An induction briefing shall be a requirement for every construction worker to be engaged in the project and shall be provided by the contractors.

The briefing shall include:

- the proposed tasks for new workers;
- safe work procedures;
- use of personal protective equipment
- emergency responses and warning notices;
- personal hygiene and site sanitation issues;
- environmental protection ; and
- hazard recognition and incident reporting.

Weekly Safety and Environmental Forum: There shall be a weekly environmental and safety awareness forum for construction workers during the construction activities at the project site. Inner Galaxy Steel Company Limited shall be responsible for coordinating these meetings.

During the operation phase of the project, Inner Galaxy Steel Company Limited shall educate all its workers on environment, health, and safety issues using the following means to disseminate information to staff and workers:

- staff and workers meetings;
- local area network and the internet; and
- annual bulletins on Inner Galaxy Steel Company Limited operations.

7.6.4 Communications/Reporting

Environmental issues will be communicated to the workforce on a regular basis. Daily project meetings, which follow a set agenda incorporating Health, Safety and Environmental issues, will be heldand a daily report will be generated and distributed.

All staff and sub-contractors involved in all phases of the project will be encouraged to report environmental issues.

EPC contractor shall be required to provide monthly reports on environmental and social monitoring and performance. The report shall include compliance status of the mitigation and monitoring requirements of the project EMP as well as other project related regulatory requirements. Inner Galaxy Steel Company Limited shall also develop a system of internal reporting that provides robust internal communication on the full range of environmental and socio-economic issues and monthly assessments of the effectiveness of the management programme.

Environmental Reporting: The contractor will report the status of project environmental activities to Inner Galaxy Steel Company Ltd on a regular basis. These reports will summarize the key environmental issues in the period and identify any non-conformances and the status of corrective actions.

Communication of Initiatives and Project Information: Communication of initiatives and project information will be developed as the project progresses. Typically, these will include campaigns to raise environmental awareness, circulars to inform staff of key environmental issues such as lessons learnt from incidents or accidents and the impact of any new legislation.

Subcontractor Environmental Reporting: All external communications with local interest groups, external agencies and also the response to any complaints will be conducted by Inner Galaxy Steel Company Ltd. Contractors shall notify the onsite Inner Galaxy Steel Company Ltd representative if any communications are received from external stakeholders.

7.6.5 Regulatory Compliance Plan

Majority of the identified impacts would take place during preconstruction and construction phases. Impacts identified for the operation phase are minimal. Mitigation measures for each of the phases have been presented in Chapter 6.

Project-specific compliance requirements such as laws, regulations, permit and approval requirement and conditions, shall be identified and documented in a Regulatory Compliance Plan (RCP). This plan will comprise of a spreadsheet that lists the identified obligations along with responsible persons and timings. It will be approved by the Project manager while the site environmental officers will be responsible for its implementation, monitoring, and reporting.

7.6.6 Environmental Audit and Review

Inner Galaxy Steel Company Ltd shall conduct periodic HSE audits (monthly / quarterly / annually, etc) of the steel-manufacturing factory construction activities in the project area in order to ascertain extent of compliance with policy and regulatory requirements. The audits shall be carried out by certified auditors and in accordance with ISO 14001 guidelines.

The scope of the audits must include the following, as a minimum:

- compliance with all regulatory requirements, codes, standards and procedures;
- examine line management systems, plant operations, monitoring practices etc.;
- identify current and potential environmental problems especially during the operational phase of the project;
- check the predictions in EIA and assure implementations and application of recommended practices and procedures; and
- make recommendation for the improvement of the management system of the operation.

After every audit exercise, the environmental auditor shall produce an Environmental Audit Report (EAR) which shall be submitted to Inner Galaxy Steel Company Ltd for review. Also, as part of audit and review this EMP shall be reviewed annually to determine its adequacy/suitability for continuous use.

7.6.7 Environmental Monitoring Programme

The Federal Ministry of Environment (FMENV) guidelines require an environmental monitoring plan as part of an EIA. The aim of the monitoring programme is to ensure that the negative environmental impacts already identified in this EIA are effectively mitigated in the design, construction, operation and decommissioning stages of the project. It also instils confidence in the host communities, the proponent of the project and regulatory bodies that the identified impacts are adequately mitigated.
Environmental monitoring of this project is therefore advocated in order to ensure that the mitigation processes put in place have adequately taken care of the predicted impacts.

Project activities shall be monitored in order to:
• ensure that the EMP is implemented; and
• assess the efficiency of mitigation actions;
• provide updates where necessary
All contractors shall be required to self-monitor their performance with respect to environmental and social performance. The Inner Galaxy Steel Company Limited HSE Engineer shall also undertake quarterly environmental assessment and random walk throughs and spot checks throughout the project lifecycle. Assessment findings shall be reviewed by the project management team and where corrective actions are necessary, specific plans (with designated responsibility and timing) shall be developed to ensure continuous performance improvement.
In addition to assessing operational aspects and monitoring, assessments shall also consider compliance with agreed objectives and targets, and the effectiveness of the EMP and its implementation. The EMP shall, therefore, be subject to ongoing review and development to ensure that it remains appropriate for all aspects of the project. As is typical with all Federal Ministry of Environment approved projects, the ministry will carry out an assessment before the end of the project to confirm compliance of project activities to the terms and conditions of the EIA approval.

This shall necessitate stable programmes to address the following:

- Alteration to the biological, chemical and physical characteristics of the recipient environment;

- Social and health issues;
- Alterations in the interactions between project activities and environmental sensitivities and interactions between the sensitivities;
- Determination of long term and residual effects; and
- Identification of project specific cumulative environmental effects.

Inner Galaxy Steel Company Ltd shall monitor the proposed steel-manufacturing factory project from mobilisation through operation stages to keep track of the entire project development life cycle. The monitoring plans for the project including the environmental components, parameters and frequency of monitoring as well as responsibilities are presented in Table 7.3.

Table 7.3: Monitoring (Schedule) Plan for the Proposed Projects

Environmental Components	**Indicator Parameters**	**Timeline or Frequency**	**Location**	**Responsibility**
Air Quality	NO_x, SO_x, CO_2, VOCs, Particulate Matter, Noise level	Monthly during construction	Within the site and communities	HSE Department
Surface Water Quality	Nutrient content, Turbidity, TSS pH, BOD, Coliform analysis	Once every month during construction and 3 months after construction	Surface water bodywithin the site	HSE Department
Sediment Quality	pH, THC, Salinity, Heavy metals, etc.	Once every month during construction and 3 months after construction	Surface water bodywithin the location	HSE Department
Hydrobiological Components (plankton, fisheries, benthos)	Diversity and abundance Stress	At the end of construction and then on a one (1) year interval	Surface water within the location	HSE Department

Biodiversity (vegetation/forest resources and wildlife)	Diversity and abundance, Pressure on species	6 months interval from beginning to end of construction	Forests within the location	HSE Department
Socio-economics	Population, Health status, Infrastructure etc	At the project peak and before comissioning	Identified host communities	HSE Department

Monitoring is a tool to ensure adherence to agreed actions, to access compliance to environmental and social standards, to provide enhanced data for risk management purposes and also facilitate any needed project design or operational changes. It provides feedback to the management on what is working and what is not working.

The quality of the environment depends on the quality of environmental components (air, water, soil); thus a study of the parameters of the environmental components will give a good indicator of the condition of the environmental resources. For example, water quality monitoring looks at the parameter-indicators of the water resources component of the environment; thus the need to identify the parameters that define the quality of the environment (air, water, soil, vegetation, etc.), as presented in the table below.

The monitoring plan for the ecological and socio-economic components of the proposed project in Table 7.4.

Table 7.4 MONITORING PLAN ***(Schedule/Programme: during the project lifecycle)***

S/N	Environmental Component	Impact/Aspect	Indicator Parameter	Monitoring method and Location	Timeline/ Frequency	Responsibility
1	Air quality	Air pollution	Gaseous emissions (SO_2, CO_2, NO_2, etc.), SPM	Use of Air-sampling instrument/ Point measurements at the plant area, mine pit, weighing bridge, office etc.	Biannually	Project Manager, HSE Officer/Site Coordinator; Consultant
2	Noise level and Vibration	high level of noise and earth-vibration effects	noise decibels and crack on walls of closest villagers	Use of Noise-monitoring meter at Mine pit and plant area. Nearby structures to be inspected for effects of vibration	Monthly	Project Manager, HSE Officer/Site Coordinator, CLO; Consultant
3	Vegetation Status (Biodiversity) and Wildlife Status	Loss of flora and fauna	Presence or extinct of rare or native vegetation and wildlife	Vegetation (sample) collection by use of 10m by 10m quadrants around the entire project area; and Wildlife Sampling through interview of reputed hunters, and walk through the area to ascertain the presence of animals by sighting and correlation of cries and footprints	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator, CLO; (Community Liaison Officer); Consultant
4	Surface (and ground) water quality	Water pollution	Temp., pH, Turbidity, Nutrients (sulphate, nitrate, etc.), Heavy metals (Fe, Cu, Pb, etc.)	Sample collection (and analysis) from water sources (of closest surface water-body or borehole)	Quarterly	Project Manager, HSE Officer/Site Coordinator; Consultant
5	Soil (and sediment) quality	Soil contamination	Heavy metals in soil, crop productivity	Soil-sample collection/analysis (esp. around fuel storage areas)	3-Yearly Audit	Project Manager, HSE Coordinator, Consultant

6	Socio-cultural	Social-life Impact	Cultural conflicts, norms, social vices, project-perception of community leaders, hospitality of indigenes	Continuous effort of Consultations (at all levels); assessment of land compensation-homage; review of implementation of Community Dev. Agreement in the host community	Monthly	Project Manager, HSE Officer/Site Coordinator, CLO: (Community Liaison Officer)
7	Community health	Health Impact	Common/prevalent diseases in the host communities	Use of questionnaires within the host communities as well as collection of health statistics from clinic and hospitals within the area	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator, CLO; Consultant
8	Demographic pattern	Economic Impact	Accommodation; markets; social infrastructure; industrialization;	Use of questionnaires within the host communities, as well as data-gathering from interviews, observations and consultation	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator, CLO; Consultant
9	Occupational health	Hazard-exposure to workforce	Frequent illness of workforce, workplace accident, medical fitness	Observation, interviews, and the use of Job-Hazard-Analysis report	Every 6 months	Project Manager, HSE Officer/Site Coordinator
10	Environmental nuisance	Aesthetic/Visual impact	Dust-raise, waste littering, effluent discharge, degradation of land formation	Observations and findings during site audit of project operations	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator; Consultant
11	Hydro-biological components (plankton, fisheries, benthos	Marine life impact	Abnormalities of indicators of Water Parameters	Sample collection of closest water source and analysis	3-Yearly Audit	Project Manager, HSE Officer/Site Coordinator; Consultant

7.6.8 Guideline for Waste Management

General

The provision of adequate waste management guideline and disposal facility is vital to the implementation of the proposed project. Waste shall be managed in accordance with Inner Galaxy Steel Company Ltd Waste Management Plan. The principle of waste reduction, recycling, recovery and reusing shall be practiced. All wastes, which cannot be reused, shall be managed and disposed in accordance with Inner Galaxy Steel Company Ltd Waste Management Plan.

Waste shall be managed in accordance with Federal Ministry of Environment guidelines and Inner Galaxy Steel Company Limited waste management procedures. The principle of waste reduction, recycling, recovery and reusing shall be practiced. In addition to the regulations of FMENV, the project will also comply with other national and international environmental standards that are binding on all staff and contractors involved in the proposed project with respect to the following:

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

The EPC contractor is also expected to develop and submit for approval to Inner Galaxy Steel Company Limited a comprehensive waste management plan to be used during the project. This waste management plan shall be in line with Inner Galaxy Steel Company Limited HSE Management System and well as comply with national and international waste management standards.

Inner Galaxy Steel Co. Ltd. recognizes the need for housekeeping hence has developed an effective Waste Management Programme that shall be adopted for the Project. The programme shall form part of the agenda to be discussed in HSE meetings thus creating awareness among personnel.

The main objectives of Inner Galaxy Steel Co. Ltd. Waste Management Plan are:

- Progressive reduction of all waste with the target of having control over all emissions/discharges which have adverse impact on the environment;
- Ensuring that all activity planning address waste management issues for domestic and industrial wastes with the aim of recycling non-hazardous wastes as much as practicable; and
- Ensuring that staff and contractors are responsible for effective management and transportation of waste from source to disposal/recycling facilities.

The basic waste management strategies shall be:

1. **Waste sorting/classification into-**

- Combustible and non-combustible
- Bio-degradable and non-biodegradable
- Toxic
- Reusable and non-reusable
- Recyclable and non-recyclable

2. **Waste disposal forms**

- Incineration
- Treating and discharging
- Landfill
- Composting
- Resale
- Recycled
- Reused as fill and backfilling material

The management shall ensure that this commitment is translated into the necessary resources to develop, operate and maintain an effective Waste Management System.

The HSE co-ordinator shall ensure full implementation of the waste management policy objectives of Inner Galaxy Steel Co. Ltd. by overseeing the day to day handling and disposal of waste generated and shall ensure wastes are appropriately disposed.

The section heads/managers/supervisors are responsible for ensuring that all wastes generated within their units are properly sorted out, weighed, or received before final disposal. They shall ensure that good house-keeping is maintained at all sites. Cleaners shall be responsible for the collection, sorting, weighing and removal of wastes generated to areas where they would be use, recycled or deposited before final disposal.
The waste management plan shall be accomplished through the hierarchical application of the practices of source reduction, waste reuse, recycling, recovery and treatment.

The waste management plan shall be adopted during the various phases (preparation, operation to abandonment) of the project as follows:

Waste Management during Site Preparation

During site development, the top humus soil shall be carefully stripped and transported to erosion areas around the site. The top-soil, together with other lateritic material, shall be compacted on theses erosion sites. This measure is a means of ameliorating environmental hazards and a means of disposal of valuable natural resource.

Waste Management during Operational Phase

Inner Galaxy Steel Co. Ltd. shall be responsible for monitoring, controlling and disposal of all waste generated during operational phase. A waste inventory shall be kept and approved by the General Manager to guarantee data integrity. The sites HSE officer shall ensure that the waste strategies and schemes are fully implemented at the site. He shall collect data for all the departments and operations for the effective management waste.

Waste Management in Abandonment

Abandoned machines and equipment shall be sold as scrap metal or for re-use. Standing buildings shall be carefully disassembled with a view to salvaging reusable materials like doors, windows, metal and aluminium frames, blocks and roofing sheets. Contaminated containers and toxic material shall be collected by Inner Galaxy Steel Co. Ltd. and appropriately disposed of.

Specially, the management of waste to be generated from the proposed development project is articulated in Table 7.5:

7.5 Waste Management Plan

Waste Type	Handling Methods	Frequency of Collection	Responsibility
Metal scraps	Stored, reused or resold	Weekly	Site HSE officer
Paper waste	Collected in bins and incinerated at site	Weekly	Site HSE officer
Clinical waste (scalpers, soaked blood cloth, bandages, syringes, blades	Collected in containers and incinerated at site	Weekly	Site HSE officer
Sewage	Collect in septic tanks if not connected to the grid	Weekly	Site HSE officer
Contaminated soil	Remediated or collection and disposal as appropriate	Weekly	Site HSE officer
Explosives	Collected in boxes and marked explosives, returned to vendor	Weekly	Site HSE officer
Waste oil	Recovered and reused	Weekly	Site HSE officer
Waste plastic	Collected and recycled	Weekly	Site HSE officer
Empty drums	Stored for reuse	Weekly	Site HSE officer
Excavated earth/top soils/ overburden	Heaped for backfilling of erosion sites around the project site	Weekly	Site HSE officer

Some of the waste management options and waste disposal systems that shall be considered for this project are highlighted below:

(a) Solid Waste / Used Containers (Garbage and Inert Materials)

Inner Galaxy Steel Company Ltd shall apply the following principles in handling of general garbage (wood, plastics, paper, and food wastes):

- Segregate components such as wood, plastic and paper, for recycling or reuse.
- Reduce packaging wastes such as paper and plastic by the use of bulk handling systems.
- Dispose all wastes at government designated dump sites.
- Refilling and reusing of containers.

All construction waste shall be collected segregated and transported to a third party contractor management and disposal. No dumping of waste in swamps or rivers shall be permitted.

Fell trees and stumps shall be cut into small pieces and given to the local communities for use as firewood.

(b) Sanitary Waste

Appropriate septic tanks shall be provided. Sewage shall be treated to residual chlorine level of 0.8 – 2.0mg/l before disposal.

7.6.8.1 **Waste Handling Guidelines**

Wastes handling and disposal procedures shall be well defined at source and a waste inventory register kept. The waste contractor shall define, and document appropriately, all wastes generated and transferred in the course of his work.

For proper handling and disposal, wastes shall be well defined at source and the definition transmitted along with the waste to the final disposal points. EPC contractor and Inner Galaxy Steel Company Limited personnel shall define and document all wastes generated during all operational processes.

The general information required, as a minimum, for adequate definition of wastes include:

- Waste stream identification;
- Proper waste categorization;
- Waste segregation;
- Appropriate handling and disposal practice; and

- Recommended Management practices.

7.6.8.2 Waste Minimization Guidelines

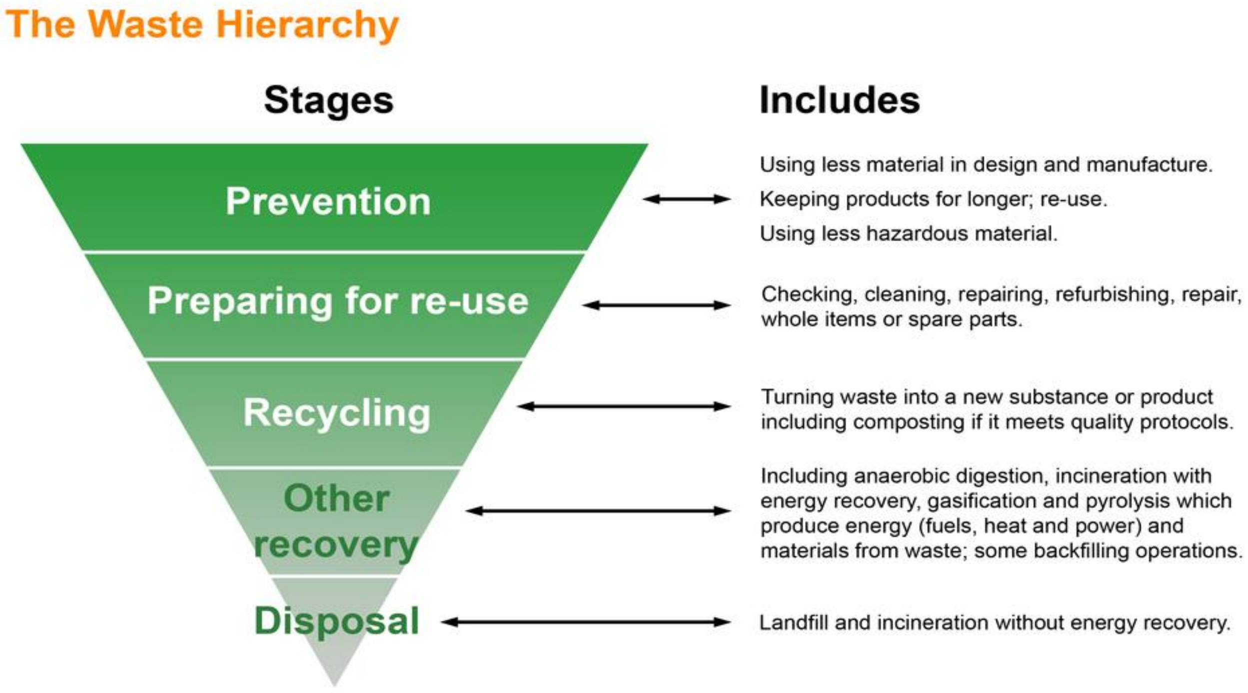
Waste minimisation involves reduction to as low as practicably possible volume or toxicity of waste materials. The four principles of waste minimisation process; **recycle, reduce; reuse and recovery** shall be adopted as applicable, to ensure reduction to the possible extent, of the volume or relative toxicity of liquid or solid wastes. In order to achieve a significant reduction in waste volume during the proposed project, the functions of activity level, age depreciation and maintenance level of facilities and operating equipment would be closely monitored. A large proportion of excavated material shall be used for landscaping or other remedial works on site.

A large proportion of the excavated material shall be used for landscaping or other remedial works on site. All wastes associated with hydrocarbons, oils, hydraulic fluids, oily sump water, etc. shall be treated and channelled to the waste treatment facility.
The key elements of the four waste minimisation/management principles/practices are outlined below.

Table 7.6: Waste Management Strategy

Category	***Definition***
Reduce	• Process modification / design change • Material elimination • Inventory control and management • Material substitution • Improved housekeeping
Reuse	• Chemical/oil containers • Re-use waste heat
Recycle/Recover	• Recycle scrap material • Recycle paper • Burn waste lubricating oil for energy recovery • Recover oil from tank bottoms

Figure 7.2: Waste Hierarchy



7.6.8.3 Waste Segregation Guidelines

All wastes to be generated from the proposed projects shall be segregated at source, into clearly designated bins at strategic locations.

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 (Figure 7.3)

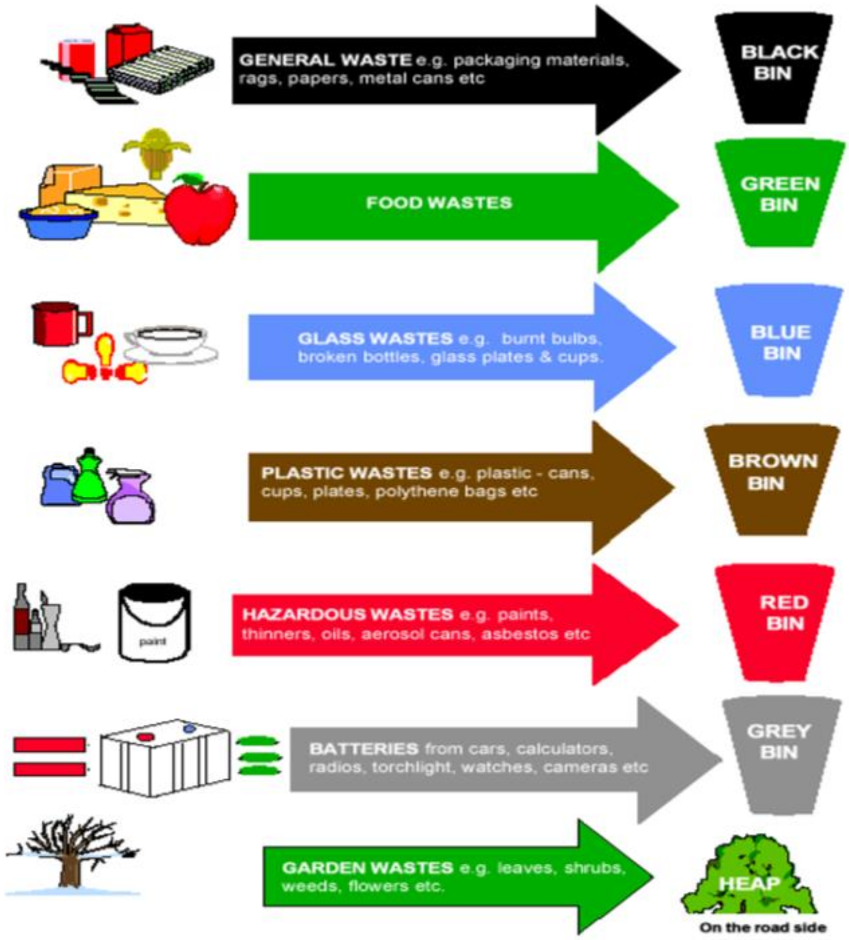


Figure 7.3: Waste Segregation Strategy

7.6.8.4 Wastes Inventory

An inventory of waste generated shall be maintained. Weighing scales or measuring devices shall be provided to measure quantities of waste generated/discharged. Records of waste generated, treated and sent for disposal shall be maintained on site. Wastes to be transferred from rig to offsite facilities for treatment and disposal shall be done in accordance with the Inner Galaxy Steel Company Limited waste transfer process and in line with statutory requirements.

7.6.8.5 Waste Disposal Guidelines

All debris, spoil materials, rubbish and other waste, except excavated soil, shall be cleared regularly from the site and disposed of accordingly at government designated sites for such wastes. Instructions on Material Safety Handling Sheet (MSDS) shall be strictly adhered to and shall form the basis for the disposal of wastes related to such products.

Adequate treatment measures shall be undertaken, where applicable, in line with applicable guidelines, for all waste before final disposal. All wastes in transit shall be tracked by waste consignment note. The waste consignment note records shall be kept and should include as a minimum the following information:

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

Only government approved waste management contractors shall be engaged for the waste categories they are licensed to dispose. Waste management audit of contractors' facilities shall be carried out in consultation with the concerned department of Inner Galaxy Steel Company Limited, and findings shall be properly documented and followed up. Accommodations, catering services and work sites shall maintain acceptable standards of hygiene and good housekeeping.

Sanitation Awareness:

The biggest cause of improper waste management is due to lack of awareness on waste and waste management. The Project will conduct awareness meetings and campaigns through posters or talks to make workers aware of the 4R's: Reduce, Reuse and Recycle and Responsibility

7.6.8.6 **Operational Wastes and Disposal Methods**

Waste shall be managed in accordance with Federal Ministry of Environment and Inner Galaxy Steel Company Limited waste management guidelines and procedures. The EPC contractor will develop a Waste Management Plan to be approved by Inner Galaxy Steel Company Limited and will be responsible for the management of all wastes from cradle to grave using licensed third party waste management contractors and facilities. Detailed inventory of the waste types, sources, and planned management practices during the proposed transmission line project is presented in Table 7.7.

Table 7.7: Waste-Stream Management Guideline for Proposed Steel-Manufacturing/Transmission-Line Construction Project

WASTE /EMISSION	CATEGORY	HAZARD	ORIGIN	DISPOSAL OPTION(S)
Empty drums & aerosol cans (plastic & steel)	Potentially Hazardous (noncombustible)	Dependent of original contents of drum	Packaging of lubricating oil, fuel and corrosion chemicals	• Residue from drums shall be purged and cleaned before reuse (subject to quality assurance). • Return empty gas cylinders to supplier(s) for refilling. • Return drums, barrels, and used containers to vendor or crush at site for recycling
Oil & fuel filter cartridges, waste water filters	Hazardous (combustible)	Potential water and sediment contamination from hydrocarbons	Internal combustion engines, equipment maintenance and repairs	• Collect in properly labelled metal or plastic drums placed at designated strategic locations. • Store in sealed, properly labelled metal or plastic drums placed in a closed container located within the designated hazardous waste storage area for evacuation to incineration sites.
Oily rags & sorbents; used protective clothing (hand gloves, coveralls, shoes, rainwear, etc	Hazardous (combustible)	Potential water & sediment contamination from hydrocarbons	Maintenance & spill clean-up operations, regular work wear	• Where possible, oily rags and protective clothing shall be washed and reused at site. Otherwise, these wastes shall be drained of excess hydrocarbon, packaged separately and contained safely for incineration in approved facilities.
Scrap metal chippings, scrap cables	Non-hazardous (combustible)	Safety risks	Scrapped equipment / engine parts / miscellaneous refuse	• Recycled or re-used. • Non reusable materials shall be stored in the designated

			metal	containers for evacuation and disposal at recycling facilities.
Medical waste (soiled dressings, empty drug containers, used needles & syringes, expired drugs, blood & blood products, cultures and stocks)	Hazardous (combustible)	Potential health risk	Inner Galaxy Steel Company Limited clinics / health centers, site first-aid treatment	• All medical waste shall be packaged separately and safely contained in designated containers for incineration at approved facilities. • Empty drug carton/bottles may be re-used at the clinics subject to quality assurance. • Used syringes/needles, containers for storing blood & its products, and culture/ stocks media shall be autoclaved (sterilised) shall be safely contained in designated containers for incineration at approved facilities • Expired tables/capsules may be cruHSEd/dissolved using hot water before flushing down the drain with expired syrups
Sanitary wastewater	Hazardous (non combustible)	Potential to contaminate water column & sediment	Black waters (urinals, toilet) & gray waters (sinks, showers)	• At camps, treated in sewage treatment plant to regulatory limits with certified equipment before discharge if feasible. Otherwise shall be collected and taken offsite to approved sewage treatment facilities and treated to meet regulatory requirements before discharge offsite.

Diesel fuel spill/leaks	Hazardous (combustible)	Potential to contamination of soil, water bodies & sediment	Fuel storage/transfer lines, leaking pipes, equipments, etc.	• Store in sealed drums for recycling
Contaminated soil affected by spills/leak	Hazardous (combustible)	Potential to to contaminate groundwater	Top soil removed from spill/leak site	• safely contained in sealed designated containers for evacuation to incineration facilities
Domestic waste (empty food containers, food waste, used cooking oils, office wastes, construction)	Non-hazardous (combustible, biodegradable)	Attracts rodent	Accommodation, office, canteen, worksite	• Manually sort plastics and metals for recycling. • Appropriate segregate and contain for evacuation to approved incineration facilities
Batteries: (lead-acid, nickel- cadmium)	Toxic and corrosive	Corrosive adverse environmental, health & safety effects. Lead or heavy metals may cause contamination to surface water/sediment	Warning equipment, portable & emergency electrical tools & electronics, construction & transmission facilities	• Lead-acid and Ni-Cd batteries shall be safely kept at designated storage locations for evacuation to facilities where they will be recycled, incinerated and safely disposed.

Spent lubricants	Hazardous (combustible)	Potential for water, soil, and sediment contamination by hydrocarbons	Engine and rotating equipment, lubricating system, etc	• Collect in properly labelled metal or plastic drums placed at designated strategic locations and sealed to prevent spill during evacuation. To be recycled or incinerated in approved facilities.
Wood scraps, pallets and packaging materials	Hazardous (combustible)	Attracts rodents	Wooden crates, paper cartons/sacks, plastic wrappings, Styrofoam, etc	• Wood pallets/paper cartons shall be returned to the supplier and non reusable one safely contained and evacuated to approved facilities for incineration
Paint & paint-related materials	Hazardous (combustible)	Potential to contaminate soil	Paint cans, spent thinner, epoxides, latex, etc	• Safely contained in designated containers and locations prior to evacuation to approved facilities for recycling or incineration.
Refrigerants (HCFC)	Non-combustion source-emission	Stratospheric ozone depletion, formation of photochemical smog;	Refrigerants & air conditioners	• Safely contain in designated locations for return to manufacturer, or to approved reuse, and recycling facilities

7.6.9 Noise and Vibration Control Guideline

Noise levels shall be established for each noise source and targets. The personnel that shall be affected by any established noise source shall be provided or equipped with appropriate protective or corrective device to ameliorate noise effect.

7.6.10 Vehicle Transport Management Guideline

Inner Galaxy Steel Company Ltd shall ensure effective management of all transport operations and give utmost priority to safe conditions. Inner Galaxy Steel Company Ltd place very high premium on the lives of all our employees hence is committed to manage our land, air and water transport operations in a manner that will minimize and control the associated Health and Safety hazards.

The Vehicle Transport (or transportation) Management Plan for the proposed project is as follows:

Vehicle Pre-Checks: All vehicles for conveyance of personnel as well as equipment at all stages of the project shall be pre0checked by the HSE coordinator and maintenance officer. This is to confirm the road worthiness and fitness for purpose of the vehicles. Also, all contractors shall ensure that their vehicles are pre-checked and confirmed fit for use.

Transport Plan: During movement of Inner Galaxy Steel Co. Ltd. vehicles/trucks, the responsible driver shall produce a Transport Management Plan for approval by the HSE coordinator. The plan shall include the following details: mobilization date; routes, cargo description as well as the details of the Job Hazard Analysis (JHA) conducted for the trip. The HSE coordinator may only approve the trip id he can confirm that all necessary precautions have been made to forestall transport accidents/incidents.
As a minimum, movements of heavy equipment shall be mush as possible be limited to right hours in order to reduce traffic on the roads while speed limits as presented in Table 7.8 below shall be compiled with. Generally, all high way codes shall be abided with at all times.

Table 7.8: Speed Limits on Road (km/h)

Vehicle	*Built-up area*	*Highways*	*Expressways*
Cars	50	80	100
Buses	60	80	90
Trailers	45	50	60

Communication: Communication shall be an integral part of the Transport Management System. The head corporate office as well as the various liaison offices shall be constantly briefed on the status of any trip. This is to keep the management informed on the event of any eventuality.

Consignation: Inner Galaxy Steel Co. Ltd. shall ensure trucks coming into the facility are well parked and in a single file to avoid road traffic. Also, trucks with chippings leaving the facility shall be covered to avoid stones flying on the road.

7.6.11 Consultation and Public Involvement Guideline

Inner Galaxy Steel Company Ltd always endeavours to maintain cordial community relations in its area of operation. For the steel-manufacturing project, the host communities (Ahala Ukwu Village, Umuahala Community, Obuzor Ukwu Autonomous, and Umuacheke, Umuigwe / Umuogogo Community, Isimiri Umuorie Autonomous) shall be consulted with. During the various consultations Inner Galaxy Steel Company Ltd anticipates that the host communities shall use the consultation meetings to familiarise themselves with their operations and also enumerate their interests. The consultation process shall be made functional and regular part of the execution during project life span. Community development packages associated with the proposed project shall always be discussed at the meetings.

Public consultation plays a critical role in raising awareness of a project’s impacts and gaining agreement on management and technical approaches in other to maximize benefits and reduce negative consequences. It can lead to reduce financial risks (from delays, legal disputes and negative publicity0 direct course saving, increase market share (through good public image) and enhance benefits to local communities.

Public involvement in planning and implementing projects can be brought about through consultation and participation. It involves soliciting people's view on the proposed actions and engaging host communities in meaningful discussions in order to further understand their perception of the project and their socio-economic needs; with a view to better provision of the moral duties of Corporate Social Responsibility (CSR). Specially, the consultation was for the following purposes:

- Help improve understanding of the potential impacts of proposed projects;
- Understand the socio-cultural values of the people;
- Help in developing best and most suitable mitigation options;
- Identify community sensitivities and sensitive receptors in the area;
- Help in determining and developing a 'Needs Assessment' for the people;
- Developing a friendly working environment through gaining of trust and transparency perception; and
- Developing a sense of community partnership/ownership of the project.

Inner Galaxy Steel Co. Ltd. shall achieve these objectives through the following Consultation Techniques:

- Holding informal field visits and courtesy calls on the community heads and other stakeholders to discuss the effectiveness of the addressed social issues on the lives of the stakeholder
- Direct contact with the affected population for their opinion (through questionnaire, interviews and visual observations) on the project
- Holding Focus Group Discussion to discuss welfare, clarify misconception and address new issues as regards the project and
- Holding Focus Group Discussion aimed at identifying new ways of rendering socio-economic assistance for the local people.

The consultation shall be by means of discussions in forums, oral interviews and by the use of questioners/checklists.

Strategies for Community Consultation:

For efficient exercises, the measures/welfares to be adopted by Inner Galaxy Steel Co. Ltd. for all consultations shall include:

- To avoid arguments;
- To avoid discussions on community disputes;
- To ensure adequate representatives of all stakeholders;
- To ensure temporary engagement of some community people
- Make the consultation community-focused
- Make the consultation inclusive
- Make it interactive
- Make it clear and as unambiguous as possible
- Make it matter
- Make it open and fair
- Make it subject to evaluation
- Make it as socially diverse as possible

These consultation programme that shall be adopted by Inner Galaxy Steel Co. Ltd. for the project is presented in table 7.9 below.

Table 7.9: Consultation Programme

Body	***Computational Goal***	***Duration***	***Responsibility***
FMEnv	Environmental procedures and standards	Throughout the Project life cycle	HSE co-ordinator
TCN	Electrification procedure and standard	Throughout the Project life cycle	General manager
State Ministry of Environment	Determine stakeholder concern	Throughout the Project life cycle	General manager
Host Communities	Identification of concerns, areas of conflict and formation of appropriate mitigation	Throughout the Project life cycle	CLO/Admin manager

Moreover, Inner Galaxy Steel Company Limited shall welcome suggestions and information from relevant stakeholders, contractors, visitors and the general public, which shall help improve its operations in order to minimise impact on the environment and worker health and safety. The office of the transmission manager shall be open to the general public for complaints and suggestions

Complaints received from the public shall be documented and follow-ups made to ensure that such grievances are addressed accordingly and in line with the Inner Galaxy Steel Company Limited’s grievance redress mechanism.

7.6.12 Health, Safety and Environmental (HSE) Plan

This Plan is intended to provide a system specification and guidance rather than development of another standard. It is aim at minimizing risk and arresting incidences of human health and safety and environmental protection.

The HSE plan shall include:

- Establishment of a site Medical Clinic
- Establishment of an on-site Health and Safety Manager
- Provision of a site Medical Practitioner
- Provision of a standby emergency Evacuation Vehicle
- Provision of site First aid kit
- Placement of directional indicators
- Provision of fire fighting equipment
- Provision of on-site notice/information board
- Provision of site information system

HSE Objectives:

The objectives of Health and Safety Plan are to:

- Ensure compliance with relevant national and international rules and regulations;
- Provide a safe, healthy and conducive working environment for all personnel and nearby community;
- Increase the awareness of all personnel to actively undertake safety measures and precautions to prevent workplace accidents;
- Develop and maintain regular inspections and reporting procedures; and
- Provide accident reporting and documentations of workplace accidents, for proactive and corrective measures of unsafe conditions and unsafe acts

HSE Organizational Structure:

The implementation and co-ordination of Health, Safety (and Environmental) Plan shall be the responsibility of all staff (administrative and operations) members. Reporting structures across Inner Galaxy Steel Co. Ltd. and individual sites and necessary contact arrangements shall be clearly defined for the members, from the Chief Executive to the grounds' man. However, the HSE Manager/Officer shall be in charge of monitoring and control of the plan.

HSE Procedures:

The following procedures shall form part of the risk assessment and control measures employed for the Occupational Health and Safety (OH&S) of the quarry operations, on and off the project site:

1. Inspection and frequency of
   - Vehicles
   - Plants and Machines
   - Work Tools
   - Safety Devices
   - Explosives and Inflammable materials
   - Guarding
   - Electrical lines and devices
   - Pressure vessels
   - Pedestrian Routes
   - Excavations and Tips

2. Controlling Risk from Vehicles:
   - Driver Competence
   - Security
   - Use Restrictions
   - Speed Limits
   - Seat Belts

3. Conditions of Benches and Haul Roads:
   - Width
   - Bends
   - Erosions
   - Traffic Routes
   - Edge Protection

4. Escape and Rescue Facilities
5. Barriers
6. Health and Safety drills
7. Competence and Training Needs

HSE Guidelines:

The HSE Plan shall include the general guidelines of assessment, operation and control. These, among others shall include:

- The Risk Assessment procedure
- Environmental, Ecological and Health-impact Risk Assessment and Management
- The measures taken to control the risks
- The method and procedures of co-ordinating Health and Safety issues
- Management structure and clearly defined responsibilities
- The control plan for explosion risks
- The plan for control and protection against machine and plant accidents
- The plan for the quarry
- Procedures for inspection and maintenance
- Vehicles rules
- Explosives, detonators and fuel rules
- Excavation and tip rules
- Appraisal and assessment of performance

7.6.13 Security Guideline

Security is the absence of danger to life, and property. Inner Galaxy Steel Company Ltd believes that security of its employees, assets and documents are imperative, and a fundamental responsibility in the successful operation of our business.

This guideline implies that:

- All personnel are particularly vigilant about the risk / hazard of anticipated or potential security issues in all intended activities.
- Inner Galaxy Steel Company Ltd shall ensure the security of staff, document and assets are identified, assessed and controlled.
- All reasonable efforts are made to ensure good security in all business operation.
- All staff understands that security of staff, document, assets and material is good business.

7.6.14 Uncertainty and Change Management

Uncertainty in the development of the transmission line project derives from a number of factors including:

- unconfirmed final design features;
- detailed data on geotechnical conditions; and
- unforeseen events.

A key element of ongoing environmental and social management is to address uncertainty through collecting information, additional assessment and, where necessary, the development of further mitigation and management measures.

The process of environmental assessment does not stop with submission of the reports to the authorities, or with government approval. This EMP shall require a mechanism to manage change. Sometimes these changes may be material ones that could influence the original findings of the environmental assessment and hence the basis for its approval. Inner Galaxy Steel Company Limited shall therefore, implement a Change Management System to ensure that changes to the scope of the project, or any new information, are subjected to an assessment process. All changes shall be evaluated for their degree of significance, and incorporated into the appropriate project documentation as follows:

• minor changes shall be reflected in updates to the EMP; and

• substantive changes that might potentially alter the environmental assessment findings (i.e. result in changes to the predicted significance of environmental and socioeconomic impacts) shall be subject to re-assessment, including the possibility of further stakeholder consultation, supplementary reporting and revision of the project's EMP. There shall be a reporting system between Inner Galaxy Steel Company Limited, the government and any other interested and affected parties.

7.6.15 Emergency and Contingency Plan

The implementation and operation of any project is faced with possible hazards irrespective of the good intentions of the operator. Inner Galaxy Steel Company Ltd recognises this fact and has put in place all necessary plans and measures to ensure compliance with standards, codes and specifications, operations and maintenance activities associated with the proposed project. The probable causes of accidents in the execution of this project are equipment failure, run-away reactions, explosion, negligence and sabotage. A contingency plan has been put in place to handle such emergency and accidental situations. Such emergency plans, consistent to identified hazardous conditions of Inner Galaxy Steel Company Ltd would include the following conditions:

- Fire/explosion
- Evacuation
- Serious accidents/fatalities
- Equipment failures
- Infringement of safety zone

The contingency plan would also include:

- The response procedures to the above situations
- Reporting requirements
- Post incident monitoring
- Procedures for personnel briefing exercise and,
- Mechanisms for updating the emergency/contingency plan (if necessary).

7.6.16 Emergency Response Plan

This plan shall describe how Inner Galaxy Steel Co. Ltd. shall identify and respond to potential incidents/accidents and environmental situations as they arise. It shall also outline the factors that shall be needed to be addressed during occurrences.

For the successful achievement of the aims and objectives of this plan, it is vital that divisional heads and management at all levels are integrated and show commitment to the plan.

Training Needs

The Training Needs for all cadres and categories of staff should be assessed with a view to providing same. Staff emergency response training shall be tailored towards:

- Understanding the aims and objectives of the plan
- Awareness of the emergency response plan including procedures
- Identifying emergency situations or what constitutes an emergency
- Familiarity with emergency contact numbers and appropriate respondents
- Ensuring immediate or timely staff response to situations
- Proper documentation

Line of Respondents

First on the Scene: It shall be the responsibility of any person or persons to first sight or identify an emergency situation to alert all workers in the immediate vicinity of the incident and then report to the HSE officer.

HSE Officer: The HSE Officer must be able to identify the type of emergency and determine the hazards posed to human health, safety and/or environment, the likelihood and potential severity of harm and the appropriate emergency procedures applicable to situations; including informing the appropriate response units/persons or management.

Site Medics and Emergency Response Units: Injuries and other health issues that can be treated on site shall be referred to the site medical personnel and incidences like fires and collapsed structures shall be the responsibilities of fire-fighting units (where possible) and engineers.

Hospitals and Relevant Agencies: Serious injuries and health hazards that cannot be treated on site shall be promptly referred to hospitals and relevant agencies like the National Emergency Management Authority (NEMA).

Emergency Response Procedures

'Safety First' shall be the watch word for this plan. In ensuring the health and safety of people on site, the HSE officer shall:

- Determine safe evacuation routes, which shall be well known to all
- Ensure the availability and adequacy of Personnel Protective Equipment (PPE)
- Establish an emergency safe zone away from site
- Provide emergency contact numbers

Tools of Emergency Response

The effective implementation of the plan shall require the provision of some basic tools of operation like:

1. Sign Posts: these are indicators showing routes and places
2. Public Announcement System (PAS): this shall be the instrument of alerting or informing the people of a pending emergency situation. This can be by electronic and information board media.
3. Tele-communication Equipment: this shall be the primary means of communication with the out-side community. This can be a mobile phone or fixed line.
4. Emergency Vehicles: these include ambulances and evacuation vehicles

Rescue Equipment: these are equipment that may be needed in the event that rescue operations are required. This equipment shall include ropes, ladders, diggers, shovels, torch lights etc.

Accordingly, in order to safe guard the lives of personnel and contractors during emergency situation, EPC contractor shall develop and implement an emergency response plan in addition to the following:

- Emergency training shall be conducted by the HSE Manager to enhance workers preparedness to respond appropriately to emergencies.

- Emergency drill shall be conducted periodically and such drill shall include fire, oil spill, abandon as well as first aid emergencies.
- Response time and roll call shall be monitored and recorded by the HSE Manager, supervisor or fire warden as required, at each drill/training to ensure compliance.
- All drills and training exercise shall be documented by the HSE Manager or the supervisor and copies sent to Inner Galaxy Steel Company Limited.
- In situations where evacuation of personnel is necessary as a result of fire or any other related accidents, Inner Galaxy Steel Company Limited shall follow the emergency medical evacuation procedure with responsible parties.

Table 7.10: Personnel Responsibilities during Emergency Evacuation

Action Party	Responsibility
Personnel at scene of incident	• Maintain calmness and alert people around • Contact site nurse or first aider/supervisor/safety officer • Begin mustering action
Medical personnel on site	• Arrange and administer first aid for sick/injured
Site supervisor/safety officer	• Contact project engineer / safety manager and report the following; • precise location and time of incidence; • site condition • patient(s)/injured or casualty; and • other pertinent information
Site Supervisor	• Arrange for medical evacuation after due consultation with management
HSE Manager	• To liaise with management to arrange for medical evacuation • Furnish management with available particulars/report about the emergency as provided by the site supervisor/safety officer • Conclude medical evacuation by ensuring the casualty is transferred from the first aid clinic (after a life saving treatment) to Inner Galaxy Steel Company Limited’s retainer clinic.

Fire Prevention/Contingency Plan-

The overall goal of the fire prevention system shall be to:

- continuously monitor all areas of the installation where either a fire hazard may exist or an accumulation of flammable gas may occur;
- alert personnel at the location of the presence, location and nature of the fire or emergency;
- automatically activate fixed fire protection systems, and
- reduce the risk to personnel by implementing executive automated systems.
- Ensure that all personnel are safely evacuated

Fire detectors (smoke, heat, flame, gas, etc) shall be installed at appropriate areas. The fire shall be detected by the quickest, most reliable means.

7.6.17 Capacity Assessments

Capacity assessment and development process for those to be charged with managing the mitigation measures and grievance procedures is usually a cyclical process. Such a cycle will comprise several steps, from recognition of capacity deficiencies/efficiencies to the implementation of capacity development initiatives.

Approval of personnel will depend on their proven experiences and capability to manage the recommended measures. Those whose capabilities are determined to meet the requirement will be approved for engagement in the project but those whose experiences and skill are determined to be insufficient will not be approved.

The implication is that the EPC may retain and engage their services if it so wishes but they will not be engaged for this project.

EPC deliverables will include engagement of sufficient and skilled personnel for key project areas, especially in the HSE and socio economic sections to ensure effective implementation of the project impacts mitigation and monitoring measures. The Project and EPC's Environmental Management Plan will specify the roles and responsibilities of those charged with HSE duties, especially for those responsible for implementing the mitigation and monitoring measures. The EMP will also include training programs for such personnel in order to enhance their capabilities and performance.

The project specific plans to be developed by the EPC such as the Environmental Management Plan, Waste Management Plan, Regulatory Compliance Plan, Socioeconomic/Community Relations and Engagement Plan, and Spill Response Plan will be submitted to Inner Galaxy Steel Company Limited project management team for review and approval prior to implementation. This will ensure that the key elements are captured in the plans. It will also ensure well-coordinated execution of project activities as well as confirm harmonized implementation of EPC's documented strategies, in accordance with the terms and conditions of the approved project EIA.

Inner Galaxy Steel Company Limited Human Resource Department shall be responsible for capacity assessment of EPC personnel responsible for the management and monitoring of impacts mitigation measures as documented in this EMP and as regularly updated to cover for the project life span. Capacity assessments and other trainings as well as competency certification and validations of personnel shall progress from before the commencement of the project, through construction and operation phases. Assessment shall also form part of the auditing/training program to be developed by the project.

In addition to overseeing the implementation of the mitigation and monitoring measures, Inner Galaxy Steel Company Limited will also be responsible for operation of the grievance procedures. In order to assure the competency of Inner Galaxy Steel Company Limited personnel charged with the above responsibilities, experienced personnel will be engaged for the execution of the project. Capacities of personnel assigned to the project will be assessed prior to their involvement in the project and appropriate trainings provided to cover identified capacity gaps. Inner Galaxy Steel Company Limited shall engage reputable consultancy firms to provide such capacity enhancement trainings and certifications.

Federal Ministry of Environment (FMEnv) will be responsible for the regulatory monitoring of the implementation of the project EIA approved mitigation and monitoring measures. The Ministry assigns personnel with proven competencies to such tasks.

7.6.18 Proposed Social Action Plan (SAP)

This is essentially concerned with the Socio-Economic Conditions of the host communities. SAP outlines measures designed to mitigate/ameliorate the identified adverse social impacts (as has been detailed in Chapter 5 of this project report).

The following measures (actions) are proposed as Social Management Plan:

i. In order to stem population growth due to immigration, Inner Galaxy Steel Company Ltd shall recruit and train locals/indigenes for the project employment.
ii. In order to minimize the depletion of the farming population and agricultural production, Inner Galaxy Steel Company Ltd shall meet with farmers or farmers' groups, to assist with agricultural extension services.
iii. In order to ease pressure on local infrastructure, the above points (i & ii) shall be implemented, in addition to expand, improve or provide needed infrastructure.
iv. In order to minimize disruption of means of livelihood, Inner Galaxy Steel Company Ltd shall relocate farms and farmers where necessary, or/and pay compensation where necessary.
v. In order to minimize deforestation due to demand for fuelwood, Inner Galaxy Steel Company Ltd shall take action on the above points i & ii.
vi. In order to reduce the potential for social crimes/youth restiveness, Inner Galaxy Steel Company Ltd shall provide employment opportunities, meet with social groups, promote public enlightenment and cultivate good community relations.

The Health Risk associated with the proposed project will be alleviated if the suggested health management plan (tabled below) are implemented.

Table 7.11: Recommended health intervention activities and performance indicators

Health intervention	Performance indicators	Time frame	Responsibility
Health education	Number of community-based Health Education Activities carried out	Quarterly	Inner Galaxy Steel Company Ltd
Provision of safe water	Number of communities with functional potable water supply system	Quarterly	Inner Galaxy Steel Company Ltd
Provision of sanitary facilities	Number of sanitary facilities per community	Quarterly	Inner Galaxy Steel Company Ltd
Strengthen Health Management Information System	Number of communities with functional Health Management Information	Quarterly	Inner Galaxy Steel Company Ltd

	System		
Train and equip Village Health Workers and Traditional Birth Attendants	Number of communities with functional Village Health Workers and Traditional Birth Attendants	Quarterly	Inner Galaxy Steel Company Ltd
Sustain and strengthen immunization services	Polio vaccine coberage	Quarterly	Inner Galaxy Steel Company Ltd

7.6.19 Decommissioning and Abandonment Plan

The design of the transmission line facilities (tower, conductors, substation, etc) shall take due recognition of the need for decommissioning at the end of project operational life (50years). However, in Nigeria, transmission lines are designed to last more than the set operational life and as such appraisals will be conducted periodically in line with international and Inner Galaxy Steel Company Limited standards to assess the condition of the transmission line prior to revalidation or decommissioning.

Inner Galaxy Steel Company Limited shall set up strategies to checkmate project abandonment. In the unfortunate event of abandonment, a project abandonment plan shall be prepared in line with applicable national and international legislative requirements, in addition to implementing measures to mitigate the impact of such abandonment. The design of the facilities shall take due recognition of the need to decommission any ancillary facilities at the end of their operational life.

Temporary structures (camp, storage yard, site offices, etc.) installed at the construction phase to support construction activities shall be cleared and cleaned and safely disposed or reuse.

Decommissioning would involve removal of all site facilities that are no longer relevant for the operation of the project which may pose some degree of safety hazards to the general public and personnel with the base. The hazards and safety risks posed by the abandoned facilities shall have long-term effect. However, decommissioning shall make the acquired equipment/material available for alternative uses.

Consequently, the following measures are to be ensured during the decommissioning aspect of the project;

- Inner Galaxy Steel Company Ltd shall develop a detailed abandonment programme, which shall address the use and management of the equipment/materials after decommissioning and abandonment.
- Facilities that cannot be removed from site shall be clearly marked as danger zone to warn people.
- Inner Galaxy Steel Company Ltd shall ensure the decommissioning and abandonment are done with the same care and respect for the environment with the project was designed, constructed and operated.
- Assement of the residual impacts that the project has had on the environment during its lifespan
- Restoring the environment to original condition; e.g. for every tree (>60cm girth) cut down as a result of construction, at least one tree will be planted in replacement.

CHAPTER EIGHT
CONCLUSIONS

Inner Galaxy Steel Company Ltd has carried out the Environmental Impact Assessment (EIA) of the proposed 1.3km 132kV Transmission Line, coupled with supplementary proposed establishment of Steel-manufacturing Factory project, at Ukwa-west Local Government Area of Abia State, South-East Nigeria.

This was carried in order to predict the impact of the proposed project activities on the various biophysical and socio-economic components of the project environment and host communities and also to proffer adequate mitigation and enhancement measures for adverse and beneficial impacts respectively. The overall goal of the EIA is to ensure that potential environmental and social impacts of the proposed project are identified and evaluated and adequate mitigation measures proffered for significant impacts.

Extensive literature review and field sampling and measurements/testing were used to carefully establish and assess the status and sensitivities of the various ecological and socio-economic components of the project area.

Data acquisition from terrestrial, aquatic and socio-economic environment as well as the assessment of the sensitivities of the various biophysical and socio-economic parameters involved a multi disciplinary approach. Consultations with the host communities (Ahala Ukwu Village, Umuahala Community, Obuzor Ukwu Autonomous, and Umuacheke, Umuigwe / Umuogogo Community, Isimiri Umuorie Autonomous), local government authority and officers as well as regulatory authorities are ongoing and shall continue throughout the project life cycle.

The potential and associated impacts assessment of the proposed development indicated that the project would beneficially and significantly impact on national energy and power transmission and the overall economic and social benefits accruable from power supply to the Nigerian people. It would also result in provision of direct and indirect employment opportunities as well as skill acquisition for Nigerians.

The adverse impacts of the project may result from injury due to operational accidents/incidents, health condition for onsite personnel due to exposure to communicable diseases and increased noise and emissions. Perturbation of surface water and aquatic fauna and flora resulting from disturbances to nearby aquatic ecosystems due to oil leaks, wastes and other associated sources during construction. However, majority of these adverse impacts are temporal, and mitigation measures have been recommended for both short- and long-term to reduce the adverse impacts to negligible limits.

The impacts assessment of the proposed development project shows that it will impact positively on the national economy as well as the revenue base of Inner Galaxy Steel Company Ltd and its joint venture partners, contribute to socio-economic development within the host communities and result in economic empowerment for the indigenes and residents as well as other professionals. These would be by way of increased financial benefits, skilled and semi skilled employment opportunities, award of contracts for supplies and services among others.

The adverse impact of the proposed project on water, land use, vegetation wildlife air, socio-economics and health are localized and can be controlled and ameliorated if the recommended measures are strictly followed.

Consequently, the EMP was developed to ensure effective implementation of prescribed mitigation measures and for proactive environmental management from project inception to conclusion. Implementation of these measures will ensure a successful execution of Transmission Line project in an environmentally safe and sustainable manner.

Considering the workable proffered mitigation measures for adverse impact, the benefits of the proposed project outweighs the negative impacts. In view of the foregoing, Inner Galaxy Steel Company Ltd requests that the proposed project be approved for implementation.

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